MINERALS YEARBOOK OF POLAND
2013

TO CONTENT

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PREFACE

The ***Minerals Yearbook of Poland 2013*** is a unique publication, which reviews mineral commodities production and utilisation in Poland. It has been compiled annually since 1996. The current 17th edition is for the second time performed as a task of the Polish Geological Survey according to a plan accepted by the Minister of the Environment. The Polish Geological Institute-National Research Institute (PGI-NRI) fulfils the role of the Polish Geological Survey according to art. 163 of the Geological and Mining Law. Therefore, PGI-NRI took supervised preparation of the publication and approved its final version, while calculations and content were prepared by authors from the Department of Mineral Policy of the Mineral and Energy Economy Research Institute at the Polish Academy of Sciences in Cracow. Similarly to its Polish version, the publication is financed by the National Fund for Environmental Protection and Water Management.

The current edition of the ***Minerals Yearbook of Poland***, like previous publications, contains information on more than 100 mineral commodities. There is a systematic review of statistical data presented for 2009-2013. Data is organised according to European standards – the obligatory Polish Classification of Goods and Services (PKWiU) and Combined Nomenclature (CN). Particular chapters contain information on mineral commodities management such as mineral commodities use, the domestic resources base, perspectives for resources development, current domestic demand and its forecast for coming years. Detailed trade statistics are also presented. ***The Minerals Yearbook of Poland 2013*** constitutes supportive material for Polish mineral policy. Therefore, it is intended for use by Ministries, government agencies as well as public and scientific institutions. On an international basis, it is sent to embassies, chambers of commerce and foreign geological surveys.

The ***Yearbook*** has also been issued in electronic form and placed on the PGI-NRI website http://geoportal.pgi.gov.pl/surowce/.

Warsaw, December 2014

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FOREWORD

The 17th edition of the ***Minerals Yearbook of Poland*** presents data on the economy of over 100 major mineral commodities in Poland in the years 2009–2013. The arrangement of the yearbook has remained basically the same as in the previous editions. The book provides a comprehensive review of the domestic supply and demand for mineral commodities, supported by numerous statistics. The important players in the mineral industries are also profiled and listed at the end of each chapter. As far as possible, the balances for the individual commodity and derivative products in Poland for the years 2009–2013 have continued to be provided. Volumes and values of minerals' foreign trade are supplemented by the trade unit values. Where it is possible, unit values of domestic production are also provided. Relevant issues affecting the mineral industry, as well as future investment and production developments have been also discussed. Introductory chapter, reviewing basic aspects of mineral commodities management in Poland in 2013 and previous four years, was supplemented by summary tables and figures.

The authors would like to thank the Department of Information Services at the Central Statistical Office (GUS), as well as the Department of Mineral Resources and Mining Areas Information at the Polish Geological Institute – National Research Institute, for their assistance in collecting statistical information for this issue of the ***Minerals Yearbook of Poland***. We are also grateful to numerous domestic mineral producers and their associations for their cooperation, which enabled us to improve our work on domestic production statistics.

Authors and Editors

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MINERAL COMMODITIES MANAGEMENT IN POLAND IN 2013

Overall Performance

In 2013, growth of Gross National Product was +1.6% in relation to the preceding year (in 2012 it was +1.9%). GDP amounted to 1,620 billion PLN (ca. 388 billion EUR). Inflation rate was distinctly lower than in 2012: 0.9% (Fig. 1). The rate of official unemployment remained at 13.4%. The Polish currency — zloty (PLN), was slightly appreciated in relation to Euro, i.e. to 4.18/1.00, and visibly appreciated versus US dollar, to 3.15/1.00 (annual average rate).

Mineral Commodities Balances

The term **mineral commodity** covers all varieties of commodities, obtained from different mineral sources in specific processes, involving all stages of production, from run of the mine to final products. Such a conception has been incorporated in the hereby **Minerals Yearbook of Poland**. This is also utilized as a tool for analysis of the mineral management in Poland, specifying the varieties and assortment of each commodity, the vertical structure governing how they are obtained, and the relationships between the domestic and international markets.

The balances of mineral commodities constitute a basis for management policy in terms both of the domestic demand and production, and foreign trade. Considering several annual mineral commodity balances it is possible to establish the tendencies in production, importation, exportation, and consumption, and the most important factors causing their fluctuations.

Mineral Commodities Production

The production of mineral commodities in Poland in the years 2009–2013 is presented according to the **Polish Classification of Goods and Services** (**PKWiU 2008**), based on the European classification **Nomenclatures des Activités de Communauté Européane** (**NACE**) in force since 1997. The production statistics have been supplied mainly by the **Department of Information Services** of the **Central Statistical Office** (**GUS**) and supplemented by producers.

Poland is a significant producer of hard coal and lignite, copper, silver, zinc and lead, as well as many industrial minerals, such as rock salt, sulfur, limestone, cement, lime,

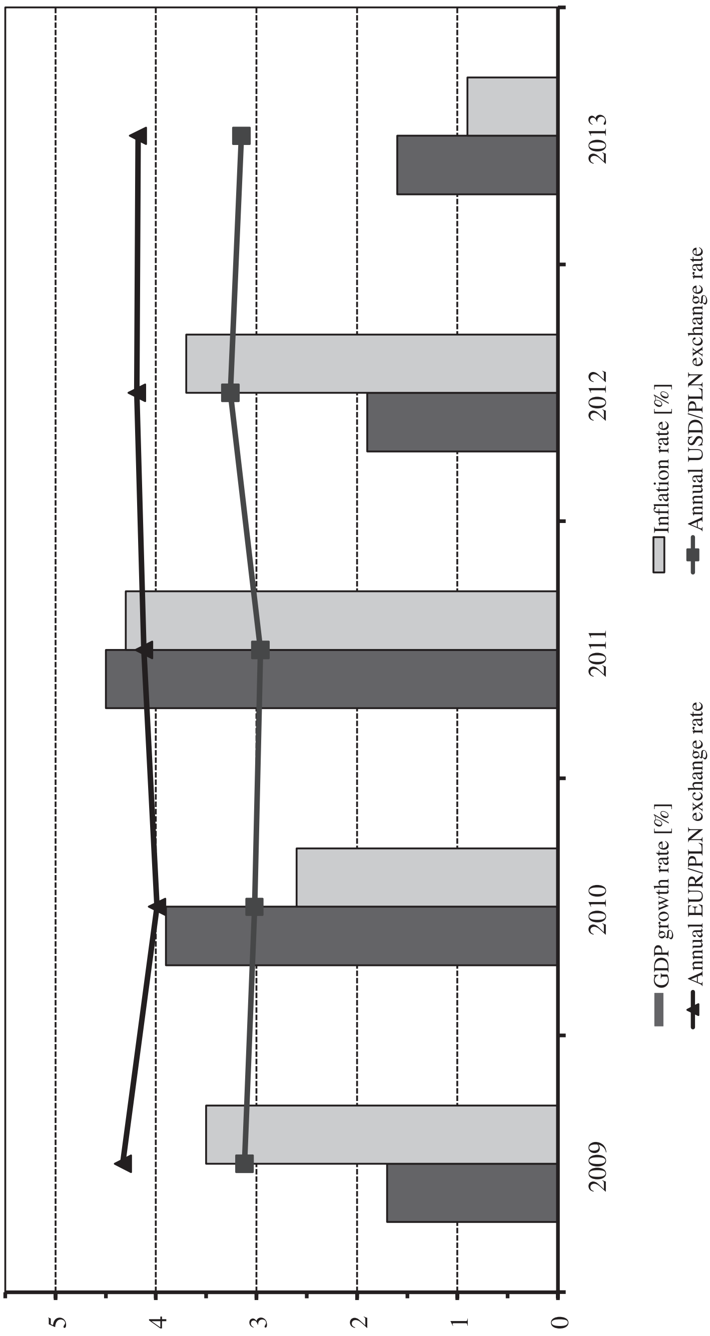
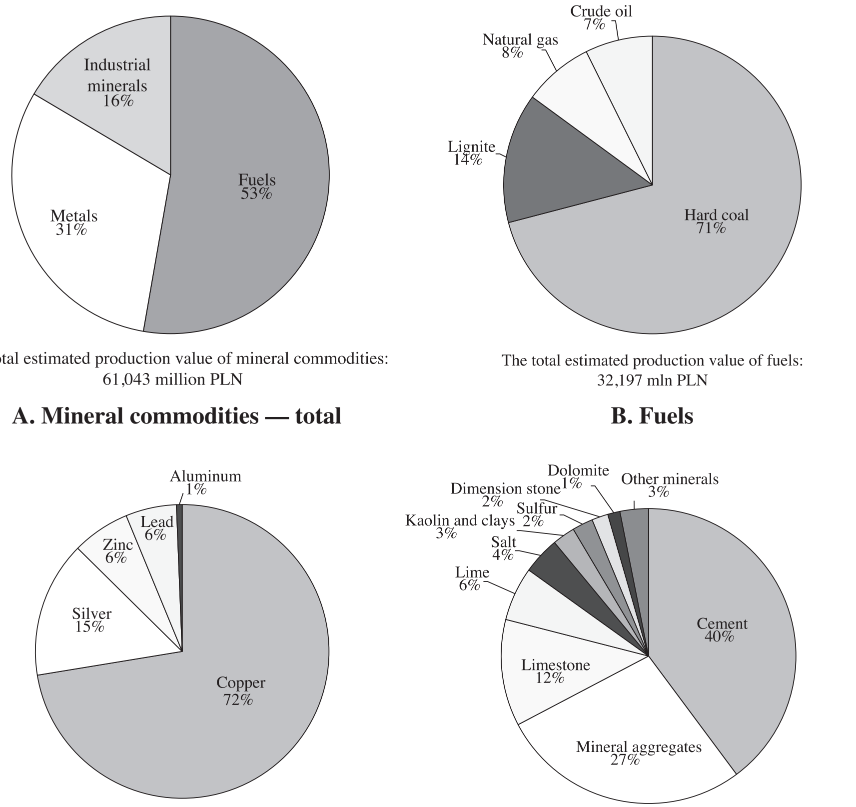


Fig. 1. Evaluation of GDP growth rate and inflation rate in Poland and exchange rates of PLN/EUR and PLN/USD in the years 2009–2013

gypsum, mineral aggregates. In 2013, the total value of the domestic mineral production was estimated at 61.0 billion PLN, with 53% share of fuels, 31% share of metallic raw materials, and 16% share of industrial and construction minerals (Fig. 2). Total value of fuels production amounted to ca. 32.2 billion PLN, 71% of which was the value of hard coal production. Total value of metallic raw materials production amounted to ca. 18.8 billion PLN, 72% of which accounted for the production of copper. Total value of industrial and construction minerals was estimated at ca. 10.1 billion PLN, with 40% share of cement and 27% share of mineral aggregates (Fig. 2). High values were also recorded for lignite, natural gas, crude oil, silver, zinc, lead, limestone and lime (Tab. 1).



The total estimated production value of mineral commodities: 61,043 million PLN

A. Mineral commodities — total

The total estimated production value of fuels: 32,197 mln PLN

B. Fuels

The total estimated production value of metals: 18,783 mln PLN

C. Metals

The total estimated production value of industrial minerals: 10,063 mln PLN

D. Industrial and Construction Minerals

Fig. 2. Estimated value of the production of mineral commodities in Poland in 2013

Tab. 1. Value of the production of mineral commodities in Poland in 2009-2013

Mineral commodity	2009		2010		2011		2012		2013	
	Value million PLN	Share %	Value million PLN	Share %	Value million PLN	Share %	Value million PLN	Share %	Value million PLN	Share %
Fuels										
Hard coal	21,411	40.9	22,336	37.4	25,980	36.3	26,973	37.3	22,838	37.4
Lignite	3,261	6.2	3,476	5.8	4,275	6.0	4,488	6.2	4,549	7.5
Natural gas	2,540	4.8	2,468	4.1	2,542	3.6	2,523	3.5	2,450	4.0
Crude oil	896	1.7	1,162	1.9	1,410	2.0	1,774	2.5	2,360	3.9
Metals										
Copper	8,816	16.8	14,239	23.9	14,080	19.7	14,234	19.7	13,601	22.3
Silver	1,732	3.3	2,447	4.1	6,736	9.4	7,100	9.8	2,815	4.6
Zinc	811	1.5	943	1.6	1,080	1.5	1,081	1.5	1,197	2.0
Lead	736	1.4	841	1.4	1,267	1.8	1,233	1.7	1,052	1.7
Aluminum	107	0.2	149	0.3	125	0.2	145	0.2	118	0.2
Industrial minerals										
Cement	4,519	8.6	4,201	7.0	5,148	7.2	4,335	6.0	4,007	6.6
Mineral aggregates	3,488	6.7	2,772	4.6	5,126	7.2	3,565	4.9	2,765	4.5
Limestone	1,073	2.0	1,157	1.9	1,382	1.9	1,352	1.9	1,177	1.9
Lime	529	1.0	552	0.9	607	0.8	513	0.7	595	1.0
Kaolin and clays	325	0.6	619	1.0	201	0.3	205	0.3	250	0.4
Salt	317	0.6	384	0.6	367	0.5	313	0.4	411	0.7
Stone, dimension	233	0.4	267	0.4	222	0.3	188	0.3	180	0.3
Sulfur	746	1.4	155	0.3	258	0.4	418	0.6	229	0.4
Dolomite	150	0.3	142	0.2	152	0.2	167	0.2	135	0.2
Gypsum and anhydrite	58	0.1	58	0.1	62	0.1	64	0.1	44	0.1
Other minerals	660	1.5	1,296	2.2	501	0.9	509	0.7	270	0.3
TOTAL	**52,408**	**100.0**	**59,664**	**100.0**	**71,580**	**100.0**	**72,280**	**100.0**	**61,043**	**100.0**

Tab. 2. Production of selected mineral commodities in Poland

Mineral	Unit	2009	2010	2011	2012	2013	Change 2013/2012 [%]
FUELS							
• Coke	'000 t	7,091	9,738	9,377	8,893	9,360	+5
• Gas, coke-oven	million m^3	3,076	4,239	4,055	3,878	3,900	+1
• Gas, natural, high-methane	million m^3	2,047	2,010	2,025	2,016	1,849	-8
• Gas, natural, nitrified	million m^3	3,511	3,753	3,896	3,855	3,941	+2
• Hard coal	'000 t	78,064	76,728	76,448	79,855	77,056	-4
• Lignite	'000 t	57,108	56,510	62,841	64,280	65,849	+2
• Oil, crude	'000 t	687	687	617	680	961	+41
METALS							
• Aluminum, metal	'000 t	17	16	14	11	16	+45
• Cadmium, metal	t	534	451	526	370	460	+24
• Copper concentrates	'000 t Cu	439	425	427	427	429	0
• Copper, metal	'000 t	503	547	571	566	565	0
• Ferroalloys	'000 t	16	54	74	81	84	+4
— ferrochromium and other ferroalloys	'000 t	4	0	-	-	10	X
— ferromanganese	'000 t	2	1	1	1	0	-100
— ferrosilicomanganese	'000 t	0[r]	0	0	0	0	X
— ferrosilicon	'000 t	10	53	73	79	74	-6
• Gold, metal	kg	814	776	704	916	1,066	+16
• Lead concentrates	'000 t Pb	37	23	18	17	16	-6
• Lead, metal	'000 t	100	120[r]	136	141	145	+3
• Pig iron	'000 t	3,095	3,638	3,975	3,944	4,014	+2
• Platinum group metals	kg	95	156	7,569	265	57	-79

• Rhenium perrhenate	t	4	4	4	4	4	0
• Selenium	t	73	79	85	90	80	-11
• Silver, content in Cu concentrates	t Ag	1,207	1,183	1,667	1,149	1,200	+4
• Silver, metal	t	1,221	1,175	1,278	1,292	1,197	-7
• Steel, crude	‘000 t	7,128	7,996	8,777	8,539	8,199	-4
• Tin, metal	t	696	893	858	1,299	1,716	+32
• Zinc concentrates	‘000 t Zn	116	92	87	77	77	0
• Zinc, metal	‘000 t	139	135	144	138	146	+6
INDUSTRIAL MINERALS							
• Aggregates, sand&gravel	‘000 t	131,075[r]	149,237[r]	238,145[r]	177,408[r]	166,280	-6
• Aggregates, crushed	‘000 t	57,903	62,433	88,697	64,860	57,945	-11
• Aggregates, artificial[e]	‘000 t	7,400	7,100	7,600	5,300	4,400	-17
• Aggregates, lightweight[e]	‘000 t	210	500	800	700[r]	700	0
• Amber	t	NA	NA	NA	NA	NA	X
• Ammonia	‘000 t	1,958	2,060	2,326	2,526	2,482	-2
• Argon	million m^3	16	30	187	44	41	-7
• Asphalts	‘000 t	1,568	1,567	1,787	1,550	1,451	-6
• Bentonite, raw	‘000 t	3	2	1	1	1	0
• Bentonite, processed	‘000 t	81	86	114	102	102	0
• Carbon black	‘000 t	28	35	45	11	32	+190
• Cement clinker	‘000 t	10,659	11,768	13,629	11,807	10,855	-8
• Cement	‘000 t	15,537	15,812	18,993	15,919	14,831	-7
• Chalk and related materials	‘000 t	677	500	614	742	782	+5
• Chlorine	‘000 t	333	279	283	299	268	-10
• Clays for building ceramics	‘000 m^3	2,640	2,157	2,309	1,835	1,518	-17
• Clays, refractory (raw)	‘000 t	115	82	136	119	118	-1
• Clays, stoneware	‘000 t	646	721	1,291	737	513	-30
• Clays, white-burning	‘000 t	42	70	48	35	35	0

•	Diatomite and related materials	‘000 t	1	1	1	1	1	0
•	Dolomite, raw	‘000 t	1,750	1,727	1,795	1,763	1,865	+6
•	Dolomite, dead-burned	‘000 t	84	94	85	67	51	-24
•	Feldspar raw materials	‘000 t	478	485	539	487	513	+5
•	Gypsum and anhydrite, natural	‘000 t	1,277	1,179	1,226	1,228	1,085	-12
•	Gypsum, synthetic	‘000 t	2,076	2,389	2,505[r]	2,572[r]	2,768	+8
•	Helium	million m^3	2.6	3.3	3.4	3.3	3.0	-9
•	Iron oxide pigments	‘000 t	4	6	6	6	6	0
•	Kaolin, washed	‘000 t	136	125	164	138	166	+20
•	Limestone rock and marl for cement production (mining production)	‘000 t	20,278	22,431	27,303	24,322	22,268	-8
•	Limestone rock for lime production (mining production)	‘000 t	14,881	17,588	21,703	16,728	16,812	+1
•	Limestone, industrial	‘000 t	29,821	33,235	40,977	38,211	35,353	-8
•	Limestone, lake	‘000 t	45	17	16	16	28	+75
•	Lime	‘000 t	1,716	1,799	2,036	1,799	1,710	-5
•	Magnesite, raw	‘000 t	47	63	75	84	97	+15
•	Nitric acid	‘000 t	2,139	2,209	2,168	2,322	2,280	-2
•	Nitrogen	million m^3	1,047	985	2,021	1,596	1,606	+1
•	Nitrogen fertilizers	‘000 t	4,472	4,709	4,986	5,455	5,407	-1
•	Oxygen	‘000 t	1,939	1,979	2,264	2,340	2,228	-5
•	Peat	‘000 t	620	672	746	759	818	+8
•	Phosphoric acid	‘000 t P_2O_5	141	293	320	271	224	-17
•	Phosphate fertilizers[1]	‘000 t	50	104	115	110	97	-12
•	Potassium salts	‘000 t	2	3	0	0	0	
•	Quartz	‘000 t	5	5	6	5	6	+20
•	Quartzite, industrial	‘000 t	20	34	47	53	88	+66
•	Salt, rock	‘000 t	999	1,236	1,254	793	1,321	+67

•	Salt in brine	‘000 t NaCl	2,533	2,464	2,633	2,732	2,736	0
•	Sand for cellular concrete (mining production)	‘000 m^3	322	397	414	355	334	-6
•	Sand for lime-sand products (mining production)	‘000 m^3	560	615	780	731	519	-29
•	Sand, filling	‘000 t	5,928	5,090	4,405	3,762	3,649	-3
•	Sand, foundry	‘000 t	720	920	980	950	930	-2
•	Sand, glass	‘000 t	1,800	2,111	2,282	2,212	2,354	+6
•	Schist, mica	‘000 t	3	3	5	3	3	-40
•	Schist, phyllite	‘000 t	24	57	157	190	143	-25
•	Schist, quartz	‘000 t	1	1	1	1	1	0
•	Soda, calcined	‘000 t	893	1,020	1,071	1,126	1,055	-6
•	Soda, caustic	‘000 t	888	610	828	875	908	+4
•	Stone, dimension	‘000 t	3,836	4,598	6,223	4,118	3,913	-5
•	Sulfur, elemental	‘000 t	479	769	918	963	835	-13
•	Sulfuric acid	‘000 t	1,515	1,978	2,184	1,977	1,735	-12
•	Titanium white	‘000 t	36	42	39	40	39	-2

[1] production, sold

Source: ***The Central Statistical Office (GUS), the author’s calculation***

In 2013, increasing tendencies of domestic production were reported for some mineral commodities, including:

- ***fuels***: coke, nitrified natural gas, crude oil, lignite;
- ***metals***: aluminum, cadmium, ferroalloys, gold, lead, pig iron, tin, zinc;
- ***industrial and construction minerals***: carbon black, chalk, raw dolomite, feldspar raw materials, synthetic gypsum, kaolin, raw magnesite, nitrogen, peat, quartz, quartzite, rock salt, glass sand, caustic soda (Tab. 2).

The list of the largest decreases (by over 5%) in the production in 2013 included:

- ***fuels***: hard coal;
- ***metals***: lead concentrates, platinum group metals, selenium, silver;
- ***industrial and construction minerals:*** sand&gravel aggregates, crushed aggregates, artificial agregates, asphalts, cement clinker, cement, chlorine, clays for building ceramics, stoneware clays, natural gypsum&anhydrite, helium, industrial limestone, lime, oxygen, sand for cellular concrete, sand for sand-lime products, mica schist, phyllite schist, calcined soda, dimension stone, elemental sulfur, sulfuric acid (Tab. 2).

Trade in Mineral Commodities

The trade statistics on mineral commodities in the years 2009–2013 presented in the commodity chapters are listed according to the **Combined Nomenclature** (**CN**), which is based on the European Union's **Combined Nomenclature** (**CN**). The data on trade in mineral commodities given in the **Yearbook** have been provided by the **Department of Information Services** of the **Central Statistical Office** (**GUS**).

There are only ca. 20 mineral commodities exported in significant quantities from Poland, including:

- ***fuels***: hard coal, coke;
- ***metals***: refined copper, refined silver, zinc, lead concentrates, refined lead, cadmium, selenium, rhenium&ammonium perrhenate, some ferroalloys;
- ***industrial minerals***: cement, fertilizers (nitrogen, phosphate and multicomponent), refractory clays, glass sand, lime, calcined soda, dimension stone, elemental sulfur, sulfuric acid (Tab. 3).

The highest shares of exports in the total sales, 30% or more, have been reported for coke, cadmium, refined copper, ferroalloys, lead concentrates, refined lead, rhenium&ammonium perrhenate, selenium, refined silver, refined zinc, asphalts, nitrogen fertilizers, calcined soda, and elemental sulfur (Tab. 3).

The list of mineral commodities, which have to be imported to Poland, is much longer. Around 70 of over 140 mineral commodities consumed in Poland (i.e. almost a half) have come exclusively from abroad. In the case of ca. ten other commodities, imports meet minimum 50% of the domestic demand (Tab. 4). This indicates how thoroughly the Polish economy is dependent on imported minerals, especially on the high-processed ones. The most important of them are as follows:

- ***fuels***: crude oil, high-methane natural gas;
- ***metals***: the majority of metals and/or their concentrates, except for copper, gold, lead, selenium, silver, zinc, pig iron, and raw steel;

Tab. 3. Share of exports sales in total sales of selected mineral commodities produced in Poland in 2013

Mineral commodity/ /Derivative product	Exports/ /Domestic production [%]	Mineral commodity/ /Derivative product	Exports/ /Domestic production [%]
FUELS		• Asphalts, natural and synthetic	36
• Coke	72	• Cement	3
• Hard coal	9	• Chlorine	6
METALS		• Clays, refractory	10
• Cadmium	99	• Dolomite, raw	2
• Copper, metal	59	• Dimension stone	5
• Ferromanganese	100	• Feldspar	2
• Ferrosilicomanganese	100	• Kaolin, washed	6
• Ferrosilicon	100	• Lime	5
• Lead, ores and concentrates	100	• Nitrogen fertilizers	32
• Lead, metal	34	• Peat	5
• Rhenium (ammonium perrhenate)	100	• Phosphate fertilizers	21
• Selenium	66	• Phosphoric acid	20
• Silver	100	• Sand, glass	7
• Zinc, metal	78	• Soda, calcined	46
INDUSTRIAL MINERALS		• Soda, caustic	7
• Aggregates, natural crushed	2	• Sulfur, elemental	49
• Ammonia	6	• Sulfuric acid	14

Source: ***The Central Statistical Office (GUS), the author's calculation***

- ***industrial minerals***: the majority or all demand for andalusite and relative minerals, barite, bentonite, borates, bromine, carbon black, white-firing clays, corundum and emery, diamonds, diatomite, fluorite, graphite, iodine, iron oxide pigments, lithium compounds, magnesite and magnesia, mica, perlite, phosphates, phosphorus, potassium salts, pumice, quartzite, strontium carbonate, talc, vermiculite, wollastonite

Consistent with **CN** nomenclature, data on the monetary value of trade in mineral commodities, as well as their balances in the years 2009–2013, were compiled in three groups: ***fuels***, ***metals***, and ***industrial minerals*** (Tab. 5). The ***fuels*** group has been showing deepening trade deficit from -40.9 billion PLN in 2009 to the record -82.1 billion PLN in 2012. In 2013 it slightly improved to -76.6 billion PLN. Permanently positive value of the trade balance in the group of ***metals*** increased to 9.3 billion PLN in 2011, due to growth of international prices of ***refined copper*** (one of the principal Polish export commodities). In the following two years this value decreased to ca. 7.3 billion PLN, primarily due to sharp change of ***iron and steel scrap*** trade balance and lower copper and silver prices (Tab. 5). The negative financial results of the trade in ***industrial minerals*** (except for ***fertilizers***) approached to almost -2.5 billion PLN in 2011, with some improvement in the following two years. The value of usually positive trade balance in ***fertilizers*** varied widely, being even temporary negative in 2009 and 2013 (Tab. 5). In 2013, the total revenues from the exportation of ***mineral commodities***

Tab. 4. Share of imports to Poland in total domestic consumption of selected mineral commodities in 2013

Mineral commodity/ /Derivative product	Imports/ /Domestic demand [%]	Mineral commodity/ /Derivative product	Imports/ /Domestic demand [%]
FUELS		• Zinc, ores and concentrates	62
• Coke	5	• Zinc, metal	62
• Gas, natural, high-methane	74	**INDUSTRIAL MINERALS**	
• Hard coal	12	• Aggregates, natural crushed	2
• Oil, crude	98	• Andalusite, kyanite and sillimanite	100
METALS		• Asphalts	27
• Aluminum, ore (bauxites)	100	• Barite	100
• Aluminum, oxide (alumina)	100	• Bentonite, raw	99
• Aluminum, metal	92	• Borates, natural	100
• Antimony, metal	100	• Bromine	100
• Antimony, oxide	100	• Carbon black	71
• Arsenic, metal	100	• Cement	5
• Arsenic, trioxide	100	• Chalk and related products	18
• Beryllium, metal	100	• Clays, refractory	22
• Bismuth, metal	100	• Clays, white-burning	92
• Boron, metal	100	• Chlorine	3
• Calcium, metal	100	• Corundum, emery and garnet	100
• Chromium, ores and concentrates	100	• Diamonds	100
• Chromium, metal	100	• Diatomite and related materials	70
• Cobalt, metal	100	• Dolomite, raw	6
• Cobalt, oxide and hydroxide	100	• Feldspar	43
• Copper, ores and concentrates	4	• Fluorite	100
• Copper, refined	8	• Graphite, natural	100
• Ferrochromium	100	• Gypsum and anhydrite	1
• Ferromanganese	100	• Iodine	100
• Ferromolybdenum	100	• Kaolin, washed	46
• Ferroniobium	100	• Lime	4
• Ferrosilicomanganese	100	• Lithium compounds	100
• Ferrosilicon	100	• Magnesite and magnesia, calcined	100
• Ferrotitanium	100	• Magnesite and magnesia, dead-burned and fused	100
• Ferrotungsten	100	• Mica	100
• Ferrovanadium	100	• Mineral wax	100
• Gallium	100	• Nitric acid	1
• Germanium oxide	100	• Nitrogen fertilizers	17
• Indium	100	• Peat	16

• Iron, ores and concentrates	100	• Perlite	100
• Iron, pig iron	5	• Phosphates	100
• Lead, refined	21	• Phosphorus	100
• Magnesium	100	• Phosphoric acid	8
• Manganese, ores and concentrates	100	• Phosphate fertilizers	6
• Manganese, metal	100	• Potassium salts	100
• Mercury	100	• Pumice	100
• Molybdenum, ores and concentrates	100	• Quartz	34
• Molybdenum, metal	100	• Quartzite, industrial	71
• Nickel	100	• Salt	22
• Niobium	100	• Soda, calcined	4
• Rare earth elements, yttrium and scandium	100	• Stone, dimension	11
• Selenium	29	• Strontium carbonate	100
• Tantalum	100	• Sulfur, elemental	11
• Tellurium	100	• Talc and steatite	100
• Tin	100	• Vermiculite	100
• Titanium, ores and concentrates	100	• Wollastonite	100
• Titanium, metal	100	• Zircon	100
• Tungsten, metal	100		

Source: ***The Central Statistical Office (GUS), the author's calculation***

(including ***fertilizers***) were **30,800 million PLN**, i.e. 3% more than in 2012, while the importation value was **102,067 million PLN**, i.e. 3% less than in 2012. That resulted in the trade deficit of **71,267 million PLN**, which was 6% less than in 2012 (Tab. 5).

Among the ***mineral commodities*** imported to Poland over the last several years, in 2013 the total trade balance was influenced the most by the following: crude oil (trade balance -55,774 million PLN), natural gas (ca. –26,300 million PLN), iron ore and concentrates (–2,160 million PLN), aluminum and aluminum alloys (–1,728 million PLN), potassium salts (-1,007 million PLN), copper concentrates (–800 million PLN), anode and blister copper (–404 million PLN), phosphates (–383 million PLN), zinc ore and concentrates (–331 million PLN), carbon black (–296 million PLN), multicomponent fertilizers (-216 million PLN), silicon (–186 million PLN), phosphorus (–182 million PLN), magnesia and magnesite (-166 million PLN), pig iron (–147 million PLN), scrap of aluminum and aluminum alloys (-135 million PLN), alumina (–131 million PLN), titanium ore and concentrates (–119 million PLN), ceramic and refractory clays (–115 million PLN), dimension stone (–101 million PLN), scrap of copper and copper alloys (-78 million PLN), feldspar (–55 million PLN), kaolin (–50 million PLN), mineral aggregates (–49 million PLN), and nickel (–48 million PLN).

In 2013 the highest positive values of trade balance in ***mineral commodities exported*** from Poland were recorded for: refined copper (+7,653 million PLN), silver

Tab. 5. Value of mineral commodities trade in Poland in 2009–2013

million PLN

Year	2009	2010	2011	2012	2013
Fuels					
Exports	3,013	3,770	3,940	3,748	5,736
Imports	43,949	63,446	76,888	85,815	82,322
Balance	**-40,936**	**-59,676**	**-72,948**	**-82,067**	**-76,586**
Metals					
Exports	11,486	17,089	21,954	21,152	20,430
Imports	6,947	10,471	12,670	12,898	13,137
Balance	**+4,539**	**+6,618**	**+9,284**	**+8,254**	**+7,293**
Industrial minerals[1]					
Exports	862	1,268	1,668	1,974	2,224
Imports	2,285	2,971	4,172	3,998	3,829
Balance	**-1,423**	**-1,703**	**-2,504**	**-2,024**	**-1,605**
Fertilizers					
Exports	1,207	1,876	2,620	2,905	2,410
Imports	1,578	1,705	2,185	2,571	2,779
Balance	**-371**	**+171**	**+435**	**+334**	**-369**
TOTAL					
Exports	16,568	24,003	30,182	29,779	30,800
Imports	54,759	78,593	95,915	105,282	102,067
Balance	**-38,191**	**-54,590**	**-65,733**	**-75,503**	**-71,267**

[1] industrial minerals (without fertilizers)

Source: ***The Central Statistic Office (GUS)***

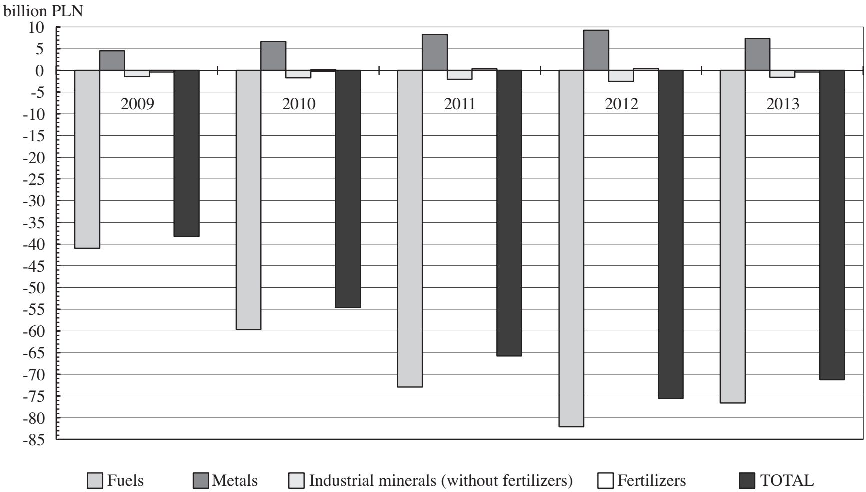


Fig. 3. Trade balance of mineral commodities in Poland in 2009–2013

(+2,720 million PLN), iron and steel scrap (+1,980 million PLN), nitrogen fertilizers (+842 million PLN), zinc (+508 million PLN), gold (+447 million PLN), hard coal (+214 million PLN), sulfur (+147 million PLN), refined lead (+122 million PLN), and lead concentrates (+114 million PLN).

Domestic Demand for Mineral Commodities

Determination of quantity and sources of mineral commodities for the domestic economy is one of the most important matters of mineral management analyses. In some cases (e.g. for ***fuels***, but also for ***cement*** and ***elemental sulfur***), it is possible to calculate the level of **real consumption**, according to the information from the Central Statistical Office, taking into account changes in stocks and losses. However, for the majority of mineral commodities, only simplified balances have been drawn up, in which production and imports are listed on the "in" side, and exports on the "out" side. The resulted **'apparent consumption'** indicates the average annual demand for these commodities. This is calculated according to the following formula:

Apparent consumption (demand) = Production + Imports – Exports

Actually, for the majority of mineral commodities, the apparent consumption is very close to the real demand. In some cases, however, especially for precious and minor metals, the former value can be underestimated due to possible unofficial smuggling or changes in inventories.

In 2013 demand for mineral commodities in Poland (real or apparent consumption), is given in Table 6 in comparison to the years 2009-2012. In 2013, the large increases of domestic demand were reported for:

- ***fuels***: lignite;
- ***metals***: alumina, antimony, bismuth, cadmium, chromium ore and concentrates, copper ore and concentrates, ferroalloys, iron ore and concentrates, pig iron, refined lead, magnesium, manganese, mercury, silicon, tin, titanium ores and concentrates;
- ***industrial minerals***: andalusite and relative minerals, borates, chalk, electrocorundum, diamonds, raw dolomite, feldspar raw materials, iodine, raw magnesite, mica, peat, phosphorus, phosphate fertilizers, potassium salts, salt, glass sand, caustic soda, strontium carbonate, talc and steatite, zircon (Tab. 6).

The most significant decreases of domestic demand in 2013, exceeding 20%, were reported for:

- ***metals***: arsenic, boron, chromium, gallium, molybdenum oxides, nickel, platinum group metals, selenium, tantalum, tellurium, titanium, tungsten, zinc;
- ***industrial minerals***: barite, stoneware clays, diatomite, dead-burned dolomite, fluorite, phosphates, phosphoric acid, pumice, sand for lime-sand products, phyllite schist, dimension stone (Tab. 6).

Tab. 6. Demand for selected mineral commodities and their derivative products in Poland in the years 2009–2013

Mineral commodity/ /Derivative product	Unit	Demand					Change 2013/2012 [%]	Notes
		2009	2010	2011	2012	2013		
FUELS								
• Coke	‘000 t	2,693	3,058	2,977	2,783	2,739	-2	r
• Gas, coke-oven	million m^3	3,076	4,239	4,055	3,878	3,900	+1	p
• Gas, natural, high-methane	million m^3	12,770	14,010	13,970	14,819	14,740	-1	r
• Gas, natural, nitrified	million m^3	3,569	3,770	3,852	3,870	3,968	3	r
• Hard coal	‘000 t	75,730	84,788	83,527	82,951	75,736	-7	r
• Lignite	‘000 t	57,084	56,569	62,633	64,008	65,331	+2	r
• Oil, crude	‘000 t	20,425	22,239	24,169	25,151	23,748	-6	r
METALS								
• Aluminum, ore (bauxites)	‘000 t	48	35	36	55	47	-15	p
• Aluminum, oxide (alumina)	‘000 t	51	62	61	62	64	+3	p
• Aluminum, metal	‘000 t	88	133	135	122	121	-1	p
• Antimony, metal	t	25	20	20	23	77	+235	p
• Antimony, oxide	t	948	1,022	968	903	760	-16	p
• Arsenic, metal	t	19	42	39	38	25	-34	p
• Arsenic, trioxide	t As_2O_3	11	0	0	0	1	X	n
• Bismuth, metal	t	17	30	20	22	31	+41	p
• Boron, metal	t	0	0	0	16	11	-31	p
• Cadmium	t	38[r]	3	2	4	24	6x	p
• Calcium	t	0	15	58	0	0	X	n
• Chromium, ores and concentrates	‘000 t	11	27	31	27	29	+7	p
• Chromium, metal	t	0	29	68	46	33	-28	p
• Cobalt	t	38	30	30	32	29	-9	p

•	Cobalt, oxide and hydroxide	t	8	10	107	14	15	+7	p
•	Copper, ores and concentrates	'000 t Cu	462	437	441	445	472	+6	p
•	Copper, refined	'000 t	203	261	256	253	234	-8	p
•	Ferrochromium	'000 t	5	7	7	9	28	+211	p
•	Ferromangananese	'000 t	30	30	43	30	39	+30	p
•	Ferrosilicomanganese	'000 t	55[r]	50	64	57	53	-7	p
•	Ferrosilicon	'000 t	9	11	15	22	15	-32	p
•	Ferromolybdenum	t	539	0	0	0	0	X	n
•	Ferroniobium	t	196	267	240	368	244	-34	p
•	Ferrotitanium	t	98	174	190	270	265	-2	p
•	Ferrovanadium	t	142	0	79	180	285	+58	p
•	Ferrotungsten	t	9	9	11	7	28	4x	p
•	Gallium	kg	17	31	27	61	26	-57	p
•	Germanium oxide	kg	3	15	77	57	51	-11	p
•	Gold	kg	1,063	919	0	0	0	X	p
•	Indium	kg	48	20,031	66	9	130	14x	p
•	Iron, ores and concentrates	'000 t gross	3,777	6,473	5,973	6,574	6,610	+1	p
•	Iron, pig iron	'000 t	3,241	3,749	4,202	4,064	4,121	+1	p
•	Lead, ores and concentrates	'000 t Pb	0	4	3	0	0	X	n
•	Lead, refined	'000 t	75	109[r]	119	117	127	+9	p
•	Magnesium	t	3,323	4,649	5,517	4,985	6,400	+28	p
•	Manganese, ores and concentrates	'000 t	2	4	3	4	4	0	p
•	Manganese, metal	t	352	1,483	369	639	878	+36	p
•	Mercury	t	0	0	33	13	32	+146	p
•	Molybdenum, ores and concentrates	t	0	0	34	0	63	X	p
•	Molybdenum, metal	t	1	3	0	0	0	X	p

•	Molybdenum, oxides	t	81	197	189	241	191	-21	p
•	Nickel	t	1,080	1,319	2,343	1,995	277	-86	p
•	Niobium	kg	38	34	5	0	49	5x	p
•	Platinum group metals	kg	128	0	0	187	48	-74	p,e
•	Rare Earth Elements, Ytrium, and Scandium - metals	t	2	8	0	2	27	13x	p
•	Rare Earth Elements, Ytrium, and Scandium - compounds	t	57	183	107	77	117	+52	p
•	Selenium	t	30	45	44	44	15	-66	p
•	Silicon	t	10,854	16,290	16,189	16,128	24,591	+52	p
•	Silver	t	97	NA	97	NA	38	X	p
•	Steel, raw	‘000 t	7,129	7,976	8,752	8,516	8,173	-4	p
•	Tantalum	kg	1,049	2,090	1,646	223	0	-100	p
•	Tellurium	kg	907	2,260	1,646	1,514	134	-91	p
•	Thallium	kg	0	1	1	1	1	X	p
•	Tin	t	1,340	877	988	717	2,319	+223	p
•	Titanium, ores and concentrates	‘000 t	84	105	99	84	97	+15	p
•	Titanium, metal	t	2	288	1,768	54	33	-39	p
•	Tungsten	t	10	36	28	4	0	-100	p
•	Zinc, ores and concentrates	‘000 t Zn	166	157	143	200	171	-14	p
•	Zinc, metal	‘000 t	77	96	80	82	68	-20	p
•	Zircon, metal	t	3	2	0	0	0	X	p
INDUSTRIAL MINERALS									
•	Aggregates, sand and gravel	‘000 t	118,522[r]	136,803[r]	232,368[r]	167,264[r]	154,670	-8	p
•	Aggregates, natural crushed	‘000 t	60,184	65,114	93,645	67,694	58,472	-14	p
•	Aggregates, artificial[e]	‘000 t	7,400	7,100	7,600	5,300	4,400	-17	p
•	Aggregates, lightweight	‘000 t	210	500	800	700[r]	700	0	p
•	Amber	t	NA	NA	NA	NA	NA	NA	n

•	Ammonia	'000 t	2,003	2,086	2,250	2,382	2,338	-2	p
•	Andalusite, kyanite, and sillimanite	'000 t	8	18	14	17	21	+24	p
•	Asphalts	'000 t	1,620	1,616	1,799	1,448	1,279	-12	p
•	Barite	'000 t	8	11	14	20	10	-50	p
•	Bentonite, raw	'000 t	126	158	210	230	210	-9	p
•	Bentonite, processed	'000 t	58	65	89	79	65	-18	p
•	Borates, natural	t	1,435	1,869	1,535	1,572	2,070	+32	p
•	Bromine	t	1	7	4	62	30	-52	p
•	Carbon black	'000 t	102	173	184	136	111	-18	p
•	Cement, clinker	'000 t	10,568	11,785	13,605	11,715	10,718	-9	p
•	Cement	'000 t	15,462	15,918	19,653	16,279	15,142	-7	r
•	Chalk and related materials	'000 t	720	587	709	892	951	+7	p
•	Chlorine	'000 t	324	297	287	302	262	-13	p
•	Clays for building ceramics	'000 m^3	2,640	2,157	2,309	1,835	1,518	-17	p
•	Clays, refractory	'000 t	133	98	153	139	136	-2	p
•	Clays, stoneware	'000 t	646	721	1,291	737	513	-30	p
•	Clays, white-burning	'000 t	293	363	465	413	400	-3	p
•	Corundum and emery	t	67	293	428	0	285	X	n
•	Corundum, synthetic (Electrocorundum)	'000 t	17	29	28	31	37	+19	p
•	Diamonds	kg	52,594	557	42,533	656	751	+14	p
•	Diatomite and related materials	'000 t	10	7	8	5	2	-60	p
•	Dolomite, raw	'000 t	1,858	1,824	1,858	1,862	1,946	+5	p
•	Dolomite, dead-burned	'000 t	85	95	89	68	47	-31	p
•	Feldspar	'000 t	746	801	941	842	878	+4	p
•	Fluorite	'000 t	10	9	11	11	8	-27	p
•	Gypsum and anhydrite	'000 t	3,511	3,697	3,813[r]	3,878[r]	3,827	-1	p

• Graphite, natural	t	2,809	6,976	9,770	6,706	6,542	-2	p
• Iodine	t	5	9	8	9	20	+122	p
• Kaolin, washed	‘000 t	214	224	270	247	287	+16	p
• Limestone, commercial product	‘000 t	29,649	33,125	40,667	37,965	34,984	-8	p
• Limestone, lake	‘000 t	45	17	16	16	28	+75	p
• Lime	‘000 t	1,734	1,769	2,039	1,766	1,679	-5	p
• Lithium compounds	t	208	229	255	265	223	-16	p
• Magnesite, raw	‘000 t	51	66	77	85	98	+15	p
• Magnesite, calcined	‘000 t	6	10	7	7	7	0	p
• Magnesite, dead-burned and fused	‘000 t	75	106	133	106	87	-18	p
• Mica	t	1,177	1,105	1,887	1,443	1,709	+18	p
• Mineral wax	t	3	3	0	6	4	-33	p
• Nitric acid	‘000 t	2,149	2,210	2,170	2,322	2,270	-2	p
• Nitrogen fertilizers	‘000 t	3,970	3,583	4,032	4,414	4,453	+1	p
• Oxygen	‘000 t	1,956	1,965	2,219	2,273	2,178	-4	p
• Peat	‘000 t	733	839	916	901	928	+3	p
• Perlite	t	21,512	24,464	25,275	24,726	22,040	-11	p
• Phosphates	‘000 t	459	1,302	1,438	1,238	948	-23	p
• Phosphorus	‘000 t	7	11	14	15	21	+40	p
• Phosphoric acid	‘000 t	131	292	308	276	195	-29	p
• Phosphate fertilizers	‘000 t	43	71	70	80	82	+3	p
• Potassium salts	‘000 t	191	818	790	812	823	+1	p
• Pumice	t	4,275	3,749	2,768	3,895	721	-81	p
• Quartz	‘000 t	13	14	10	8	8	0	p
• Quartzite, industrial	‘000 t	35	122	150	163	156	-4	p
• Salt (with brine)	‘000 t	3,505	4,022	4,409	3,584	4,337	+21	p
• Sand for cellular concrete	‘000 m^3	322	397	414	355	334	-6	p

•	Sand for lime-sand products	‘000 m^3	560	615	780	731	519	-29	p
•	Sand, filling	‘000 m^3	5,928	5,090	4,405	3,762	3,649	-3	p
•	Sand, foundry	‘000 t	720	920	980	950	930	-2	p
•	Sand, glass	‘000 t	1,952[r]	2,259[r]	2,351[r]	2,164[r]	2,199	+2	p
•	Schist, mica	‘000 t	3	3	5	3	3	0	p
•	Schist, phyllite	‘000 t	24	57	157	190	143	-25	p
•	Schist, quartz	‘000 t	1	1	1	1	1	0	p
•	Soda, calcined	‘000 t	574	677	697	699	595	-15	p
•	Soda, caustic	‘000 t	828	575	789	820	850	+4	p
•	Stone, dimension	‘000 t	3,929	4,926	7,478	5,460	4,143	-24	p
•	Strontium carbonate	t	80	144	196	169	174	+3	p
•	Sulfur, elemental	‘000 t	295	483	545	450	384	-15	r
•	Sulfuric acid	‘000 t	1,208	1,712	1,772	1,591	1,491	-6	p
•	Talc and steatite	‘000 t	18	26	25	27	33	+22	p
•	Titanium white	‘000 t	37	43	40	41	40	-2	p
•	Vermiculite	t	139	NA	NA	NA	NA	X	n
•	Wollastonite[e]	t	5	NA	NA	NA	NA	X	n
•	Zeolites, synthetic	t	6	7	NA	NA	NA	X	n
•	Zircon	t	363	523	475	653	670	+3	p

Notes: **e** — estimated, **n** — assumption impossible, **p** — apparent consumption, **r** — real consumption

Source: ***The Central Statistical Office (GUS), the author's calculation***

AGGREGATES

Overview

A few main groups of **mineral aggregates** are different from each other regarding quality and graining. However, in some applications they are used interchangeably in building, as well as road and railway construction. Mineral aggregates are divided into a few main groups:

- **natural aggregates** obtained from deposits, obtained in simple mechanical processing (crushing, classification, washing); they are divided into two subgroups:
  - **natural sand** and **gravel aggregates** obtained from loose sedimentary rocks (sand and gravel),
  - **natural crushed aggregates**, obtained from compact rocks by their extraction and processing;
- **artificial aggregates**, recovered from mining and metallurgical wastes, as well as by thermal processing of various primary and secondary raw materials;
- **recycled aggregates** derived from reprocessing materials previously used in construction.

The definition of natural aggregates does not include: ***sand for the production of cellular concrete and silicate brick*** (see: **SAND FOR CELLULAR CONCRETE AND SAND-LIME PRODUCTS**), ***filling sand*** for stowing in underground mines (see: **SAND, FILLING**), ***industrial sand*** for foundries, construction chemistry, water filtering, construction sandblasting, cement durability testing, hydraulic fracturing in oil and gas industry (see: **SAND, INDUSTRIAL**), as well as the most valuable ***glass sand*** (see: **SAND, GLASS**). Therefore, this chapter refers exclusively to ***construction sand*** and ***gravel***.

Natural sand and **gravel aggregates** are a loose mixture of ***pebbles***, ***gravel***, and ***sand***. Among them, two main groups can be distinguished, depending on the degree of processing and grain size:

- **natural non-crushed sand** and **gravel aggregates**: ***common sand*** 0–2 mm, ***gravel*** (fractions 2–4, 4–8, 8–16, 16–31.5, 31.5–63 mm, and mixed fractions, e.g.: 2–8, 2–16, 8–16 mm etc.), ***classified*** and ***non-classified sand*** and ***gravel mixes*** (fractions 0–4, 0–8, 0–16, 0–31.5, 0–63 mm), and ***pebbles*** (63–250 mm);
- **natural crushed sand** and **gravel aggregates**: ***crushed sand*** 0–2 mm, ***pebble grits*** (fractions the same as gravel), and ***pebble mixes*** (fractions the same as sand and gravel mixes).

The group of compact rocks, suitable for the production of **natural crushed** aggregates, consists of magmatic, metamorphic, and sedimentary rocks, characterized by suitable resistance to climatic factors, compression, and wear. In order to determine whether they can be applied in buildings, roads, or railways, the rocks should be thoroughly examined: the mineral composition should be determined to detect any constituents, which may decompose under prevailing climatic conditions, and the physical and mechanical properties: density, water absorption, compression strength, grindability, freeze-resistance, emulgation index. Rocks for the production of **natural crushed aggregates** (**crushed stone**) are extracted from deposits with the use of explosives. The output is crushed and classified as required. The shape of aggregates may be modified by granulation. Thus, natural crushed aggregates are divided into:

- **common natural crushed aggregates**: ***crushed stone*** (63–250 mm), ***breakstone*** (31.5–63 mm), ***key aggregate*** (4–31.5 mm), and ***rock dust*** (0–4 mm);
- **granulated natural crushed aggregates**: ***grits*** in a few grain size classes (between 2 and 63 mm), ***crushed sand*** (0–2 mm), and ***classified mixes of crushed aggregates*** (various fractions between 0 and 63 mm).

Artificial aggregates are produced from ***clay minerals*** or ***industrial waste materials***. The most important of them are:

- **artificial aggregates manufactured from clays by thermal processing**, such as ***gravelite*** (***haydite***);
- **artificial aggregates obtained through the thermal processing of industrial waste materials**, e.g. ***gralite shale***, ***shale gravelite*** (***"łupkoporyt"***), ***ash gravelite*** (***"popiołoporyt"***), ***pumice-stone slag***, ***granulated slag***, etc.;
- **artificial aggregates made of industrial waste materials without any thermal processing**, e.g. ***"elporyt"*** (comminuted slag from power plants fired with coal dust), ***shale gravelite*** (self-burnt carbonaceous shale obtained by comminution and classification of old coal waste dumps), ***fly ash***, ***blast-furnace slag***, etc.;
- **organic aggregates**, produced from artificial organic materials.

Sources

Natural sand and ***gravel aggregates*** are common in Poland. They form large deposits, of which the most important are deposits of glacial natural aggregates, mainly from the **North Polish Glaciation**. Approximately 40% of the resources occurs in river valleys of the **Carpathians** and **Sudetes** (the latter one are characterized by the highest quality among domestic aggregates). Underwater deposits of aggregates are also known and exploited in the southern part of the **Baltic Sea** (the **Słupsk Bank**). There were 9,316 deposits of ***natural sand*** and ***gravel aggregates*** in Poland, the resources of which amounted to ca. 17,973 Mt (as of 31 December 2013). The largest deposits occur in the Lower Silesia and the Carpathians, as well as in NE Poland. In 2013, over 2,500 deposits were exploited, while over 2,000 were abandoned.

Rocks for the production of ***natural crushed aggregates*** (***crushed stone***) — recognized in the group of crushed and dimension stone deposits — occur mainly in the Lower Silesia (54% of domestic resources), in the Świętokrzyskie Mountains (22%), in the Carpathians (12%), and in the Silesia-Cracow region (9%). The total resources of crushed and dimension stones in 747 deposits amounted to 10,664 Mt (as of 31 December 2013). This figure does not include deposits of ***limestone for lime*** and ***cement production***, ***dolomites for metallurgy*** and ***ceramics***, ***phyllite-schist***, ***mica-schist***, or ***quartz-schist***. In the Lower Silesia there are deposits of high quality ***granite***, ***basalt***, and ***melaphyre***, as well as ***gabbro/diabase***, ***syenite***, ***porphyry***, ***gneiss***, ***amphibolite***, ***serpentinite***, ***migmatite***, ***hornfels***, ***sandstone***, and ***greywacke***. In the Świętokrzyskie Mountains, among the recognised deposits are primarily ***limestone***, ***dolomite***, ***sandstone***, and ***chalcedonite***. The Silesia-Cracow region is rich in ***dolomite*** and ***limestone*** deposits and a few extrusive rock deposits (***porphyry***, ***diabase***, ***melaphyre***), whereas in the Carpathian Mountains there are almost exclusively ***sandstone*** deposits. The largest resources have been recognized in the case of: ***limestone*** (1,795 Mt), ***granite*** (1,698 Mt), ***sandstone*** (1,679 Mt), ***dolomite*** (1,106 Mt), ***porphyry*** (775 Mt), ***basalt*** (587 Mt), ***gabbro-diabase*** (537 Mt), and ***melaphyre*** (483 Mt).

The production of ***artificial aggregates*** from natural raw materials in Poland is based mainly on common ***clays*** of proper expansion properties or bulk density. Their deposits are widespread in the country, but the largest ones occur in the Pomorskie and Lubelskie voivodeships. The total resources of 42 recognised deposits were 169 Mm^3, i.e. ca. 338 Mt (as of 31 December 2013).

Other important sources for the production of ***artificial aggregates*** include waste materials, such as ***hearth slag*** and ***fly ashes*** from power stations, ***blast furnace slag***, ***converter slag***, ***shaft furnace slag*** from smelters, and ***coal shale***.

Debris materials (consisting mainly of concrete) is also important, but in Poland of rather only potential significance in the production of ***recycling aggregates***.

Production

Mineral aggregates have been produced from primary and secondary sources, but primary sources have predominated. In recent years the production from secondary sources has based mainly on mining, metallurgical and power industry wastes. Use of secondary materials has been limited to the main industrial regions of the country. Therefore, mineral aggregates obtained from primary sources (deposits) will remain the main group of aggregates manufactured in Poland.

In 2009 mining output of ***natural sand*** and ***gravel aggregates*** was temporary reduced by 5% to 141 Mt, but in 2010-2011 it sharply rose by 76% to the record volume of over 248 Mt (Tab. 1). However, in the last two years it was reduced, by 30%, i.e. to 173 Mt in 2013.

The largest mining output of ***natural sand*** and ***gravel aggregates*** has recently come from voivodeships with large resource base, but also from voivodeships of high demand for such aggregates. The first group consists of: Dolnośląskie, Małopolskie, Opolskie, Podlaskie, Warmińsko-Mazurskie, and Zachodniopomorskie voivodeships; the second group includes: Mazowieckie (especially in 2010 and 2011), Pomorskie, Kujawsko-Pomorskie (especially in 2009), Podkarpackie (especially in 2011-2013), Wielkopolskie (especially in 2011), and Łódzkie (2011-2013) voivodeships. Significance of various regions depends also on intensity of construction works. Recently, good examples of high mining output have been: Mazowieckie, Łódzkie, Wielkopolskie, Lubuskie and Zachodniopomorskie voivodeships due to construction of A-2 motorway, while until 2010 - Pomorskie and Kujawsko-Pomorskie voivodeships, due to construction of A-1 motorway, Mazowieckie and Warmińsko-Mazurskie voivodeships as a result of construction (partly reconstruction) of S-7 and S-8 expressways, and since 2010 - Małopolskie and Podkarpackie voivodeships (construction of A-4 motorway). The

Tab. 1. Mining output of natural aggregates in Poland

'000 t

Year	2009	2010	2011	2012	2013
Total output	**141,114**	**157,236**	**248,690**	**184,745**	**173,267**
Dolnośląskie	14,599	14,062	21,674	13,903	10,024
Kujawsko-Pomorskie	9,362	6,188	14,748	4,837	5,737
Lubelskie	3,439	5,220	8,262	7,208	6,425
Lubuskie	4,094	4,946	9,090	6,305	5,519
Łódzkie	7,994	8,148	21,905	21,764	24,024
Małopolskie	12,025	14,467	20,975	15,234	11,574
Mazowieckie	14,306	20,585	28,756	15,487	12,650
Opolskie	6,848	6,385	8,151	6,593	6,799
Podkarpackie	5,928	9,568	24,192	22,833	17,095
Podlaskie	9,010	13,142	20,485	14,464	20,994
Pomorskie	12,094	11,370	12,403	11,843	11,055
Śląskie	6,679	4,939	8,218	6,204	5,689
Świętokrzyskie	2,276	2,632	3,268	2,643	1,921
Warmińsko-Mazurskie	11,099	13,675	19,690	13,475	12,611
Wielkopolskie	8,754	11,910	14,065	11,834	10,921
Zachodniopomorskie	12,607	9,999	12,240	9,838	9,939
Baltic Sea	–	–	569	279	290

Source: ***Mineral Resources Datafile****-verified*

smallest amounts of natural sand and gravel aggregates (mainly sand) have been produced in Świętokrzyskie and Lubelskie voivodeships. Offshore extraction was restarted in 2011 (Tab. 1).

From among numerous ***natural sand*** and ***gravel aggregate*** mines (almost 2,600), only in 22 the output exceeded 1 Mt in 2013, in 42 it was between 0.5 and 1 Mtpy, whereas 0.1–0.5 Mtpy have been produced in ca. 300 plants. Almost 80% of the total number of aggregates mines produce less than 50,000 tpy, most often only a few thousand tons per year (Tab. 2).

Due to the fact that data on mining sector production are compiled only for companies employing minimum of 10 people, natural sand and gravel aggregates production from a large number of small manufacturers is not included in the official production statistics published by the **Central Statistical Office** (Tab. 3). This is well visible when we compare the mining output level reported by **Mineral Resources Datafile** (over 173 Mt in 2013) with official production data (73.0 Mt). So, the production of each assortment was estimated on the basis of mining output, share of fraction <2 mm and technical equipment in each mine. Such estimated total production of natural sand and gravel aggregates has shown dynamic growth since 2002 and in 2011 it amounted to over 238 Mt with drop to ca. 166 Mt in 2013 (Tab. 3). Processing wastes make the balance between total mining output and total estimated production. From among seven voivodeships with production exceeding 10 Mtpy, supplies of ***gravel*** and ***other classified***

Tab. 2. Structure of natural sand and gravel aggregates mining output in Poland in 2013

Voivodeship	Mines and mining output level ['000 tpy]						
	<50	50–100	100–200	200–500	500–1,000	>1,000	Total
Total number of mines	2 022	197	174	132	42	22	2 589
Dolnośląskie	70	15	11	11	4	-	112
Kujawsko-Pomorskie	126	8	6	4	2	-	146
Lubelskie	171	12	8	2	-	1	194
Lubuskie	45	7	9	5	2	-	68
Łódzkie	209	19	14	23	8	3	276
Małopolskie	56	10	15	21	2	-	104
Mazowieckie	324	13	18	10	1	2	368
Opolskie	30	5	5	3	6	-	49
Podkarpackie	156	13	19	8	3	3	202
Podlaskie	193	15	11	10	5	5	239
Pomorskie	84	20	15	7	1	2	129
Śląskie	24	12	5	5	-	2	48
Świętokrzyskie	41	4	4	1	-	-	50
Warmińsko-Mazurskie	143	20	13	10	3	1	190
Wielkopolskie	313	16	14	3	-	2	348
Zachodniopomorskie	37	8	7	9	5	1	67

*Source: **Mineral Resources Datafile**-verified*

products have dominated in Dolnośląskie, Małopolskie, Śląskie, Lubuskie, Warmińsko-Mazurskie and Podlaskie voivodeships, while the production of ***raw sand*** and ***non-classified mix*** — in Mazowieckie, Wielkopolskie, Łódzkie, Zachodniopomorskie, and Pomorskie voivodeships.

Classified sand and ***raw sand*** have had the largest shares in the production of ***natural sand*** and ***gravel aggregates*** (Tab. 3). Low demand for classified sand, especially in N and W Poland, has resulted in discarding of a part of sand back to the mines. So, its consumption has been much lower than production. Recently, dynamic growth of ***raw sand***, ***raw sand with gravel admixture*** and ***non-classified mix*** has been observed. They have been used primarily (over 90%) in the substructure of new motorways and other roads, especially in Wielkopolskie, Łódzkie, and Mazowieckie voivodeships, and recently — in Pomorskie, Kujawsko-Pomorskie, and Podkarpackie voivodeships.

Gravel is the second most important aggregate of this group. The production rose sharply to over 49 Mt in 2011 (Tab. 3), especially in Dolnośląskie and Małopolskie voivodeships (over 4 Mtpy), as well as Mazowieckie, Podlaskie, Warmińsko-Mazurskie, Opolskie, and Podkarpackie voivodeships (over 3 Mtpy each). There is no gravel production in Świętokrzyskie voivodeship, and very small amounts in Lubelskie and Kujawsko-Pomorskie voivodeships.

Tab. 3. Natural sand and gravel aggregates statistics in Poland — CN 2505 90, 2517 10 10

'000 t

Year	2009	2010	2011	2012	2013
Mining output[1]	**141,114**	**157,236**	**248,690**	**184,745**	**173,267**
Production[2]	**78,487**	**85,586**	**109,969**	**76,773**	**72,953**
• Construction sand	39,590[e]	44,960[e]	56,520[e]	40,280[e]	36,470[e]
• Gravel and mixes, aggregates from pebbles	38,897	40,626	53,449	36,493	36,483
Production[3,r]	**131,075[r]**	**149,237[r]**	**238,145[r]**	**177,408[r]**	**166,280**
• Sand, raw	30,155[r]	35,050[r]	69,756[r]	52,017[r]	46,843
• Sand, raw with gravel admixture	15,497[r]	24,973[r]	47,000[r]	33,841[r]	29,741
• Mix, non-classified	5,302[r]	5,783[r]	15,386[r]	13,555[r]	13,963
• Gravel	31,933	33,739	42,867[r]	31,454	30,538
• Mix, classified	5,702	5,790	7,356[r]	5,524	5,363
• Sand, classified	42,486	43,902	55,780[r]	41,017	39,823
— *including: sand, sold*	*28,873*	*30,731*	*48,400*	*30,100*	*28,274*
Imports[2]	**1,188**	**853**	**1,721**	**902**	**487**
• Construction sand	174	5	143	25	128
• Gravel and mixes	1,014	848	1,578	877	359
Exports[2]	**128**	**116**	**118**	**129**	**548**
• Construction sand	101	98	83	44	217
• Gravel and mixes	27	18	35	85	331
Consumption[2]	**79,547**	**86,323**	**111,572**	**77,546**	**72,892**
Consumption[3,r]	**118,522[r]**	**136,803[r]**	**232,368[r]**	**167,264[r]**	**154,670**

Source: (1) ***Mineral Resources Datafile****-verified, (2)* ***The Central Statistical Office (GUS)****, (3)****authors' estimation***

The assortment of ***natural sand*** and ***gravel aggregates*** production has varied in various regions, depending on possibilities of the local production of gravel and grits of pebbles, as well as on demand for particular assortment. For example, large gravel output reported in western voivodeships (Dolnośląskie, Opolskie, Lubuskie), in SE Poland (Małopolskie, Podkarpackie voivodeships) and in NE Poland (Podlaskie and Warmińsko-Mazurskie voivodeships), has been sold on other regional markets (Warsaw, Łódź, Poznań). Regions around large metropolises (Warsaw, Kraków, Wrocław, Gdańsk) show balanced structure of the production, with higher share of mixes and sand.

Until 2010 around 41% of the total supply has come from 18 largest companies or producing groups, extracting 1 Mtpy or more each, except a few companies exploiting 1-2 Mtpy through only 1 or 2 years - mainly from sand deposits (Tab. 2, 5). In the last 3 years the share of these companies in the total output of natural aggregates decreased by 10%, to 31-33%. Formerly state-owned, but for many years private, multi-plant Mineral Mines constituted significant part of them. In 2013 the largest companies producing natural aggregates were (Tab. 4): **ZPK Rupińscy Partnership** – entirely private Polish company, **Górażdże Kruszywa** owned by Heidelberger (consisting of Zielonogórskie Mineral Mines, Opolskie Mineral Mines and Białostockie Mineral Mines), **Lafarge Kruszywa & Beton**, **Olsztyńskie Mineral Mines** owned by **CRH plc** (Ireland), **Cemex Poland**, three workers' companies: **Szczecińskie Mineral Mines**, **Kruszgeo Rzeszów**, and **Kruszgeo Wielkopolskie Mines Poznań**, as well as **Suwalskie Mineral Mines** (sold in 2004 to **Eko-Invest** of Białystok), **Eurovia Aggragates** - former **Tarmac** (Wrocławskie Mineral Mines and Kosmin Mineral Mines of Łódź). The number of large private companies, established in the last decade, is also significant, especially in western and northern Poland. It is especially informal group of 7 mines in Zachodniopomorskie voivodeship owned by three persons: **Szczepański-Durał-Danilewicz**. Significance of some producers, especially delivering sand and non-classified mix, is temporary, and is related to large engineering works in some areas (Tab. 4). There are no larger sand and gravel producers in Lubelskie and Świętokrzyskie voivodeships, due to lack of deposits of sufficient quality.

Tab. 4. The largest domestic producers of natural sand and gravel aggregates in Poland in 2013

Producer	Voivodeship	Market share [%]
ZPK Rupińscy	Podlaskie, Warmińsko-Mazurskie, Mazowieckie, Dolnośląskie	**4.1**
Górażdże Kruszywa	Opolskie, Dolnośląskie, Lubuskie, Podlaskie	**3.9**
Lafarge Kruszywa and Beton	Zachodniopomorskie, Pomorskie, Mazowieckie, Małopolskie, Lubuskie	**3.4**
Kruszgeo Rzeszów	Małopolskie, Podkarpackie	**2.6**
Olsztyńskie KSM	Warmińsko-Mazurskie, Mazowieckie, Pomorskie, Podlaskie, Zachodniopomorskie	**2.5**
Cemex Polska	Opolskie, Mazowieckie, Małopolskie, Warmińsko-Mazurskie, Łódzkie	**2.4**
Szczecińskie KSM	Zachodniopomorskie, Lubuskie	**1.8**
Szczepańscy-Durał-Danilewicz	Zachodniopomorskie, Kujawsko-Pomorskie	**1.6**
Suwalskie KSM Suwałki	Podlaskie, Warmińsko-Mazurskie	**1.4**
Lubelskie KSM	Lubelskie	**1.4**
Budokrusz	Mazowieckie, Podlaskie, Warmińsko-Mazurskie	**1.3**
KZEK Kruszywo Kraków	Małopolskie, Śląskie	**1.0**
Kruszgeo Wielkopolskie Kopalnie	Wielkopolskie	**0,9**
PPDM Suwałki	Podlaskie, Warminsko-Mazurskie	**0.8**
PPKMiL Katowice	Śląskie	**0.7**
Trans-Żwir Jan Kitowicz	Warmińsko-Mazurskie, Łódzkie	**0.7**
Eurovia Kruszywa	Łódzkie, Dolnośląskie, Lubuskie	**0.6**
Utex Terra	Śląskie	**0.6**

Source: ***authors' estimation***

The mining output of ***crushed*** and ***dimension stone*** in Poland, which are used in about 90% for the production of ***natural crushed aggregates***, since 2003 has been increasing continuously up to a record level of ca. 83.4 Mt in 2011, out of them over 85% have been obtained to crushed aggregates production (Tab. 5). In the last two years it was reduced by 31% due to lower demand. Location of deposits results in concentration of mining output in southern part of Poland. Dolnośląskie voivodeship of has dominated the total output (47–53%), while Świętokrzyskie has accounted for 27–31%, Małopolskie - 10–13%, Śląskie - 5–8%, and Opolskie voivodeship - 2–4%.

Tab. 5. Mining output of compact rocks in Poland

'000 t

Year	2009	2010	2011	2012	2013
TOTAL MINING OUTPUT	**53,639**	**61,438**	**83,382**	**61,992**	**57,754**
Magmatic Rocks	**23,600**	**25,124**	**33,461**	**25,080**	**24,122**
• Basalt	8,414	8,556	11,555	8,626	6,966
• Melaphyre	3,255	3,950	4,993	3,774	4,085
• Porphyry	1,099	1,237	1,554	1,342	1,351
• Diabase	1,601	1,654	2,136	1,629	1,275
• Gabbro	1,646	1,379	1,750	1,254	1,042
• Granite and granodiorite	6,802	7,469	10,671	8,138	8,966
• Syenite	780	879	802	318	438
Metamorphic Rocks	**5,271**	**6,275**	**6,639**	**3,883**	**3,525**
• Amphibolite	790	1,023	1,031	632	684
• Gneiss	1,125	1,205	1,856	923	749
• Migmatite	2,689	2,875	2,693	1,652	1,691
• Serpentinite	667	1,172	1,059	676	402
Sedimentary Rocks	**24,768**	**30,039**	**42,282**	**33,029**	**30,107**
• Chalcedonite	158	219	143	191	-
• Dolomite	10,465	10,392	15,278	12,270	9,185
• Greywacke	542	363	481	461	218
• Limestone	7,368	11,514	17,292	13,299	14,170
• Quartzitic sandstone	1,763	2,254	2,749	2,042	1,772
• Sandstone	4,472	5,297	6,339	4,766	4,749

Source: ***Mineral Resources Datafile****-verified,* ***authors' estimation***

The production of ***crushed aggregates*** based on output of compact rocks has been continuously growing, reaching a record level of over 73 Mt in 2011 due to apogee in the road construction works, with a drop by 36% to 47 Mt in 2013. The main rock types for the production of crushed aggregates have been: ***basalt***, ***granite***, ***melaphyre***, and ***gabbro/diabase*** among magmatic rocks; ***amphibolite*** and ***migmatite*** among metamorphic rocks; and ***dolomite***, ***limestone***, and ***sandstone*** among sedimentary rocks. By 2010 magmatic rocks dominated in the structure of mining output. However, their share in the supply decreased from 50–51% in 2008 to less than 42% in 2013 in favour of sedimentary rocks (Tab. 5). In this group, the most intensively exploited have been: ***basalt*** (7-9 Mtpy) in over

20 mines of various sizes, ***granite*** (increasing output to 10.7 Mt in 2011, with reduction to 9.0 Mt in 2013) in over 40 quarries, ***melaphyre*** (3-4 Mtpy) in five large mines, ***gabbro/ diabase*** (2-3 Mtpy) in three quarries. Single quarries of ***porphyry***, and ***syenite*** are of minor importance. All quarries of magmatic rocks are located in the Lower Silesia, except of single mines of ***porphyry*** and ***diabase*** in Kraków vicinity. The assortment of the production has been variable: in some plants ***grits*** have dominated, while in others — ***key aggregate***, ***breakstone***, or even ***crushed stone*** or ***large engineering stone***.

There are only single mines of metamorphic rocks used for crushed aggregates production: ***amphibolite***, ***serpentinite***, ***gneiss***, and — since 2007 — ***migmatite*** (the total output rose to 6.6 Mt in 2011, while in 2013 it dropped to 3.5 Mt). All quarries of metamorphic rocks are located in the Lower Silesia.

The share of sedimentary rocks in the production of crushed aggregates has been significant: 42–45% in recent years, with rise to 52% in 2013 (Tab. 6). The predominant type of sedimentary rocks extracted for crushed aggregates has been ***limestone*** (a record level 17.3 Mt in 2011, ca. 14.2 Mt in 2013), and ***dolomite*** (a record level of ca. 15.3 Mt in 2011, ca. 9.2 Mt in 2013), with minor — but increasing importance of ***sandstone*** (6.3 Mt in 2011 and 4.7 Mt in 2013) and ***quartzitic sandstone*** (1.8-2.7 Mtpy). The production of ***limestone*** crushed aggregates has been concentrated in the Świętokrzyskie Mountains (over 20 mines), while in the Carpathians, Kraków region and a few other regions single limestone mines have been operating. Moreover, significant quantities of limestone crushed aggregates have been produced by lime plants. ***Dolomite*** crushed aggregates production is concentrated in the Upper Silesia-Kraków region and the Świętokrzyskie Mountains (8 mines per each). Moreover, they have been also obtained from waste dolomite rock in zinc-lead ore mines, and dolomite rock from deposits recognised for smelters and refractories (the Upper Silesia-Cracow region). The mining production of ***sandstone*** is concentrated in the Carpathians, where 8 large mines and almost 30 smaller quarries have been operated. Another sedimentary rocks used for crushed aggregates production is ***greywacke***, mined in three quarries (two in Opole region, one near Kłodzko).

Production of ***natural crushed aggregates*** in Poland rose almost four-fold to a record level of 88.7 Mt in 2011, with 35% drop in the next two years due to reduction of road construction works (Tab. 6). In recent years the most significant growth has been reported in the case of crushed aggregates made of dolomite and limestone, as well as of metamorphic rocks.

Tab. 6. Crushed aggregates statistics in Poland — CN 2517 10 20–80

'000 t

Year	2009	2010	2011	2012	2013
Mining output[1]	53,639	61,438	83,382	61,992	57,754
Production[2]	57,903	62,809	88,697	64,860	57,945
• including production from compact rocks deposits[3,e]	*46,122*	*52,246*	*73,778*	*53,950*	*47,050*
Imports[2]	3,074	3,217	5,881	3,659	1,533
Exports[2]	793	912	933	825	1,006
Consumption[a]	60,184	65,114	93,645	67,694	58,472

*Source: [(1)]**Mineral Resources Datafile**, [(2)]**The Central Statistical Office (GUS)**, [(3)]**author's estimation***

Rocks from other groups of deposits have been also partly used for the production of crushed aggregates, for example: ***limestone rock*** from deposits recognised for the lime and cement industry (5–7 Mtpy), ***waste dolomite rock*** in zinc-lead mines (up to 1 Mtpy), and ***dolomite rock*** from deposits recognised for metallurgy and the refractory industry (ca. 2 Mtpy).

In 2013 the structure of ***natural crushed aggregates*** production was dominated by ***granulated natural crushed aggregates*** (***grits***), the share of which rose up to 60–65%. The rest has been constituted by ***common natural crushed aggregates*** (***breakstone***, ***key aggregate***). Crushed aggregates have been manufactured primarily in Dolnośląskie (30–35%), Świętokrzyskie (21–23%), and Małopolskie voivodeships (15–17%), with minor importance of Śląskie (10–14%) and Opolskie voivodeships (2–4%). Type and quality of natural crushed aggregates has been diversified. Natural crushed aggregates of magmatic rocks, manufactured mainly in Dolnośląskie and Opolskie voivodeships, have had the highest quality. In Małopolskie voivodeship, high quality porphyry and diabase aggregates, and lower quality dolomite and sandstone aggregates have been produced. In Świętokrzyskie voivodeship, medium quality limestone aggregates, as well as higher quality dolomite aggregates have been manufactured. The share of granulated natural crushed aggregates has been the largest in Dolnośląskie, Małopolskie, and Opolskie voivodeships.

In Poland ***natural crushed aggregates*** have been delivered by ca. 110 companies. Over 20 of them are small, with annual production of below 0.1 Mtpy. Recently, the output of ca. 110 mines have exceeded 0.1 Mtpy (Tab. 7). The majority of them occur in the Lower Silesia and in SE Poland. In 2013, ca. 55% of the total supply came from the 18 large companies, extracting over 0.8 Mtpy each (Tab. 8). The majority of these companies have operated one or two plants, while multi-plant companies (3–5 mines) have been rather rare.

Tab. 7. Structure of mines extracting compact rocks deposits in Poland in 2013[1]

Voivodeship	Mines and mining output level [‘000 tpy]					
	<100	100–200	200–500	500–1,000	>1,000	Total
Total number of mines	136	33	31	26	18	244
Dolnośląskie	42	14	10	10	10	86
Lubelskie	4	-	-	-	-	4
Łódzkie	19	1	3	1	-	24
Małopolskie	26	5	9	-	2	42
Mazowieckie	12	-	-	-	-	13
Opolskie	3	4	2	-	-	9
Podkarpackie	9	1	-	1	-	11
Śląskie	7	1	4	2	-	14
Świętokrzyskie	14	7	3	12	6	42

[1] primarily for natural crushed aggregates production [2] mainly small mines delivering dimension stone

Source: ***Mineral Resources Datafile****-verified*

Tab. 8. The largest domestic producers of natural crushed aggregates in Poland in 2013

Producer	Voivodeship	Estimated market share [%]
I. Production from crushed and dimension stone deposits		
Lafarge Kruszywa i Beton, Warszawa[1]	Świętokrzyskie, Dolnośląskie, Małopolskie, Kujawsko-Pomorskie	8.2
Kopalnie Dolomitu, Sandomierz	Świętokrzyskie, Podkarpackie	7.2
Strabag, Warszawa (Kopalnie Melafiru w Czarnym Borze Ltd., Czarny Bór; Mineral Polska Ltd., Czarny Bór)	Dolnośląskie	5.5
Basalt AG (Kopalnie Surowców Skalnych w Bartnicy, Bartnica)	Dolnośląskie	5.1
Colas Kruszywa, Palędzie	Dolnośląskie	3.7
Dolnośląskie Surowce Skalne, Warszawa	Dolnośląskie	3.6
Kieleckie Kopalnie Surowców Mineralnych, Kielce	Świętokrzyskie	3.6
Kopalnia Wapienia Morawica, Morawica	Świętokrzyskie	2.6
Kopalnie Porfiru i Diabazu, Krzeszowice	Małopolskie	2.4
PGP Bazalt, Wilków	Dolnośląskie	2.0
Kopalnia Melafiru Tłumaczów, Tłumaczów	Dolnośląskie	2.0
Georyt Krzysztof Witkowski, Nieciecza	Świętokrzyskie	2.0
Kopalnia Granitu Kamienna Góra, Micigózd	Świętokrzyskie, Opolskie	1.7
Mota Engil Central Europe, Kraków	Dolnośląskie	1.5
KiZWK Bukowa Góra, Łączna	Świętokrzyskie	1.6
Eurovia Kruszywa, Wrocław	Dolnośląskie, Świętokrzyskie	1.4
II. Production from other deposits		
Nordkalk Miedzianka, Piekoszów	Świętokrzyskie	3.0
ZPW Trzuskawica, Trzuskawica	Świętokrzyskie	2.5
Górnicze Zakłady Dolomitowe, Siewierz	Śląskie	2.0
Boloil, Bukowno	Małopolskie	1.5

[1] also on the basis of industrial limestone from Barcin-Piechcin-Pakość deposit and granodiorite stone imported from Ukraine

Source: ***authors' estimation***

Artificial aggregates from metallurgical and ***mining wastes*** are produced in the same way like natural aggregates, i.e. by crushing and sieving (sometimes also washing). Their quality is sometimes even better than quality of some crushed aggregates (e.g. some limestone aggregates). They compete with natural crushed aggregates, regarding quality and price. **Harsco Metals Polska** (previously **Alexander Mill Services**) with plants in Warsaw, Ostrowiec, Zawiercie, and Bytom is currently the most important supplier. Its maximum production has achieved ca. 2.5 Mtpy, but recently it has amounted to below 1.5 Mtpy. **Slag Recycling** of Kraków, utilising the slag dumps of the **Sendzimir Steelworks**, was another very important producer of this type of aggregates, with production up to 2.5 Mtpy. However, since 2009 this company has discountinued that production. Older dump of the **Sendzimir Steelworks'** slag has been extracted by **Madrohut**, while in the Upper Silesia a few smaller producers of such aggregates have been operating, with **HK Eko-Grys** in Dąbrowa Górnicza and **Ehazet** in Katowice as the most important. Outside the Silesia-Cracow region, metallurgical slag has been also utilized in Warsaw, Ostrowiec Świętokrzyski, and Stalowa Wola. Similar aggregates have been also manufactured from ***shaft furnace slag from copper smelters*** in Głogów (a new unit of **KGHM Ecoren/Metraco**, up to 1.0 Mtpy) and Legnica. ***Aggregates from shaft furnace slag from zinc smelter*** have been also delivered by **Miasteczko Śląskie Zinc Smelter**. The total production of ***aggregates from metallurgical slag*** was estimated at ca. 4.9 Mt in 2011, with rapid drop to only 1.9 Mt in 2013 (Tab. 9). This production decreased distinctly in the last four years due to exhaustion of some old dumps of slag.

Artificial aggregates from coal processing wastes are of lower quality comparing to ***aggregates from metallurgical slag***. They have been recently manufactured on the basis of old dumps of such wastes by several companies in the Upper Silesia. Since 2010 their total estimated production has risen to ca. 2.5-3.0 Mtpy (Tab. 9), primarily due to development of low quality aggregates production on the basis of sandstone and mudstone-sandstone wastes by **Haldex**[1]. Minor producers of aggregates from self-burnt coal shale have been: **Tercharpol** of Siemianowice Śląskie, **Barosz Gwimet** of Marklowice**,** and **Haller** of Katowice**.**

Artificial aggregates manufactured from clays by thermal processing, i.e. ***gravelite*** from clays, have been recently produced by two companies: **Saint-Gobain Construction Products Polska Weber Leca Unit** in Gniew near Gdańsk, and **Keramzyt** in Mszczonów near Warsaw. Their combined production amounted to ca. 0.3 Mt in 2013.

Artificial aggregates obtained through the thermal processing of industrial waste materials are of marginal importance in Poland. Currently, this is only ***ash gravelite*** manufactured primarily under the name ***pollytag*** by **Pollytag** of Gdańsk at ca. 0.1 Mtpy, and by **PGE Turów** power plant at ca. 0.3 Mtpy.

Recycled aggregates have been produced in Poland in very small amounts. There is no exact data on production of such aggregates, because a lot of them are commonly used directly for construction purposes on site by their producers. Their production has not been reported by the Central Statistical Office. However, this production can be estimated at 0.5–1.0 Mtpy.

Trade

A characteristic feature of the ***aggregates*** market is local production and use within a distance convenient for road transportation (seldom railway). However, in the case of the particularly favourable location of plants, they can be traded internationally. Recently, exports of gravel from Lower Silesia to Germany and the Czech Republic, have not exceeded 0.5 Mtpy, with a growth in 2013 (Tab. 10). On the other hand, imports

[1] Such aggregates are often produced due to coal recovery and only a part of them find application (the rest is dumped)

Tab. 9. Structure of domestic market of aggregates

Mt

Year	2009	2010	2011	2012	2013
Aggregates, total					
Production[1]	**183.3[r]**	**206.9[r]**	**327.9[r]**	**237.4[r]**	**217.7**
Demand[1]	**186.6[r]**	**209.9[r]**	**334.4[r]**	**241.0[r]**	**218.3**
• **Natural sand and gravel aggregates**					
Production (sold)	117.5[r]	136.1[r]	230.8[r]	166.5[r]	154.7
Consumption	118.5[r]	136.8[r]	232.4[r]	167.3[r]	154.7
• **Natural crushed aggregates**					
Production	57.9	62.8	88.7	64.9	57.9
Consumption	60.2	65.1	93.6	67.7	58.5
• **Artificial aggregates from metallurgical slag**					
Production[e] = Consumption[e]	5.0	4.6	4.9	2.3	1.9
• **Artificial aggregates from mining wastes[2]**					
Production[e] = Consumption[e]	2.4	2.5	2.7	3.0	2.5
• **Artificial aggregates from materials thermally processed[3]**					
Production[e] = Consumption	0.5	0.9	0.8	0.7	0.7
• **Aggregates from recycling**					
Production = Consumption	NA	NA	NA	NA	NA

[1] without aggregates from recycling [2] mostly from self-burned coal shale

[3] from clays and industrial wastes thermal processing

Source: ***authors' estimation***

of ***natural sand*** and ***gravel aggregates*** increased to 0.8-1.4 Mtpy in the years 2009-2011, primarily due to development of imports from Germany and Ukraine, while in 2013 it decreased to below 0.5 Mt (Tab. 11).

Similar phenomena have been observed in ***natural crushed aggregates*** trade. Proximity of market of eastern lands of Germany resulted in continuous exports of such aggregates at 0.8-1.1 Mtpy. Recently, also exports to Lithuania started to be developed (Tab. 12).

Lack of sources for ***natural crushed aggregates*** production in northern and eastern Poland, and high costs of transportation of aggregates from other regions of Poland, resulted in growing imports of crushed aggregates, up to over 5.8 Mt in 2011, with very strong drop by over 70% to only 1.5 Mt in 2013 (Tab. 13). These come primarily from Norway and Sweden (northern Poland market), Ukraine (eastern Poland market), the Czech Republic and Slovakia (southern Poland market), and recently also from Germany.

The volume of ***artificial aggregates*** trade is difficult to determine, because they are classified under various items of the official trade nomenclature. Probably they

Tab. 10. Natural sand and gravel aggregates exports from Poland, by country — CN 2517 10 10, 2505 90

'000 t

Year	2009	2010	2011	2012	2013
Exports	**127.5**	**115.6**	**118.4**	**128.2**	**547.9**
Czech Republic	116.3	106.5	96.8	57.9	276.6
Germany	0.2	0.1	0.0	19.7	144.9
Lithuania	8.0	6.0	17.7	46.8	124.3
Others	3.0	3.0	3.9	3.8	2.1

Source: ***The Central Statistical Office (GUS)***

Tab. 11. Natural sand and gravel aggregates imports to Poland, by country — CN 2505 90, 2517 10 10

000' t

Year	2009	2010	2011	2012	2013
Imports	**1,187.2**	**853.1**	**1,721.4**	**902.5**	**486.8**
Czech Republic	14.3	20.6	9.1	12.9	0.7
Germany	947.4	481.3	907.6	504.0	328.8
Slovakia	49.8	57.7	155.3	81.4	30.7
Sweden	-	-	-	85.0	0.1
Ukraine	171.3	289.5	635.4	208.5	121.6
Others	4.4	4.0	14.0	10.7	4.9

Source: ***The Central Statistical Office (GUS)***

Tab. 12. Natural crushed aggregates exports from Poland — CN 2517 10 20–80

'000 t

Year	2009	2010	2011	2012	2013
Exports	**793.3**	**911.5**	**932.9**	**825.0**	**1,006.2**
Czech Republic	21.9	18.3	7.2	0.7	0.9
Germany	763.7	883.7	902.0	763.9	853.1
Lithuania	-	-	13.0	52.1	143.1
Others	7.7	9.5	10.7	8.3	9.1

Source: ***The Central Statistical Office (GUS)***

are included together with ***crushed aggregate*** in the common item **CN 2517 10 80**. Nevertheless, it is known that **Saint-Gobain Construction Products Polska Weber Leca Unit** in Gniew has exported a part of its production of ***gravelite***, while **Pollytag** of Gdańsk – more than 50,000 tpy of ***ash gravelite*** called ***pollytag***.

The trade balance in ***natural sand*** and ***gravel aggregates***, due to significant decrease of exports and large increase of imports, has been negative, reaching ca. -63 million PLN in 2011. However, it has recently improved and in 2013 small surplus was reported (Tab. 14). The deficit in ***natural crushed aggregates*** trade deepened to 257 million PLN

Tab. 13. Natural crushed aggregates imports to Poland — CN 2517 10 20–80

'000 t

Year	2009	2010	2011	2012	2013
Imports	**3,073.7**	**3,217.4**	**5,881.2**	**3,658.9**	**1,533.4**
Belarus	–	0.1	–	–	–
Czech Republic	34.1	290.9	212.4	48.3	26.0
Finland	38.5	30.6	22.7	–	4.1
Germany	1,273.4	867.5	1,825.9	991.7	435.3
Norway	735.2	946.7	2,567.3	2,001.5	718.8
Slovakia	415.9	225.8	101.1	100.4	85.0
Sweden	388.6	353.3	311.2	203.6	122.4
Ukraine	182.7	487.6	826.5	303.1	135.3
Others	5.3	14.9	14.1	10.3	6.5

Source: ***The Central Statistical Office (GUS)***

Tab. 14. Value of mineral aggregates trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Natural sand and gravel aggregates					
Exports	4,498	4,119	4,351	5,443	18,056
Imports	50,665	37,654	67,820	42,781	17,215
Balance	**-46,167**	**-33,535**	**-63,469**	**-37,338**	**+841**
Natural crushed aggregates					
Exports	21,281	20,461	23,201	20,787	25,566
Imports	173,036	134,491	280,607	189,462	74,824
Balance	**-151,755**	**-114,030**	**-257,406**	**-168,675**	**-49,258**

Source: ***The Central Statistical Office (GUS)***

in 2011, but in the last two years it improved to 49 million PLN due to imports volume reduction and some decrease of their prices (Tab. 14).

Consumption

The consumption of ***natural sand*** and ***gravel aggregates*** has been closely linked to civil engineering works in residential construction, industrial construction, transport infrastructure, etc. Domestic demand for such aggregates has revived. Moreover, a quick increase of consumption of sand and non-classified mix in engineering works has been also reported. This is why the total domestic consumption of ***sand and gravel aggregates*** rose to as much as ca. 241 Mt in 2011, with reduction to ca. 166 Mt, i.e. by more than 30%, in 2013 (Tab. 3).

The construction industry has been the main consumer of aggregates. Currently, over 70 Mtpy, i.e. almost all the production of ***classified sand and gravel aggregates*** (gravel, classified sand, classified mix) has been consumed by the construction industry for the production of ready-mix concrete, concrete products and dry mixes, or used on site in the construction of individual houses. Ready-mix concrete, produced by concrete-mixing plants, is consumed by the residential construction, industrial construction, and road building industries (see: **CONCRETE AND CONCRETE PRODUCTS**). These sectors have traditionally consumed classified mixes, though gravel and classified sand have started to dominate in this sector. Classified sand is also used for the production of building mortar and construction chemistry products. On the other hand, the majority of produced ***non-classified mix*** and ***raw sand*** (60-110 Mtpy, in 2011 even over 128 Mt) has been recently utilized in engineering works (embankments of roads).

Value of domestic ***natural sand*** and ***gravel aggregates*** market has been estimated at 2,000–2,500 million PLN/y in recent years. It has not been precisely illustrated by the Central Statistical Office, because it collects data on sold production only from large producers, employing over 50 workers. Reported value of natural sand and gravel aggregates sales by large producers rose from 410 million PLN in 2001 to ca. 2,100 million PLN in 2011, with the reduction to ca. 1,400 million PLN in 2013. Sales of natural sand and gravel aggregates by smaller companies make probably another ca. 500–800 million PLN/y.

Situation on the domestic natural aggregates market can also be illustrated by the average unit values of the main ***natural sand*** and ***gravel aggregates*** assortments. In 2009-2010 these prices declined by over 20%, with small improvement in 2011-2012 and further reduction in 2013 (Tab. 15). It is worth mentioning, that price spread of the same assortment in different regions has varied widely, depending on local demand for such aggregates, availability of local sources and transportation costs. For example, price of ***building sand*** has varied from ca. 6–8 PLN/t in Warmińsko-Mazurskie, Podlaskie and Zachodniopomorskie to 18–20 PLN/t in Małopolskie, Podkarpackie and Świętokrzyskie voivodeships. Average price of ***gravel*** has fluctuated from 24–28 PLN/t in Dolnośląskie, Lubelskie, and Wielkopolskie voivodeships to over 35 PLN/t in Warmińsko-Mazurskie and Podlaskie voivodeships.

Tab. 15. Average unit values of sales of the main types of aggregates in Poland

PLN/t

Year	2009	2010	2011	2012	2013
Sand	10.9	10.0	11.2	11.5	11.2
Gravel and mixes	27.6	26.7	27.3	27.8	25.0
Natural crushed aggregates	27.9	27.3	28.3	26.2	23.9

Source: ***The Central Statistical Office (GUS)***

The main areas of ***classified sand*** and ***gravel aggregates*** consumption in Poland are a few large cities. On the basis of the value of construction production and level of ready-mix concrete production, the most important markets for ***classified sand*** and ***gravel aggregates*** in Poland have been the following voivodeships: Mazowieckie — 16-18% of the domestic market, Śląskie and Wielkopolskie — 9–10% each, Dolnośląskie, Małopolskie, and Pomorskie — 7–8% each, Łódzkie — 6-7%. These markets have comprised 65-70% of domestic ***classified sand*** and ***gravel aggregates*** consumption. Some of these markets are self-sufficient, but not Warsaw, Poznań, and Łódź ones, where a large amounts of aggregates have come from SW, SE, and NE Poland.

Non-classified mix and ***raw sand*** are used in the largest amounts in areas of intensive road engineering works. Recently, they have been located especially in Łódzkie, Mazowieckie, Podkarpackie, Pomorskie, and Wielkopolskie voivodeships. Share of foreign suppliers of natural sand and gravel aggregates has been marginal (below 1%).

Natural crushed aggregates are utilized mainly in the road and railway construction. The most important rock materials for these purposes are ***crushed aggregates*** (crushed stone, breakstone, key aggregate, grits) made of ***basalt***, ***melaphyre***, ***diabase***, ***porphyry***, ***granite***, ***gabbro***, ***amphibolite***, ***gneiss***, ***migmatite***, ***serpentinite***, ***dolomite***, ***limestone***, ***sandstone***, and ***greywacke***. ***Basalt*** and ***melaphyre*** aggregates are also used for road pavements. In the civil construction, the majority of aggregates made of magmatic rocks is used for high grade and special concrete. Sedimentary rock aggregates are used for lower grade concrete. A special application of crushed stone aggregates is the production of ***terrazzo***, which is manufactured using primarily ***grits*** from ***marble***, ***dolomitic marble***, and ***decorative limestone***. It is estimated, that currently ca. 70% on natural crushed aggregates has been used in road construction, 10-15% in railway construction, 15-20% in industrial and housing construction (for the production of high-class concrete).

Some of these stones have specific applications, e.g. ***basalt*** for the production of ***rock wool*** and ***basalt casting products*** (see: **ROCK SMELTING COMMODITIES**), ***diabase*** also for ***rock wool***, ***melaphyre*** for ***asphalt pavements***, ***granite*** for ***feldspar*** and ***feldspar-quartz flours*** (see: **FELDSPAR**), ***limestone*** and ***dolomite*** for ***fertilizers***, ***pure limestone*** and ***dolomitic marble*** for ***flour for the glass-making*** and ***ceramics industries*** (see: **LIMESTONE AND LIME**; **DOLOMITE**), etc.

The consumption of ***natural crushed aggregates*** has been closely linked to the level of civil engineering work in transport infrastructure (roads, railways) and to the demand for high-class concrete. Since 2003 domestic demand for such aggregates has spectacularly increased in Poland, due to intensification of construction works, especially road construction, being a result of high level of EU funds for infrastructure development. This is why total domestic consumption of ***natural crushed aggregates*** rose to ca. 93.6 Mt in 2011, i.e. by ca. 220% as compared to 2002 (Tab. 7). However, in the last two years, as road construction works weakened, ***natural crushed aggregates*** consumption dropped by 38%, to ca. 58.5 Mt.

Value of domestic ***natural crushed aggregates*** market was strongly increasing up to almost 2,300 million PLN in 2011, with reduction to ca. 1,450 million PLN in 2013. According to the Central Statistical Office, collecting data on sold production only from large producers, employing over 50 workers, the value of natural aggregates production was increasing continuously in the years 2002–2011, up to 2,320 million PLN in 2011, with drop to under 1,400 million PLN in 2013. The next 50–70 million PLN of natural crushed aggregates sales has come probably to smaller companies. The average unit values of natural crushed aggregates, after rapid growth reported in the years 2007-2008, were fluctuated between 27 and 28 PLN/t in 2009-2011, while over the last two years they were reduced by 15% (Tab. 15).

Crushed aggregates regional markets have had different sources of supply, as a result of crushed aggregates producers' location almost entirely in southern Poland. Regional markets in southern Poland have been dominated by local producers. Warsaw and Łódź markets have been supplied by both Lower Silesian producers of the highest quality crushed aggregates from magmatic rocks, and by closer located limestone and dolomite crushed aggregates suppliers from Kielce region. Some imported crushed aggregates also have recently entered this market (e.g. from Ukraine). In northern and eastern Poland market shares of imported crushed aggregates have sometimes exceeded even 40%. The average share of imported crushed aggregates in Poland amounted to 6% in 2011, but below 3% in 2013.

Artificial aggregates from metallurgical and ***mining wastes*** have been applied as cheaper substitutes of ***crushed aggregates*** in the road, railway and civil construction. Their market has been developing since the mid-1990s, up to ca. 11 Mtpy in 2006–2007, with distinct reduction to only ca. 4.4 Mt in 2013 (Tab. 10). Some of them (aggregates from metallurgical wastes) have effectively competed with natural crushed aggregates, but their market has been limited primarily to the Upper Silesia-Cracow region. ***Recycled aggregates*** are also raw materials competitive to natural aggregates, but mainly in large cities.

Around 75% of domestic ***gravelite*** is consumed by the construction and road building industries for insulation, drainage, and structural purposes. Much smaller quantities are utilised by horticulture (as subsoil in new cultivable areas and for potted plants) and geotechnics (as a filling material for the construction of light embankments). The principal consumers of ***gravelite*** are ***lightweight concrete*** manufacturers. Uses of ***ash gravelite*** are similar to those of ***gravelite***.

Major companies involved in mineral aggregates production in Poland, as of December 2013

- Lafarge Kruszywa i Beton Sp. z o.o. (Lafarge Kruszywa i Beton Ltd.), ul. Iłżecka 24, 02–135 Warszawa, tel. +48 22 3246000, fax +48 22 3246005, www.lafarge.pl — *natural sand and gravel aggregates, basalt, melaphyre, granite, limestone, dolomite and sandstone crushed aggregates.*
- Górażdże Kruszywa Sp. z o.o. (Górażdże Kruszywa Ltd.), ul. Cementowa 1, Chorula, 47–316 Górażdże, tel. +48 77 4468600, fax +48 77 4468602, www.heidelbergcement.com/pl — *natural sand and gravel aggregates.*
- Kruszgeo S.A. Przedsiębiorstwo Produkcji Kruszywa i Usług Geologicznych w Rzeszowie (Kruszgeo Aggregates Production and Geological Services Enterprise Joint Stock Co. — Rzeszów), ul. Reja 16, 35–959 Rzeszów, tel. +48 17 8536051, fax +48 17 8636278, www.kruszgeo.com.pl — *natural sand and gravel aggregates.*
- Cemex Polska Sp. z o.o. (Cemex Polska Ltd.), Al. Jerozolimskie 212A, 02-486 Warszawa, te. +48 22 5714100, fax +48 22 5714101, www.cemex.pl — *natural sand and gravel aggregates, granite and dolomite crushed aggregates.*
- Olsztyńskie Kopalnie Surowców Mineralnych Sp. z o.o. w Olsztynie (Olsztyńskie Mineral Mines Ltd.), ul. Budowlana 3, 10–424 Olsztyn, tel. +48 89 5211000, fax +48 89 5122637, www.oksm.pl — *natural sand and gravel aggregates, basalt, granite and sandstone crushed aggregates.*
- Eurovia Kruszywa Sp. z o.o. we Wrocławiu (Eurovia Kruszywa Ltd. of Wrocław), ul. Szwedzka 5, 55–040 Kobierzyce, tel. +48 71 3800300, fax +48 71 3800330, www.eurovia-kruszywa.pl — *natural sand and gravel aggregates, basalt, granite and quartzite crushed aggregates.*
- Zakłady Produkcji Kruszyw Rupińscy Sp. j. w Szumowie (Rupińscy Aggregates

Production Plants Co. of Szumowo), ul. Przemysłowa 28, 18-305 Szumowo, tel. +48 86 4768122, fax +48 86 4768131, www.zpkszumowo.pl — *natural sand and gravel aggregates.*

- Szczecińskie Kopalnie Surowców Mineralnych S.A. w Szczecinie (Szczecin Mineral Mines Joint Stock Co.), ul. Tartaczna 9, 70–893 Szczecin, tel. +48 91 4621242, fax +48 91 4621096, www.sksm.com.pl — *natural sand and gravel aggregates.*
- Kruszgeo Wielkopolskie Kopalnie Sp. z o.o. w Poznaniu ("Kruszgeo" Wielkopolskie Mines — Poznań Ltd.), ul. Grunwaldzka 21, 60–783 Poznań, tel. +48 61 8662249, fax +48 61 8659811, www.kruszgeo.poznan.pl — *natural sand and gravel aggregates.*
- Kopalnie Surowców Skalnych w Bartnicy Sp. z o.o. (Rock Mineral Quarries Ltd. of Bartnica), Bartnica 70, 57–451 Świerki, tel. +48 74 8720070, fax +48 74 8720078, www.bartnica.com.pl — *melaphyre, gabbro and diabase crushed aggregates.*
- Kopalnie Melafiru w Czarnym Borze Sp. z o.o. (Melaphyre Mines Ltd. of Czarny Bór), ul. Wesoła 12, 58–379 Czarny Bór, tel. +48 74 8866830, fax +48 74 8866833, www.mineral-polska.com — *melaphyre crushed aggregates.*
- Colas Kruszywa Sp. z o.o. w Palędziu (Colas Kruszywa Ltd. of Palędzie), ul. Nowa 49, 62–070 Palędzie, tel. +48 61 8945460, fax +48 61 8945465, www.colas.pl — *basalt and granite crushed aggregates.*
- Dolnośląskie Surowce Skalne S.A. w Warszawie (Dolnośląskie Surowce Skalne Joint Stock Co. of Warsaw), Rondo ONZ 1, 00–124 Warszawa, tel. +48 22 3549320, fax +48 22 3549330, www.dss.pl — *amphibolite and migmatite crushed aggregates.*
- Przedsiębiorstwo Górniczo-Produkcyjne Bazalt S.A. w Wilkowie (Bazalt Mining and Producing Plant Joint Stock Co. of Wilków), 59–500 Złotoryja, P.O. Box 34, tel. +48 76 8783872, fax +48 76 8783421, www.pgpbazalt.pl — *basalt crushed aggregates.*
- Kopalnie Porfiru i Diabazu Sp. z o.o. w Krzeszowicach (Porphyry and Diabase Quarries Ltd. of Krzeszowice), ul. Kościuszki 10, 32–065 Krzeszowice, tel. +48 12 2820619, fax +48 12 2822600, www.kruszywa.com — *porphyry and diabase crushed aggregates.*
- For producers of limestone and dolomite crushed aggregates, see: **LIMESTONE AND LIME**; **DOLOMITE**.
- Harsco Metals Polska Sp. z o.o. (Harsco Metals Polska Ltd.), al. Komisji Edukacji Narodowej 36, 02–722 Warszawa, tel. +48 22 5461050 fax +48 22 5461060, www.harscometals.com — *aggregate from metallurgical slag*.
- KGHM Ecoren S.A. w Lubinie (KGHM Ecoren Joint Stock Co. of Lubin), ul. Marii Skłodowskiej-Curie 45A, 59–301 Lubin, tel. +48 76 7468970, fax +48 76 7468971, www.ecoren.pl — *aggregate from metallurgical slag*.
- HK Eko-Grys Sp. z o.o. w Dąbrowie Górniczej (HK Eko-Grys Ltd. of Dąbrowa Górnicza), ul. Koksownicza 8, 42–523 Dąbrowa Górnicza, tel./fax +48 32 7955218, www.ekogrys. pl — *aggregate from metallurgical slag*.
- Haldex S.A. w Katowicach (Haldex Joint Stock Co. of Katowice), Pl. Grunwaldzki 8/10, 40–127 Katowice, tel. +48 32 7869552, fax +48 32 7869559, www.haldex.com.pl — *shale gravelite from dumps*.
- Saint-Gobain Construction Products Polska Sp. z o.o. Oddział Weber Leca w Gniewie ("Saint-Gobain Construction Products Polska" Ltd. Weber Leca Unit of

Gniew), ul. Krasickiego 9, 83–140 Gniew, tel. +48 58 5352595, fax +48 58 5352596, www.netweber.pl — *gravelite*.

- Przedsiębiorstwo Kruszyw Lekkich Keramzyt Sp. z o.o. w Mszczonowie (Keramzyt Lightweight Aggregate Enterprise Ltd. of Mszczonów), ul. Warszawska 43, 96–320 Mszczonów, tel./fax +48 46 8571710, www.keramzyt.pl — *gravelite*.
- Pollytag S.A. (Pollytag Joint Stock Co.), ul. Wielopole 6, 80–556 Gdańsk, tel./fax +48 58 3431129, www.pollytag.com.pl — *ash gravelite*.

ALUMINUM

Overview

Aluminum (**Al**) ranks after iron as the second most commonly used metal in the world. It has maintained its standing in the world economy, despite the fact that in practice it is of importance only in the form of drawn, rolled, or extruded products, or as a component of alloys. The main areas of application are the manufacture of transportation means (automobiles, aircraft, railway cars), the building, engineering, and electrical industries, the production of packing materials, and others. Approximately 80% of world aluminum production is obtained from ***alumina*** processing, as so-called **primary aluminum**, whereas the rest is recovered from ***scrap***, as **secondary aluminum**.

Sources

There is no domestic production of ***alumina***, which was imported for ***primary aluminum*** production (see: **BAUXITE AND ALUMINA**). The secondary sources of aluminum consist of ***Al scraps*** and ***wastes***.

Production

The only Polish producer of ***primary aluminum*** - the **Konin Aluminum Smelter** of Konin (owned by **Impexmetal** belonging to **GK Boryszew**), in 2009 terminated this production, carried on since 1966. Smelter had capacity of electrolysis unit ca. 55,000 tpy. The smelter produced three grades of ***primary aluminum*** — 99.8%, 99.7% and 99.5% Al — on the basis of imported ***alumina***. This plant remains the largest producer of ***rolled products*** in Poland. Since 2009 plant consumed majority of imported aluminum, as well as aluminum and aluminum alloys scraps. Now, smelter can produce max. 80,000 tpy of rolled products.

Tab. 1. Aluminum statistics in Poland — CN 7601 10

'000 t

Year	2009	2010	2011	2012	2013
Production[e]	16.9	16.0	13.9	11.1	16.0
— *Secondary*	*16.9*	*16.0*	*13.9*	*11.1*	*16.0*
Imports	72.4	126.0	125.9	112.5	106.9
Exports	1.4	8.8	5.3	1.9	2.0
Consumption[a]	87.9	133.2	134.5	121.7	120.9

Source: ***The Central Statistical Office (GUS).***

The recovery of ***non-alloyed aluminum*** from ***scrap*** and ***wastes*** is not well developed in Poland, though in 2013 it increased again up to 16,000 t (Tab. 1). Reliable data on production of ***alloyed primary and secondary aluminum*** have been reported since 2006 (Tab. 2). However, in 2013 only combined volumes of primary and secondary aluminium production and trade were reported. Primary alloys are produced from non-alloyed aluminum, while secondary alloys from ***aluminum scrap*** and ***wastes***. Total production of secondary aluminum can be estimated at ca. 214,000 t Al in 2012, and 255,000 t Al in 2013.

Tab. 2. Aluminum alloys statistics in Poland — CN 7601 20

'000 t

Year	2009	2010	2011	2012	2013
Production	236.3	265.7	302.6	312.0	368.1
— *primary*	*91.6*	*92.6*	*111.9*	*109.0*	*129.1*[e]
— *secondary*	*144.7*	*173.1*	*190.6*	*203.0*	*239.0*[e]
Imports	151.1	199.5	249.0	252.8	288.6
— *primary*	*104.9*	*135.2*	*164.3*	*176.5*	.
— *secondary*	*46.2*	*64.3*	*84.7*	*76.3*	.
Exports	63.9	98.4	110.4	115.5	158.1
— *primary*	*6.1*	*11.0*	*11.7*	*9.7*	.
— *secondary*	*57.8*	*87.4*	*98.7*	*105.8*	.
Consumption[a]	329.6	366.8	441.2	449.3	498.6
— *primary*	*196.5*	*216.8*	*264.5*	*275.8*	.
— *secondary*	*133.1*	*150.0*	*176.6*	*173.5*	.

Source: ***The Central Statistical Office (GUS)***

Trade

In the years 2008–2009, imports of ***aluminum*** were reduced by ca. 30% to ca. 72,400 tpy, in the years 2010–2011 they recovered up to 125,900 tpy, while in the years 2012–2013 they decreased by 15% to ca. 106,900 t (Tab. 3). In 2013 majority of imports originated from European countries, mostly from Russia — ca. 37%, Iceland — ca. 12%, the Netherlands — ca. 11%, Germany and Belgium — both ca. 5%, while ca. 26% of imports from non-European countries, e.g. Canada, Mozambique, USA, China, South Africa, and others (Tab. 3). Exports (re-exports) of ***aluminum*** were recently negligible, though in the period 2009–2013 ca. 1,400–1,900 tpy were sold to Germany, while in 2010–2011 7,400 t and 3,600 t (respectively) were sold to the Czech Republic (Tab. 1). Growth of ***aluminum*** imports volume and unit price in the years 2010–2011 (Tab. 6) resulted in strong increase of negative trade balance by over 140% to 947 million PLN, but in the years 2012–2013 due to lower purchases and lower unit values decrease of negative trade balance by over 23% to 724 million PLN was reported (Tab. 5).

With exception of 2009, increasing tendency of ***aluminum scrap*** and ***waste materials*** trade was reported. In 2010–2012 their exports volume was higher than imports volume (Tab. 4), and changes of exports and imports unit values (Tab. 6) resulted in variations of

Tab. 3. Polish imports of aluminum, by country — CN 7601 10 00

'000 t

Year	2009	2010	2011	2012	2013
Imports	**72.4**	**126.0**	**125.9**	**112.5**	**106.9**
Belgium	11.4	16.8	14.8	4.8	5.1
Brazil	–	4.3	1.3	0.7	–
Canada	0.2	3.7	0.1	0.9	14.2
China	–	–	–	0.1	1.8
Czech Republic	0.0	2.0	1.2	0.1	0.4
France	0.0	0.1	1.2	–	0.4
Germany	16.3	10.1	5.3	5.7	5.7
Ghana	–	–	0.7	0.7	0.5
Iceland	2.9	9.7	10.7	13.5	13.1
India	–	–	–	0.1	0.5
Ireland	0.3	–	–	–	–
Italy	1.6	3.6	3.5	2.1	1.8
Japan	–	–	1.6	0.8	0.3
Mozambique	3.9	4.4	1.7	2.1	5.7
Netherlands	0.6	3.3	1.0	3.8	11.6
Norway	4.1	0.0	0.1	0.0	–
Romania	0.7	–	–	–	–
Russia	15.1	65.5	80.0	65.4	40.0
Slovakia	14.6	1.2	–	–	–
Slovenia	0.1	–	–	0.7	0.6
South Africa, Republic of	–	0.2	0.2	2.5	0.8
Sweden	–	0.5	0.9	0.1	0.1
United Kingdom	0.3	0.1	1.0	2.5	0.0
USA	0.0	0.0	–	5.8	3.7
Others	0.3[r]	0.5[r]	0.6	0.1[r]	0.6

Source: ***The Central Statistical Office (GUS)***

positive trade balance (Tab. 5). In 2013 imports volumes and unit values were higher than for exports. Poland became net importer of aluminum scrap and waste materials, and their trade deficit reached 135 million PLN (Tab. 5). In 2013 unit values of ***aluminum alloys*** trade were reduced (Tab. 6), but reduction of imports unit values was stronger (Tab. 2), while trade deficit decreased to ca. 1,000 million PLN (Tab. 5).

Tab. 4. Aluminum scrap and waste materials trade in Poland — CN 7602

'000 t

Year	2009	2010	2011	2012	2013
Imports	66.8	84.9	106.4	111.8	176.5
Exports	99.5	124.0	150.6	156.1	154.8

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Value of aluminum commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Aluminum CN 7601 10					
Exports	11,710	63,287	43,511	17,204	18,703
Imports	405,957	895,167	990,205	830,360	742,963
Balance	**-394,247**	**-831,880**	**-946,694**	**-813,156**	**-724,260**
Aluminum alloys CN 7601 20					
Exports	349,834	733,876	925,261	889,982	1,174,024
Imports	1,022,458	1,533,432	2,127,547	2,066,332	2,177,444
Balance	**-672,624**	**-799,556**	**-1,202,286**	**-1,176,350**	**-1,003,420**
Aluminum scrap and waste materials CN 7602					
Exports	394,838	600,692	746,604	822,505	772,293
Imports	225,931	422,795	597,609	578,801	907,699
Balance	**+168,907**	**+177,897**	**+148,995**	**+243,704**	**-135,406**

*Source: **The Central Statistical Office (GUS)***

Tab. 6. Average unit values of aluminum commodities trade in Poland

Year	2009	2010	2011	2012	2013
Aluminum CN 7601 10					
Exports unit values					
— PLN/t	8,224.8	7,166.0	8,140.9	8,829.4	9,147.3
— USD/t	2,638.0	2,351.9	2,832.2	2,699,3	2,915.7
Imports unit values					
— PLN/t	5,603.6	7,103.5	7,866.3	7,382.9	6,948.7
— USD/t	1,834.6	2,347.2	2,694.8	2,263.9	2,210.9
Aluminum alloys CN 7601 20					
Exports unit values					
— PLN/t	5,478.6	7,461.1	8,380.7	7,705,2	7,426.7
— USD/t	1,773.6	2,473.7	2,861.5	2,358.4	2,364.2
Imports unit values					
— PLN/t	6,768.9	7,685.3	8,543.8	8,173.8	7,544.1
— USD/t	2,191.1	2,549.4	2,924.3	2,498.4	2,401.0
Aluminum scrap and waste materials CN 7602					
Exports unit values					
— PLN/t	3,967.4	4,845.1	4,958.2	5,270.6	4,988.0
— USD/t	1,278.9	1,604.6	1,698.7	1,609.7	1,586.9

Imports unit values					
— PLN/t	3,382.6	4,982.8	5,614.6	5,175.5	5,142.5
— USD/t	1,112.5	1,657.1	1,914.7	1,586.6	1,637.9

Source: ***The Central Statistical Office (GUS)***

Consumption

Consumption of ***aluminum metal*** in Poland was quickly increasing until 2007, reaching ca. 181,000 tpy in the years 2006–2007. In 2008–2009, it was cut twice to only 87,900 t in 2009. In the years 2010–2011 it recovered to 134,500 t, but in 2012–2013 it decreased again to 120,900 t (Tab. 1). It gives 3.2 kg Al per capita (3.5 kg per capita in the years 2010–2011) and is still one of the lowest consumption factors in Europe. If we account also consumption of ***alloyed aluminum*** (estimated at ca. 340,000 t in 2012, and ca. 370,000 t in 2013), total ***aluminum*** consumption amounted to ca. 462,000 t in 2012, and ca. 491,000 t in 2013.

The exact aluminum consumption pattern in Poland is not known. It is estimated that ca. 90% of this metal is consumed by a few large plants delivering ***aluminum*** and ***aluminum alloy products***. These are **Impexmetal, Konin Aluminum Smelter** (casting alloys, sheets and bands made of aluminum and aluminum alloys, aluminum foil), **Kęty** (casting alloys, tubes, bars, wires made of aluminum and aluminum alloys), **NPA Skawina** (wire rods, wires, casting alloys, powders, oxides), **PPZ Nicromet** (casting alloys, non-alloyed aluminum, aluminum for steel deoxydation), **Alumetal** (casting alloys, aluminum for steel deoxydation), **Poland Smelting Technologies POLST** (casting alloys), **Dziedzice Metals Mill** (rods and rolled sections made of aluminum alloys), and **Będzin Smelter** (bands, disks, cast profiles made of aluminum; declared bankruptcy). Since the mid-1990s, Polish aluminum industry undergoes process of consolidation. Then two capital groups were formed. In 1995, **Impexmetal** foreign trade company bought shares of **Konin Aluminum Smelter**. Later on, it started to control **Skawina Metallurgical Plant** (currently: **NPA Skawina**). It bought also majority of **Dziedzice Metals Mill** shares. In 2005, **Boryszew Capital Group** took control of **Impexmetal**. As a result, **Boryszew Capital Group** has a 100% share in domestic manufacture of ***Al and Al alloys rolled products***.

The second capital group was formed by **Kęty Light Metals Works**. Since 1996, the **Kęty** plant started to be modernized. Later on, Group started to control **Metalplast** of Bielsko-Biała (aluminum windows and doors), as well as constructed in 1998 a new aluminum containers plant in Tychy, managed by **Alupol**. At present, **Kęty Capital Group** has ca. 35% share in domestic ***extruded and drawn aluminum products*** manufacture, ca. 22% share in ***aluminum containers*** production, and ca. 40% in ***aluminum windows and doors*** manufacture.

Companies involved in aluminum production in Poland, as of December 2013

- Impexmetal S.A., Huta Aluminium Konin w Koninie (Impexmetal Joint Stock Co., Konin Aluminum Smelter of Konin); ul. Hutnicza 1, 62–510 Konin; tel. +48 63 2474488, 2474422; fax +48 63 2474788, 2474787, www.aluminium-konin.com.pl — *secondary aluminum.*

- Kęty S.A. (Kęty Joint Stock Co. of Kęty); ul. Kościuszki 111, 32–650 Kęty; tel. +48 33 8446000; fax +48 33 8453093, 8453094, www.gk-kety.com.pl — *secondary aluminum*.
- NPA Skawina Sp. z o.o. (NPA Skawina Ltd. of Skawina); ul. Piłsudskiego 23, 32–050 Skawina; tel. +48 12 2760808; fax +48 12 2760888, www.npa.pl — *secondary aluminum*.
- Przedsiębiorstwo Przerobu Złomu Nicromet (Nicromet Scrap Processing Enterprise of Bestwinka); ul. Witosa 28, 43–512 Bestwina; tel. +48 32 3242100; fax. +48 32 3242130, www.nicromet.pl — *secondary aluminum*.
- Alumetal S.A. (Alumetal Joint Stock Co. of Kęty); ul. Kościuszki 111, 32–650 Kęty; tel. +48 33 8446815; fax +48 33 8450261, www.alumetal.pl — *secondary aluminum*.
- POLST Sp. z o.o. (Poland Smelting Technologies Ltd. of Wałbrzych); ul. M. Jachimowicza 2, 58–306 Wałbrzych; tel. +48 74 8869800; fax. +48 74 8869801, www.polst.com.pl — *secondary aluminum*.

ANDALUSITE — KYANITE — SILLIMANITE

Overview

Andalusite, **kyanite**, and **sillimanite** occur in metamorphic rocks (***schists***, ***gneiss***, ***quartzites***, ***corundum-sillimanite rocks***) and in clastic rocks, e.g. in ***beach sands***, as heavy minerals. When these minerals are roasted, beginning at 1,315°C (**kyanite**) up to 1,549°C (**sillimanite**), they form a mixture of ***mullite*** and ***quartz glaze***, and at 1,810°C ***corundum*** and ***quartz glaze***. This feature is very useful in the production of ***high-alumina refractories***.

Sources

Poland has no deposits of ***andalusite***, ***kyanite***, or ***sillimanite***, and their discovery is unlikely.

Production

There is no production of ***andalusite***, ***kyanite***, or ***sillimanite*** in Poland.

Trade

The demand for ***andalusite*** and ***related minerals*** is covered entirely by imports. The volume of importation depends on the domestic steel industry, being the main consumer of ***andalusite refractories***, as well as on a level of world prices. Due to these factors, in recent years it varied in a wide range between 7,700 and 20,900 tpy (Tab. 1). Imports of ***andalusite concentrates*** were dominated by the Republic of South Africa (partly through European brokers) and France, but since 2010 also ***andalusite concentrates*** from the new Peruvian mine have been imported. Decreasing amounts of ***kyanite concentrates*** were also imported from the US, India, China and others (Tab. 2). Re-exports were negligible and irregular (Tab. 1).

Tab. 1. Andalusite and related minerals statistics in Poland — CN 2508 50

t

Year	2009	2010	2011	2012	2013
Imports	7,764	17,979	13,579	17,384	20,873
Exports	1	-	-	0	0
Consumption^{p}	7,763	17,979	13,579	17,384	20,873

*Source: **The Central Statistical Office (GUS)***

Tab. 2. Polish imports of andalusite and related minerals, by country — CN 2508 50

t

Year	2009	2010	2011	2012	2013
Imports	**7,764**	**17,979**	**13,579**	**17,384**	**20,873**
Canada	-	-	-	300	-
China	20	100	-	-	-
France	2,810	7,289	3,386	3,495	2,078
Germany	39	597	345	527	1,795
India	225	450	-	-	-
Netherlands	-	170	-	-	-
Peru	20	1,582	2,800	3,850	2,568
South Africa, Republic of	4,444	7,746	6,621	8,693	14,369
USA	124	20	329	324	0
Others	82	25	98	195	63

Source: ***The Central Statistical Office (GUS)***

The trade balances of ***andalusite*** and ***related minerals*** have been always negative. Depending on the volume of imports and world prices, they varied between 10.4 and 27.2 million PLN (Tab. 1, 3). Average unit values of imported ***andalusite*** and ***related minerals*** concentrates — in USD/t — have recently oscillated between 412 and 503 USD/t (Tab. 4).

Tab. 3. Value of andalusite and related minerals trade in Poland — CN 2508 50

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	2	-	-	0	11
Imports	10,358	23,711	20,029	25,222	27,237
Balance	**-10,356**	**-23,711**	**-20,029**	**-25,222**	**-27,226**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Average unit values of imported andalusite and related minerals to Poland — CN 2508 50

Year	2009	2010	2011	2012	2013
PLN/t	1,334.0	1,318.8	1,475.1	1,450.8	1,304.9
USD/t	450.6	440.7	503.1	441.1	412.5

Source: ***The Central Statistical Office (GUS)***

Consumption

Andalusite, as well as marginal amounts of ***kyanite***, have been utilized mainly for the production of ***high-alumina refractory materials*** in several domestic plants, e.g. especially in **Vesuvius Skawina**, with minor importance of **ArcellorMittal Refractories**

Kraków and **PCO Żarów**. The production of high alumina refractory materials is a function of the variable domestic steel industry demand, which results in unstable level of the consumption of these raw materials in Poland, between 7,700–20,900 tpy in recent years.

Applications of ***andalusite*** in the foundry industry (as components of molding sands) are of minor importance.

ANTIMONY

Overview

Antimony (**Sb**) and its compounds are obtained from individual deposits of ***antimony ores***, and as a ***co-product*** from the processing of ***Zn***, ***Pb***, ***Cu***, and ***Ag ores***, or from secondary sources, mainly from ***scrap*** of the ***lead-acid batteries***.

Antimony is a typical alloying metal. Its consumption increased rapidly until the mid-1970s, due to its application in ***lead alloys*** for the production of ammunition. Currently, antimony compounds used as flame retardants in plastics, started to be the main direction of antimony use.

Sources

Some polymetallic veins with ***antimony minerals*** are known in Lower Silesia, but they have only historical importance. Insignificant admixtures occur ***in copper ore deposits*** (Fore-Sudetic Monocline) and ***zinc-lead ore deposits*** (Silesian-Cracow area).

Production

There is no production of ***antimony ores*** or ***commodities*** in Poland.

Trade

Domestic demand has been covered by the importation of various amounts of ***antimony oxides*** and ***antimony metal***. Imports of ***antimony metal*** in the years of 2009–2013 varied between 70 and 115 tpy (Tab. 1). Recently, the main suppliers of antimony metal were China, often through Western European brokers, e.g. Belgium, the Netherlands, the United Kingdom, Slovakia or Italy, and in 2011 - also Kazakhstan (Tab. 1). ***Antimony oxides*** have been traded too, and major suppliers have been China, Korea, Bolivia and Western European countries. In the years of 2009–2011 imports of ***antimony oxides*** stabilized at a level of around 1,000 tpy, while in the last two years they decreased to 800-900 tpy (Tab. 1). Re-exports of ***antimony metal***, as well as of ***antimony oxides*** have been also recorded (Tab. 1), with Central and East European countries as the main recipients.

The balances of ***antimony commodities*** trade have been consistently negative (Tab. 2). The increase of their prices on international markets caused deepening of the deficit, which in the years of 2010–2012 was around 24 and 38 million PLN/y, respectively, but improved in 2013 to 26 million PLN/y (Tab. 2).

The unit values of imported ***antimony commodities*** rose rapidly in the years of 2010-2012, by more than 100%, while in 2013 they decreased reflecting quotations on

Tab. 1. Antimony commodities statistics in Poland

t

Year	2009	2010	2011	2012	2013
Antimony metal CN 8110 10					
Imports	**70**	**48**	**67**	**62**	**115**
Belgium	–	–	2	–	–
China	19	–	–	27	55
Italy	1	8	–	–	–
Kazakhstan	–	–	10	–	–
Luxembourg	–	–	–	14	–
Netherlands	33	7	11	8	–
Slovakia	–	–	–	–	25
Spain	5	–	9	–	–
United Kingdom	7	30	32	11	30
Others	2	3	3	2	5
Exports	**45**	**28**	**47**	**39**	**38**
Consumption[a]	**25**	**20**	**20**	**23**	**77**
Antimony oxides CN 2825 80					
Imports	**1,030**	**1,069**	**1,021**	**948**	**840**
Belgium	161	334	324	258	233
Bolivia	–	–	–	181	196
China	800	674	642	324	114
France	18	0	3	1	4
Germany	15	31	31	50	19
Italy	0	3	9	10	20
Korea, Republic of	–	–	0	14	116
Netherlands	10	–	–	4	–
Slovakia	–	1	–	102	99
Spain	25	25	11	3	33
USA	–	–	–	–	6
Exports	**82**	**47**	**53**	**45**	**80**
Consumption[a]	**948**	**1,022**	**968**	**903**	**760**

Source: ***The Central Statistical Office (GUS)***

international market (Tab. 3). In the years 2009-2012 the unit values of imported antimony commodities expressed in PLN/t were continuously increasing, despite decreased prices in USD/t in 2009 and in 2012 (Tab.3). Last year saw substantial reduction both of values expressed in USD/t and in PLN/t (Tab. 3).

Tab. 2. Value of antimony commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Antimony metal CN 8110 10					
Exports	895	734	2,252	1,753	1,410
Imports	1,334	1,228	3,043	2,700	3,477
Balance	**-439**	**-494**	**-791**	**-947**	**-2,067**
Antimony oxides CN 2825 80					
Exports	1,341	1,273	2,057	1,675	2,709
Imports	14,865	24,674	39,200	35,013	26,701
Balance	**-13,524**	**-23,401**	**-37,143**	**-33,338**	**23,992**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit value of antimony commodities imports to Poland

Year	2009	2010	2011	2012	2013
Antimony metal CN 8110 10					
PLN/t	19,051.3	25,768.4	42,424.6	43,675.8	30,288.1
USD/t	6,290.6	8,616.6	15,504.7	13,285.4	9,623.8
Antimony oxides CN 2825 80					
PLN/t	14,432.3	23,085.2	38,407.3	36,940.7	31,767.5
USD/t	4,693.5	7,644.4	13,091.5	11,310.7	10,141.2

Source: ***The Central Statistical Office (GUS)***

Consumption

The majority of ***metallic antimony*** is used for the production of ***printer's metal*** and ***bearing alloys*** containing tin and lead (so-called ***hard lead***), copper alloys, fuses, thermometers, and the solders for electronics. More than 30% of ***antimony*** is used in the form of compounds (mainly ***oxides***) in the rubber, paint and varnishes, textile, and glass-making industries etc. Imported ***antimony sulfides*** were in temporary use for the production of safety matches, among others.

ARSENIC

Overview

Arsenic trioxide (As_2O_3), obtained from sulfides and used for hundreds of years as a poison, is the basic raw material for the production of arsenic (As). It is primarily recovered during the initial roasting of ***copper***, ***lead***, ***gold***, and other ***ores*** for ecological reasons. Small amounts of **arsenic metal** are obtained by the reduction of ***arsenic trioxide***. **Arsenic** and its sulfides were used for making poisons, and for depilation and leather dressing.

Sources

The resources left in the abandoned **Złoty Stok** ***As-Au ore*** deposit amount to 19,600 t As. Moreover, there is ca. 2,150 t As in abandoned mine of polymetallic ores - **Czarnów**. Both deposits are located in the Sudetes (as of 31 December 2013).

Production

Neither arsenic-bearing ores nor ***arsenic trioxide*** have been produced in Poland since 1961 due to a lack of demand and its toxic properties.

Trade

Little demand for ***arsenic trioxide*** in Poland has been satisfied entirely by imports, which in 2010-2012 decreased to less than 1 tpy (Tab. 1), i.e. amounted to only 16 kg in 2010, 386 kg in 2011 and 392 kg in 2012. In 2013 there was 1 ton imported, mainly from Belgium (Tab. 1). In the years 2009 - 2013 ***arsenic trioxide*** was not exported from Poland (Tab. 1). Since 2010, stable amounts of ca. 42-49 tpy of ***arsenic metal*** - have been imported, except for 2013 when it decreased to 32 t (Tab. 2). The main suppliers have been Belgium and China, and in 2013 also Germany. In the years 2009-2013 small re-exports of ***arsenic metal*** from Poland were recorded. The imports of ***arsenic commodities*** have resulted in a negative trade balance (Tab. 3). The unit values of their importation to Poland have depended mainly on the quantity of traded material (Tab. 4).

Tab. 1. Polish imports of arsenic trioxide, by country — CN 2811 29 10

t

Year	2009	2010	2011	2012	2013
Imports=Consumption[a]	**11**	**0**	**0**	**0**	**1**
Belgium	10	–	–	0	0.5
Others	1	–	0	0	0.5

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Polish imports of arsenic metal by country — CN 2804 80

t

Year	2009	2010	2011	2012	2013
Imports	**20**	**49**	**45**	**44**	**32**
Belgium	8	49	44	43	25
China	5	–	1	1	5
Germany	2	0	0	0	2
Exports	**1**	**7**	**6**	**6**	**7**
Consumption	**19**	**42**	**39**	**38**	**25**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Value of arsenic commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Arsenic trioxide CN 2811 29 10					
Exports	–	–	–	–	–
Imports	139	4	7	12	841
Balance	**-139**	**-4**	**-7**	**-12**	**-841**
Arsenic metal CN 2804 80					
Exports	9	58	39	49	51
Imports	240	389	260	276	391
Balance	**-231**	**-331**	**-221**	**-227**	**-340**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Unit values of arsenic commodities imports to Poland

Year	2009	2010	2011	2012	2013
Arsenic trioxide CN 2811 29 10					
PLN/t	12,613	228,438	18,912	31,191	36,637
USD/t	4,533	76,500	6,733	9,319	11,573
Arsenic metal CN 2804 80					
PLN/t	11,725	7,926	5,834	7,407	12,013
USD/t	3,886	2,616	1,986	2,294	3,875

Source: ***The Central Statistical Office (GUS)***

Consumption

Arsenic trioxide is used mainly in agriculture (insecticides), the ceramic, glass--making, and chemical industries. Although arsenic trioxide is highly toxic, it was shown that this compound has a therapeutic effect against cancer cells. A***rsenic metal*** is utilized as a component of tin and lead alloys (bearing alloys, etc.).

ASBESTOS

Overview

Asbestos is a fibrous, flexible, easily-felting mineral belonging to the ***serpentine*** group (***chrysotile asbestos***) or ***amphibole*** group (***actinolite***, ***amianthus***, ***antophyllite***, ***crocidolite***, etc.). It was widely used in many industries, due to its tensile strength and flexibility, as well as heat resistance (***chrysotile asbestos***) and chemical resistance (***amphibole asbestos***).

Over the last 30 years **asbestos** has been eliminated from use in many countries, due to the carcinogenic effect of its very small microscopic fibers. The health hazard is confirmed in some applications, but in others its use is permissible, provided that the required conditions for production and use are maintained. Nevertheless, the problems have considerably reduced the asbestos consumption. Since the early 1990s, total or partial ban of their application was introduced in several countries, also in Poland.

Sources

Poland has no deposits of ***asbestos***, nor any prospects for their discovery.

Production

There is no domestic production of ***asbestos***.

Trade

Since 1997, when the new law on “prohibited use of products containing asbestos” was put into force, the imports of them was almost completely ceased, with the exception for small amounts which were imported in 2009 from Canada, and in 2010 from the United Kingdom (11 kg, Tab. 1). They were consumed in the manufacturing of asbestos diaphragms, utilised in the chlorine production at **Zachem Chemical Plant** of Bydgoszcz[1]. In this case, the law allows using asbestos, due to the lack of other substitutes, which reduce the risk of explosion. At the end of 2012 Zachem Plant ceased the production of chemicals, both organic and inorganic, focusing its activities only on the sale of energy, sewage treatment and disposing its land or real estate properties.

In the years 2010 and 2013 the marginal exportation of asbestos to Norway was recorded (Tab. 1), probably from stocks accumulated at Zachem Plant, as a consequence of the closure of the production facility.

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[1] Besides of **Zachem plant** in **Bydgoszcz**, there are only two chemical plants producing chlorine with the use of asbestos diaphragms. In Europe: **Rheinsberg** and **Stade** (both in Germany)

Tab. 1. Asbestos statistics in Poland — CN 2524, PKWiU 14502340

t

Year	2009	2010	2011	2012	2013
Imports	35	0.0	–	–	–
Exports	–	0.7	–	–	1.2

Source: ***The Central Statistical Office (GUS)***

Trade balance of ***asbestos*** was negative in the years when imports occurred and was minimally positive in 2013 (Tab. 2).

Tab. 2. Value of asbestos trade in Poland — CN 2524

'000 PLN

Year	2009	2010	2011	2012	2013
Imports	554	2.5	–	–	–
Exports	–	1.1	–	–	0.5
Balance	**-554**	**-1.4**	–	–	0.5

Source: ***The Central Statistical Office (GUS)***

Consumption

Asbestos on an industrial scale was utilised only in the **Zachem Chemical Works** of **Bydgoszcz** (since 2006 the part of **CIECH Chemical Group**) for manufacturing of diaphragms being applied in chlorine production. The company used asbestos basing on the required consent of the Minister of Economy for imports and utilization of asbestos (valid to the end of 2008), while in the following years it was based on the Integrated Licenses granted by the Voivode of Kujawsko-Pomorskie voivodeship valid until 2016. In December 2009 the company made efforts to build a new asbestos-free chlorine production plant, but plans to carry out the investment were thwarted by the economic situation of the company. Finally, at the end of 2012 the company ceased the production of chemicals, including chlorine.

ASPHALTS, NATURAL AND SYNTHETIC

Overview

Natural asphalts belong to the group of **liquid caustobiolites** (**bitumens**), the products of ***crude oil*** weathering in the vicinity of natural leaks on the earth surface. **Asphaltites**, related to asphalts, are products of the oxidation and polymerization of some of its constituent elements. Differences in climatic conditions result in corresponding differences in the black, dense, or fragile substances thus produced, which are often known by specific local names.

Natural asphalts in most cases have been replaced by **synthetic asphalts**, obtained in course of ***crude oil*** refining (distillation). The following types of asphalts are distinguished: ***road asphalt***, ***brittle industrial asphalt*** for paper, rubber, paints and varnishes, etc., ***insulating asphalts***, ***compounds***, and ***solutions of asphalt***, etc.

Sources

Poland has no deposits of ***natural asphalt***, nor any prospects for their discovery.

Production

There is no domestic production of ***natural asphalt***. In the years 2009–2013 the production of ***synthetic asphalt*** in Poland stabilized at 1.5-1.6 Mtpy, except for 2011, when it climbed to almost 1.8 Mt, and 2013, when it decreased to less than 1.5 Mt (Tab. 1). The main producers have been: **Lotos Asfalt** (over 50% of domestic production) with three production centers in Gdańsk, Jasło and Czechowice, and **Orlen Asfalt**, which has two production centers in Płock and Trzebinia refineries. There are also smaller ***synthetic asphalt*** producers, e.g. **BP Bitumen Polska**, delivering mainly ***modified road asphalts*** on the basis of imported components.

Tab. 1. Asphalt statistics in Poland — CN 2713 20, 2714 90

'000 t

Year	2009	2010	2011	2012	2013
Production[1]	1,567.5	1,566.6	1,787.8	1,549.9	1,450.5
Imports	305.7	422.7	490.6	403.7	349.9
Exports	253.3	373.0	479.4	505.2	521.5
Consumption[a]	1,619.9	1,616.3	1,799.0	1,448.4	1,278.9

[1] asphalt recovery in oil refineries

Source: ***The Central Statistical Office (GUS)***

Trade

Natural and ***synthetic asphalts***, due to their similarity, are often confused in trade documents. Currently, probably almost all ***synthetic asphalt*** is imported and exported. In parallel with the increased production, also asphalt trade with neighbouring countries has been intensified, e.g. with the Czech Republic, Germany, Slovakia, Sweden, Lithuania, Romania, Austria, Hungary, and others (Tab. 2, 3). Between 2009 and 2013 the exportation of asphalt increased almost twice , while the importation after an increase by 2011 dropped, so in the last two years the trade balance turned positive approaching ca. 304 million PLN in 2013 (Tab. 4). Unit values of imports and exports were very similar (Tab. 5).

Tab. 2. Polish exports of asphalt, by country — CN 2713 20, 2714 90

'000 t

Year	2009	2010	2011	2012	2013
Exports	**253.3**	**373.0**	**479.4**	**505.2**	**521.5**
Austria	20.8	21.2	13.0	20.0	6.5
Bulgaria	0.3	0.1	0.1	10.8	10.5
Czech Republic	47.0	44.0	62.0	92.3	112.8
Equatorial Guinea	–	5.4	–	–	–
Finland	–	–	28.7	51.8	–
France	–	2.5	6.5	0.2	2.5
Gabon	–	0.5	4.3	–	–
Ghana	–	0.2	0.6	1.1	4.4
Germany	36.2	60.5	71.1	55.6	83.3
Hungary	6.7	10.8	9.8	9.5	34.1
Ireland	–	12.3	–	–	–
Ivory Coast	0.2	3.8	–	–	–
Kenya	–	1.9	6.4	3.6	1.4
Latvia	0.5	1.2	10.2	16.0	12.0
Lithuania	10.6	17.8	41.5	31.9	34.2
Moldova	–	–	1.4	4.6	2.3
Netherlands	8.8	7.1	20.3	–	0.8
New Caledonia	–	1.6	5.7	2.6	2.2
Norway	–	11.6	2.7	–	0.0
Philippines	–	1.7	0.1	–	–
Romania	85.1	75.9	97.4	126.2	116.1
Russia	1.6	1.5	0.1	0.3	0.2
Senegal	7.1	7.9	14.5	7.8	0.7
Slovakia	19.5	17.3	16.6	20.9	17.1
Sweden	0.3	13.4	43.3	31.9	32.3
Switzerland	6.8	7.6	1.5	1.6	1.6
Tanzania	–	0.1	1.1	9.7	2.4

Uganda	–	0.0	0.6	5.3	11.5
Ukraine	0.0	0.2	0.4	0.8	0.4
United Kingdom	–	41.4	13.8	–	30.0
Others	1.8	3.5	5.7	0.7	2.2

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Polish imports of asphalt, by country — CN 2713 20, 2714 90

'000 t

Year	2009	2010	2011	2012	2013
Imports	**305.7**	**422.7**	**490.6**	**403.7**	**349.9**
Austria	0.0	1.0	1.5	14.5	9.7
Belarus	0.9	–	0.2	–	–
Bulgaria	–	–	1.7	19.5	27.4
Czech Republic	23.6	67.1	70.9	66.8	60.1
Denmark	0.0	0.1	0.1	–	0.0
France	0.1	10.1	18.4	5.9	0.3
Germany	156.9	197.1	228.8	193.6	149.2
Hungary	38.6	50.9	64.5	28.4	42.3
Italy	4.4	–	–	–	0.0
Lithuania	4.8	14.8	9.2	6.3	2.4
Slovakia	1.1	9.5	23.4	20.2	17.7
Sweden	71.4	67.1	71.2	48.0	40.0
Ukraine	2.7	5.0	–	–	–
Others	1.2	0.0	0.7	0.5	0.8

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Value of asphalt trade in Poland — CN 2713 20, 2714 90

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	325,454	498,112	843,615	1,026,676	949,828
Imports	360,594	567,061	859,981	826,557	645,842
Balance	**-35,140**	**-68,949**	**-16,366**	**+200,119**	**+303,986**

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Average unit values of asphalt trade in Poland — CN 2713 20, 2714 90

Year	2009	2010	2011	2012	2013
Exports unit values					
PLN/t	1,285.1	1,335.5	1,759.7	2,032.1	1,821.2
USD/t	418.4	436.0	607.0	622.7	577.1
Imports unit values					
PLN/t	1,179.6	1,341.4	1,753.0	2,047.3	1,845.7
USD/t	388.8	439.3	602.9	627.1	584.9

Source: ***The Central Statistical Office (GUS)***

Consumption

There is no precise information about the structure of ***asphalts*** consumption in Poland. ***Natural asphalts*** are utilized for road pavements (road asphalts constitute over 94% of total asphalts production), for the production of moisture-proofing materials and acid/base resistant coatings, and in the paint and varnish industry. They are regarded as equivalent to their substitutes, the ***synthetic asphalts*** obtained in petroleum refining, produced in the following grades: ***road asphalt***, ***brittle commercial asphalt***, ***insulating commercial grades***, ***asphalt for lacquers***, and other special products such as ***pitches***, ***cements***, ***masses***, ***filling compounds***, ***solutions***, ***emulsions***, and ***pastes***. They compete with similar products from the coke industry, i.e. ***pitches*** and ***pitch products*** (see: **COKE**).

Companies involved in synthetic asphalts production in Poland as of December 2013

- ORLEN Asfalt Sp. z o.o. w Płocku (ORLEN Asphalt Ltd. of Płock), ul. Chemików 7, 09–411 Płock, tel. +48 24 3653827, fax +48 24 3655596, www.orlen-asfalt.pl — *road asphalt, commercial asphalt, modified asphalt*.
- ORLEN Asfalt Sp. z o.o. w Trzebini (ORLEN Asphalt Ltd. of Trzebinia), ul. Fabryczna 22, 32–540 Trzebinia, tel. +48 32 6180123, 6180132, fax +48 32 6180133, www.orlen-asfalt.pl — *road asphalt, commercial asphalt.*
- LOTOS Asfalt Sp. z o.o. w Gdańsku (LOTOS Asphalt Ltd. of Gdańsk), ul. Elbląska 135, 80–718 Gdańsk, tel. +48 58 3264300, fax +48 58 3264380, www.lotosasfalt.pl — *road asphalt, commercial asphalt, modified asphalt*.
- LOTOS Asfalt Sp. z o.o. w Jaśle (LOTOS Asfalt Ltd. of Jasło), ul. 3 Maja 101, 38–200 Jasło, tel. +48 13 4466544, fax +48 13 4466549, www.lotosasfalt.pl — *commercial asphalt, road asphalt.*
- LOTOS Asfalt Sp. z o.o. w Czechowicach-Dziedzicach (LOTOS Asfalt Ltd. of Czechowice-Dziedzice), ul. Łukasiewicza 2, 43–502 Czechowice-Dziedzice, tel. +48 32 3237811, fax +48 32 3237813, www.lotosasfalt.pl — *modified asphalt*.
- BP Polska Sp. z o.o., Terminal Asfaltów Drogowych w Ścinawie (BP Polska Ltd., Road Asphalts Terminal of Ścinawa), ul. Leśna 8, 59–330 Ścinawa, tel. +48 76 8436436, fax +48 76 8436006, www.bp.pl/bitumen — *road asphalt*.

BARITE

Overview

The main source of **barium** (**Ba**) is ***barite*** (***$BaSO_4$***), which forms individual deposits of different types or occurs as a component in other deposits, whereas ***witherite*** (***$BaCO_3$***) is of minor importance. Generally, barium is used in the form of barite, and only small amounts are utilized for the production of other barium compounds, including ***synthetic barite*** and ***synthetic witherite***.

Barite is a mineral of declining economic importance. In many applications it has been replaced by substitutes, except for drilling, utilizing 85–90% of the barite supplies on the market.

Sources

The resources of four known ***barite*** deposits in **Stanisławów**, **Jedlinka**, **Jeżów Sudecki** (the Lower Silesia), and **Strawczynek** amounted to 5.7 Mt (as of 31 December 2013). Most of these reserves are in the **Stanisławów** deposit (5.2 Mt), where an important mineral accompanying barite is ***fluorite***, which could be obtained in course of ore dressing.

Production

Until 1997, Polish mining production of ***barite*** was based on the **Boguszów** and **Stanisławów** deposits, extracted by the **Boguszów Barite Mine Ltd.** In the years 1999–2006, and in 2008 again, **R&S Co.** of **Boguszów** was producing barite commodities, mainly ***flotation barite powders***, in the remaining processing plant, however — not on the basis of the raw material, but from old flotation tailings being deposited for many years nearby processing plant. This production was ended in 2008 (324 t).

Tab. 1. Barite statistics in Poland — CN 2511 10

'000 t

Year	2009	2010	2011	2012	2013
Imports	7.5	11.1	13.6	20.1	9.7
Exports	–	0.0	0.0	0.0	0.0
Consumption[a]	7.5	11.1	13.6	20.1	9.7

Source: ***The Central Statistical Office (GUS), producer's data***

Trade

The demand for ***barite*** in Poland has been covered by imports. Following the end of the domestic production, the importation has become the only barite source. The main imported grades are ***flotation barite powders*** for drilling mud, supplemented by high quality ***flotation barite powders*** for the glass, paints, rubber and chemical industries. Until 2012, the main supplier of barite powder for drilling muds was Slovakia (**Zelba a.s.**), in 2012 - Turkey and Morocco, while in 2013 – Turkey and Slovakia. Barite powders of higher quality were delivered mainly by China, Italy, Germany, the United Kingdom, as well as Dutch traders (Tab. 2).

Tab. 2. Polish imports of barite, by country — CN 2511 10

'000 t

Year	2009	2010	2011	2012	2013
Imports	**7.5**	**11.1**	**13.6**	**20.1**	**9.7**
China	1.5	1.2	1.2	0.5	0.3
Germany	0.2	0.3	0.8	0.2	0.4
Italy	0.1	0.3	0.5	0.5	0.6
Morocco	–	2.1	1.8	5.4	–
Netherlands	1.6	1.3	1.7	2.9	1.8
Slovakia	4.0	5.3	5.2	3.7	2.4
Slovenia	–	–	0.8	–	–
Turkey	–	0.2	1.0	6.2	3.4
United Kingdom	–	0.3	0.4	0.5	0.7
Others	0.1	0.1[r]	0.2[r]	0.2[r]	0.1

Source: ***The Central Statistical Office (GUS)***

The trade balances in ***barite*** have been always negative (Tab. 3), and the deficit has depended on imports level and average unit values of imported grades (Tab. 4).

Tab. 3. Value of barite trade in Poland — CN 2511 10

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	0	10	25	59	87
Imports	6,368	8,810	11,798	16,230	11,317
Balance	**-6,368**	**-8,800**	**-11,773**	**-16,171**	**-11,230**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Average unit values of barite imported to Poland — CN 2511 10

Year	2009	2010	2011	2012	2013
PLN/t	846.8	793.0	867.1	806.0	1,162.7
USD/t	273.2	263.6	300.5	245.3	370.7

Source: ***The Central Statistical Office (GUS)***

Consumption

Currently ca. 60-80% of ***barite*** has been consumed by the domestic drilling sector. The rest has been utilised by the glass-making, paint and varnishes, rubber, and other industries. Demand for barite has been strictly correlated with the drilling activity in Poland. Development of prospection of shale gas and deep drillings resulted in large increase in domestic ***barite*** consumption in the years 2010-2012, though in 2013 this tendency reversed.

BAUXITE AND ALUMINA

Overview

Aluminum (*lat*. aluminium, **Al**) is one of the most common elements of the lithosphere, constituting 8.05% of its mass. Aluminum is present in many minerals, but only some of them, mainly hydroxides (***gibbsite***, ***diaspore***, or ***boehmite***) and hydroxide-bearing rocks (***gibbsite***, ***diaspore***, and ***boehmite bauxites***), form huge individual deposits of latheritic type in the equatorial band. These are the main source for the production of **alumina** (***aluminum oxide*** or ***hydroxide***, Al_2O_3). It is the main commodity for the production of **primary aluminum**, **alundum** (***fused aluminum oxide***), **high-alumina refractories**, **chemical compounds of aluminum**, etc. Other aluminum — bearing rocks, such as ***nephelinite*** and ***leucite***, as well as ***alunites***, are of local significance for alumina production.

The three main commodities — **bauxite**, **alumina**, **primary aluminum** — predominate in the broad and complex structure of aluminum commodities. More than 95% of bauxite is processed into alumina, and almost 90% of alumina is consumed by manufacturers of primary aluminum.

Bauxite

Sources

There are no ***bauxite*** deposits in Poland, and no prospects for their discovery.

Production

There is no domestic production of ***bauxites***.

Trade

All domestic demand for bauxites has been met by imports. These are mainly ***calcined bauxites***, with minor quantities of ***raw bauxite***. In the years 2009-2013 imports varied mostly between 45 and 49 ktpy, only in 2012 they exceeded 55 kt (Tab. 1). The main supplier of ***raw bauxite*** was Greece, joined in the years 2009–2010 and 2013 by Turkey. In the case of ***calcined bauxite*** the largest supplies originated from China. Only in 2011 they were surpassed by deliveries of cheaper bauxite from Guyana (Tab. 2). Usually, small quantities of bauxite were re-exported (Tab. 1). In 2010-2011 these re-exports rose significantly. Their key recipient was the Czech Republic. In 2012–2013 re-exports were practically not reported.

Tab. 1. Bauxite statistics in Poland — CN 2606

'000 t

Year	2009	2010	2011	2012	2013
Imports	48.9	48.2	44.8	55.4	46.7
Exports	0.6	12.9	8.5	–	0.0
Consumption[a]	48.3	35.3	36.3	55.4	46.7

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Polish imports of bauxite, by country — CN 2606

'000 t

Year	2009	2010	2011	2012	2013
Imports	**48.9**	**48.2**	**44.8**	**55.4**	**46.7**
China	4.8	10.0	8.8	9.5	5.8
Czech Republic	0.3	0.2	0.6	1.2	0.6
Germany	2.1	1.3	1.3	1.4	1.3
Greece	36.7	25.9	20.3	34.5	29.1
Guyana	0.9	2.1	10.0	5.4	1.0
Hungary	–	0.3	–	0.4	0.0
India	–	0.1	0.3	0.1	0.0
Luxembourg	–	0.3	0.5	0.0	–
Netherlands	2.3	2.3	2.4	2.6	2.3
Turkey	1.3	5.5	–	–	6.3
United Kingdom	–	–	0.5	0.0	0.0
Others	0.5	0.2	0.1	0.3	0.3

Source: ***The Central Statistical Office (GUS)***

The trade balance in ***bauxite*** is consistently negative (Tab. 3), while deficit is correlated with imports volume and imports unit values (Tab. 4).

Tab. 3. Value of bauxite trade in Poland — CN 2606

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	1,175	3,470	1,741	–	5
Imports	32,968	35,925	35,947	40,348	28,733
Balance	**-31,793**	**-32,455**	**-34,206**	**-40,348**	**-28,728**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Average unit values of bauxite imports to Poland — CN 2606

Year	2009	2010	2011	2012	2013
PLN/t	673.8	746.0	801.9	728.4	615,5
USD/t	219.3	249.0	278.4	221.7	196,4

Source: ***The Central Statistical Office (GUS)***

Consumption

The detailed information on bauxite consumption structure in Poland is not available. Lower grades of ***crude bauxite*** are used in the steel industry, while higher grades for the production of aluminous cement and in chemical industry. ***Calcined bauxite*** was used mainly by refractory industry. Reduction of high-alumina refractories production on the basis of calcined bauxite resulted in much lower consumption of this raw materials in 2009 (Tab. 5). Since 2010 high-alumina refractories and aluminous cement production has recovered, so reduction of apparent consumption of bauxite in 2010 and minimal growth in 2011 was probably related to the change of consumers' bauxite stocks. In 2012 and 2013 (but especially in 2012) the apparent consumption was much higher, so probably some stocks were supplemented due to low prices (tab. 4), but data on stock changes are not available.

Tab. 5. Structure of bauxites consumption in Poland

'000 t

Year	2009	2010	2011	2012	2013
Consumption[a]	**48.3**	**35.3**	**36.3**	**55.4**	**46.7**
• aluminous cement[e]	36.7[r]	19.0[r]	20.3[r]	34.5[r]	29.1
• refractories and others[e]	11.6[r]	16.3[r]	16.0[r]	21.4[r]	17.6

Source: ***The author's estimation***

Alumina

Sources

The only potential domestic source of ***alumina*** is ***fly ash*** from the **Turów Power Plant**, containing over 30% Al_2O_3. Until 1993, this was used in the production of ***calcined alumina*** at the **Groszowice Cement Plant** in a pilot operation based on an original production method developed by Polish scientist Jerzy Grzymek.

Production

Alumina is not currently produced in Poland.

Trade

Domestic demand for ***alumina*** has been met entirely by imports (Tab. 6). Closure of ***electrolytic aluminum*** production in Konin smelter in the beginning of 2009 (see: **ALUMINUM**) resulted in sharp decrease of ***calcined alumina*** (aluminum oxide) importation, which until 2009 constituted over 80% of total imports, while ***hydrated alumina*** (aluminum hydroxide) — the rest. In 2009, these shares changed to 55% and 45%, respectively, while in 2010 imports of ***hydrated alumina*** were higher than that of ***calcined alumina***. Since 2010 ***calcined alumina*** imports has increased (Tab. 7). Since 2009 the domestic market of calcined alumina has been dominated by products from Germany, Bosnia & Herzegovina, and Hungary. Hydrated alumina was imported mainly from Germany, Spain, Hungary, and Sweden. Marginal amounts of alumina have been recently re-exported (Tab. 6).

Tab. 6. Alumina statistics in Poland — CN 2818 20, 30

'000 t

Year	2009	2010	2011	2012	2013
Imports	50.8	62.2	61.1	62.8	63.9
Exports	0.1	0.1	0.2	0.7	0.3
Consumption[a]	50.7	62.1	60.9	62.1	63.6

Source: ***The Central Statistical Office (GUS)***

Tab. 7. Polish imports of alumina, by country — CN 2818 20, 30

'000 t

Year	2009	2010	2011	2012	2013
Imports	**50.8**	**62.2**	**61.1**	**62.8**	**63.9**
• ***calcined alumina***	***27.7***	***30.4***	***34.3***	***37.0***	***34.7***
• ***hydrated alumina***	***23.1***	***31.8***	***26.8***	***25.8***	***29.2***
Austria	0.0	0.0	0.0	2.0	1.1
Bosnia and Herzegovina	3.7	6.3	8.7	8.6	7.8
China	0.5	1.1	0.1	0.2	0.2
France	1.3	1.6	2.1	2.4	4.5
Germany	18.3	27.9	24.9	25.8	28.4
Greece	0.0	0.0	0.3	0.0	0.0
Hungary	9.9	12.6	13.3	10.7	5.1
Ireland	0.0	–	0.0	–	–
Italy	0.2	0.2	0.3	0.4	0.3
Romania	–	–	–	3.0	4.0
Slovenia	0.5	1.7	1.5	0.9	0.9
Spain	11.2	9.7	4.6	2.7	7.5
Sweden	4.2	0.4	4.1	5.1	3.5
United Kingdom	0.4	0.1	0.1	0.1	0.1
USA	0.4	0.2	0.2	0.3	0.1
Others	0.2	0.4	0.9	0.6	0.6

Source: ***The Central Statistical Office (GUS)***

The trade balance in ***alumina*** has been constantly negative (Tab. 8). After reduction in 2009, the deficit deepened to ca. 131–133 million PLN/y in 2012–2013 (tab. 8). The main reason was the increase in expensive ***calcined alumina*** imports (tab. 9).

Tab. 8. Value of alumina trade in Poland — CN 2818 20, 30

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	432	368	1,418	1,922	2,427
Imports	102,678	115,490	116,155	134,983	133,456
Balance	**-102,246**	**-115,122**	**-114,737**	**-133,061**	**-131,029**

Source: ***The Central Statistical Office (GUS)***

Tab. 9. Average unit values of alumina imports to Poland

Year	2009	2010	2011	2012	2013
Calcined alumina CN 2818 20					
PLN/t	2,719.3	2,725.0	2,500.2	2,827.9	2884.6
USD/t	877.8	903.3	853.6	866.5	917.3
Hydrated alumina CN 2818 30					
PLN/t	1,182.6	1,030.0	1,138.2	1,178.1	1136.3
USD/t	387.7	342.5	389.2	360.8	361.5

Source: ***The Central Statistical Office (GUS)***

Consumption

By 2009 ***calcined alumina*** was utilised basically for the production of aluminum at the **Aluminum Smelter** in Konin (ca. 64% of the total domestic consumption). After the closure of ***aluminum electrolysis*** unit in Konin smelter, all imported ***hydrated and calcined alumina*** have been used in non-metallurgical applications, for the manufacture of ***high-alumina refractory materials*** and ***aluminous cement*** for the chemical, glass, and electroceramic industries, among others (Tab. 10).

Tab. 10. Structure of alumina consumption in Poland

'000 t

Year	2009	2010	2011	2012	2013
Consumption[a]	**50.8**	**62.1**	**60.9**	**62.1**	**63.6**
• refractories, aluminous cement[e]	26.4	28.8	34.1	36.6	34.6
• and others[e]	24.4	33.3	26.8	25.5	29.0

Source: ***the author's estimation***

BENTONITES AND BLEACHING CLAYS

Overview

Bentonites and **montmorillonite clays** are sedimentary rocks rich in ***montmorillonites***. A common feature of these rocks is their ability to swell, their capacity to form dispersions in water, and their easy absorption of cations and organic substances from water solutions. Accordingly, these rocks are utilized in the foundry, drilling, and ceramic industries.

Montmorillonites, particularly ***sodium montmorillonite***, have an outstanding capacity for decoloring solutions and removing impurities from oil. That is why they are used as **bleaching clays**. However, the most effective agents in decoloring and clearing solutions and suspensions, are ***palygorskite*** and its variety ***attapulgite***, considered a separate group of clay minerals. In the US they are called **Fuller's earth**, whereas in the United Kingdom this term is used for some ***calcium montmorillonites***.

Sources

In Poland typical ***bentonites***, i.e. containing more than 75% montmorillonite, occur very seldom. More common are ***bentonite clays*** and ***montmorillonite clays*** containing 50–75% of montmorillonite. Due to documentation of the new Dylągówka-Zapady deposit in the Podkarpackie voivodeship in 2013 the total domestic resources of eight deposits increased by 172,500 t to almost 2.9 Mt (as of 31 December 2013). However, the output of these clays has been still very low, 800-3,000 tpy. It has originated from one basalt deposit - Krzeniów (with resources of 0.5 Mt), in which bentonite is an accompanying mineral.

Production

The total domestic production of ***bentonites*** and ***bleaching clays*** recorded by the **Central Statistical Office**, after a significant decline in 2009, in the following years began to progressively recover, reaching almost 114,000 t in 2011 and slightly lower level of around 102,000 t in 2012-2013 (Tab. 1).

The **Bazalt Mining and Production Plant** in **Wilków**, extracting ***bentonite*** accompanying basalt in the **Krzeniów** deposit, has been recently the only ***raw bentonite*** producer in Poland. Small mining output of ca. 1,000–3,000 tpy of unprocessed raw material has been almost entirely sold to the **PTP Certech** (Tab. 1).

The **Zębiec Mining and Metal Works** (near Starachowice — central Poland) is the traditional domestic producer and supplier of ***processed bentonite*** in various grades. The production is based on imported raw bentonites, recently only from Slovakia (from

Tab. 1. Bentonites and bleaching clays statistics in Poland — CN 2508 10

'000 t

Year	2009	2010	2011	2012	2013
Mine production[1]	3.0	2.2	0.9	0.8	1.1
Production of processed bentonites and bleaching clays	81.3	86.0	113.8	102.1	101.8
Imports[2]	122.5	156.2	207.8	229.2	208.8
Exports[2]	23.4	21.4	24.4	22.9	37.0

[1] crude bentonite

[2] a total of crude bentonite and other grades, including foundry and drilling ones

Source: ***The Central Statistical Office (GUS), producers' data***

the **Stara Kremnicka-Jelsovy Potok** deposit). The company offers wide assortment of ***bentonites***, basically for ***foundry*** and ***drilling*** (about 75% of production) as well as grades for ***civil construction*** (e.g. ***hydro-insulating shielding***) and other of minor importance, i.e. for ***pharmaceuticals***, ***nutritive mixes***, ***animal feed***, ***pet litter***, etc. The supply of bentonites from this plant after significant reduction to about 16,000 t in 2009, resulting from decline in demand in the foundry industry, in subsequent years significantly improved to around 30,000 t in 2012, and almost 36,000 t in 2013. Offered bentonite materials are sold mainly in the domestic market and in small quantities are exported, mainly to the Eastern European countries.

The other domestic supplier of bentonite is the **Certech Co.** of **Niedomice** near Tarnów — the largest Polish producer of ***bentonite pet litter***, offered under ***Super Benek*** trade mark. Since 2011, the production of bentonite for industrial applications (for geoengineering, waterproofing, foundry and drilling) has significantly increased and now represents more than 30% of the sales of all products. Recently, the company has also developed its offer for the ceramic industry, fertilizers and very fast growing sector of the production of feed (detoxification of feed and gas). Production of all types of bentonite, after the reduction in 2009 to 17,000 t, began to rapidly grow in the following years, reaching the level of more than 38,000 t in 2013, whereas the raw material consumption reached more than 45,000-47,000 tpy. The company based on raw materials imported from Slovakia (from the **Kopernica** and **Jelsovy Potok** deposits, and recently from **Lastovce** and **Hlinik** deposits), supplemented by domestic raw bentonite from **Krzeniów** mine, montmorillonite clay from **Bełchatów** lignite mine (since 2010) and local ceramic clays in the recent year. The volume of domestic raw materials consumption in the plant significantly increased from 10% to over 30% due to the increased utilization of Bełchatów clays.

Hekobentonity Co. in **Korzeniów** near Dębica is another supplier of ***processed bentonite***, mainly of ***drilling grade***. The production, based on raw bentonite imported from Slovakia (mainly from the **Brezina-Kuzmice** region), and – to lesser extent - from Ukraine, and India, after reduction to less then 6,000 t in 2009, in the period 2010-2012 exceeded 10,000 tpy, approaching 20,000 t in 2013.The considerable part of the production (about 40%) has been sold to European countries, mainly to Germany.

Celpap Ltd. located in Wieliczka near Cracow with production facility in Jasło is the next supplier of the ***bentonite pet litter*** under ***Bazyl*** trade mark, as well as a wide range of bentonite products for building applications (***TerraBent***), based on raw materials imported from Slovakia and Hungary. The production volume of the company is unknown.

CETCO Poland Ltd. in **Szczytno** (NE Poland) is the next important producer of ***processed bentonite***, delivering mainly ***bentonite mat*** and ***hydro-insulating materials*** made of ***granulated sodium bentonite*** supplied from the USA, India, Turkey, and recently also from Morocco, Egypt and Ukraine in total amount of 80,000 tpy. The level of the production is unknown, while products processed to a various degree are recorded in different positions of **PKWiU** classification.

The next bentonite plant has been operated in Gdańsk by **Süd-Chemie Polska** — a part of the German chemical group **Süd-Chemie AG** — which in 2011 was entirely taken over by Swiss group **Clariant International**. After the expansion of the capacity to ca. 60,000 tpy, the production increased, and - despite the crisis – stabilised at a level of ca. 30,000 tpy in the recent years. The bentonite mixes have been manufactured basing on granulated materials from its own mines in Sardinia and Greece. The company has delivered mainly foundry products (about 80-86% of the production) containing ***activated sodium bentonite*** (***Geko S***), and the mixture with pulverized activated carbon (***Ecosil***) for the production of castings for the automotive industry. Their production, however, is recorded in a different code of **PKWiU** classification **(2466472010)** as prepared binders and cores for casting molds. The company has also offered products for drilling and construction — ***Bentonil*** types ***CF***, ***C2***, ***ASN***, ***XR*** in amounts of about 4,000 tpy (ca. 13-14% of the supply). The expansion of the production capacity was linked to plans of introduction of new products for zoological application (pet liters), but these plans have been delayed.

Besides ***foundry bentonites*** (***for molding sands***) and ***drilling bentonites***, another commodity produced from primary raw materials is ***montmorillonite type bleaching clay***. Its only producer until to the end of 2012, was the **Siarkopol Tarnobrzeg Chemical Plant Ltd.**, production of which was based on imports from Slovakia. The production of these raw materials, after significant reduction to 2,900 t in 2011 (Tab. 1), was halted in 2012 due to strong competition of products imported from German Süd-Chemie. In that year about 40-43% of the company's sales were exported, while at the domestic market they were mainly consumed by comestible fats industry (23-28%).

Trade

Domestic demand for ***raw bentonite*** is almost entirely satisfied by imports. The level of foreign deliveries has risen systematicaly in recent years, with the exception for 2009, when significant reduction to less than 123,000 t was recorded (Tab. 1). Slovakia was traditionally the main supplier of bentonite. Since 2007 due to increased supplies from India, and since 2009 also from Turkey, the share of imports from Slovakia decreased to 40-42% (Tab. 2). In 2013 45% of supply originated from this country. Significant quantities of bentonite were also purchased from India (17% in 2013), Turkey (16%), Italy (9%), and Germany. The detailed structure of bentonite importation is difficult to ascertain, as all the grades, both crude and processed, are listed under one item of the Polish trade nomenclature (**CN 2508 10**). The majority of deliveries has been probably constituted by ***raw bentonite*** purchased by **ZGM Zębiec**, **PTH Certech,** and **Hekobentonity** from Slovakia, what can be deduced from low unit values of importation, i.e. 34–44 USD/t. The unit values of importation from other countries were much higher, e.g. Italy 91-115 USD/t (delivered for **Süd-Chemie**), Turkey (99-109 USD/t, probably the hydroinsulating grades imported for **Cetco Poland** from the **Amcol's** Turkish subsidiary **Bensan Activated Bentonite Co**.), India (recently ca. 86-96 USD/t, probably raw bentonites with high swelling capacity, mainly sodium variety - natural or activated - for cat litter production), as well as Germany (219–245 USD/t, delivered by **Süd-Chemie AG,** mainly foundry grades).

Tab. 2. Polish imports of bentonite and bleaching clays, by country – CN 2508 10

'000 t

Year	2009	2010	2011	2012	2013
Imports	**122.5**	**156.2**	**207.8**	**229.2**	**208.8**
Czech Republic	5.6	4.3	4.2	4.9	5.6
Denmark	0.2	0.1	0.1	–	0
Egypt	–	0.2	1.5	2.8	2.7
France	1.1	2.1	4.5	0.1	0.2
Germany	6.5	8.0	13.5	10.5	12.8
Hungary	1.2	1.3	1.6	1.0	0.9
India	0.1	10.2	37.6	63.0	36.1
Italy	14.7	25.3	14.5	22.1	18.5
Morocco	–	–	5.7	0.1	0.2
Slovakia	58.4	66.0	93.0	93.3	95.1
Turkey	33.3	35.8	28.4	29.9	33.0
Ukraine	0.5	0.8	1.0	0.6	0.6
United Kingdom	0.3	0.6	0.5	0.3	0.3
USA	0.1	0.2	0.6	0.1	2.1
Others	0.5	1.3	1.1	0.5	0.7

Source: ***The Central Statistical Office (GUS)***

Simultaneously, negligible exports of ***bentonites*** have also been recorded, basically to the neighbouring countries, e.g. Germany (in 2013: 40% of exports), and Russia (20%). The trade balances of these commodities have been always negative, despite of rising exports (Tabs. 1 and 3).

Tab. 3. Value of bentonites and bleaching clays trade in Poland – CN 2508 10

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	26,696	23,231	27,276	26,500	49,137
Imports	38,751	46,522	57,293	64,374	59,984
Balance	**-12,055**	**-23,291**	**-30,017**	**-37,874**	**-10,847**

Source: ***The Central Statistical Office (GUS)***

Between 2010 and 2013 the average unit values of ***bentonite*** importation to Poland was at the level of 275-298 PLN/t (Tab. 4).

Tab. 4. The unit values of bentonite and bleaching clays imports to Poland – CN 2508 10

Year	2009	2010	2011	2012	2013
PLN/t	316.4	297.8	275.8	280.8	287.2
USD/t	102.5	97.4	94.5	85.2	91.3

Source: ***The Central Statistical Office (GUS)***

Consumption

The total domestic consumption of ***processed bentonite*** can be estimated basing on the information on the domestic production and importation of commodities of high unit values. Taking this into account the domestic consumption of ***processed bentonite*** in ***various grades*** can be estimated in between 130,000 and 180,000 tpy in recent years.

The principal traditional end-user of ***processed bentonite*** has been the ***foundry engineering*** (***molding sands***). Other important consumers have included the ***construction*** and ***drilling*** industries, however of smaller significance. ***Crude bentonite*** has been utilized in hydro-engineering and insulating works, which are important environmental applications of increasing significance in Poland. The characteristic feature of recent years has been fast growing ***cat litter*** market. The lowest quality montmorillonite clays are suitable for the production of ***absorbing fertilizers***, which are utilised in agriculture and forestry for the reclamation and improvement of soils. Other minor applications, mainly of ***raw bentonite***, include the following: pelletizing of iron ore concentrates, wine clarification, sewage purification (absorbents), and the ceramic and enamel industries.

Another important direction of bentonite commodities utilisation has been ***bleaching clay*** manufacturing (Tab. 1). These products, supplied basically by **Siarkopol Tarnobrzeg**, are principally consumed in the comestible fats industry for processing of edible oils in order to remove impurities (ca. 40–50% of the sales), by petroleum chemistry (5–20%), cosmetics and the dyeing industry.

Companies involved in bentonites and bleaching clays production in Poland, as of December 2013

- PGP Bazalt S.A. w Krzeniowie (Bazalt Joint Stock Co. in Krzeniów), 59–500 Złotoryja, P.O. Box 34, tel. +48 76 8783872, fax. +48 76 8783421, www.pgpbazalt.pl — *crude bentonite.*
- Zakłady Górniczo-Metalowe Zębiec S.A. w Zębcu (Zębiec Mining and Metal Works Joint Stock Company in Zębiec), 27–200 Starachowice, tel. +48 41 2767400, fax +48 41 2767500, www.zebiec.com.pl — *foundry bentonite, bentonite for hydro-insulating materials, drilling bentonite, pharmaceuticals, nutritive, for animal feed, building construction, cat litter*.
- PTH Certech S.J. w Niedomicach (Certech Co. in Niedomice), 33–132 Niedomice, ul. Fabryczna 36, tel./fax +48 14 6458703, www.certech.com.pl — *cat litter.*

- Celpap Sp. z o.o. (Celpap Ltd.), 32–020 Wieliczka, ul. Czarnochowska 21, tel. +48 12 2882708, fax +48 12 2881908, www.celpap.pl — *pet liter.*
- Hekobentonity Sp. z o.o. w Korzeniowie (Hekobentonity Ltd. of Korzeniów), 39–203 Nagoszyn, Korzeniów 42a, tel. +48 14 6818962, fax. +48 14 6818017, www.bentonit.pl — *bentonite drilling fluids*, *foundry bentonite*, *hydro-insulating materials.*
- CETCO Poland Sp. z o.o. w Szczytnie (CETCO Poland Ltd. in Szczytno), 12–100 Szczytno, Korpele 13A — Strefa, +48 89 6249279, fax +48 89 6249732, www.cetco.pl — *bentonite drilling fluids*, *bentonite mat*, *hydro-insulating materials.*
- Süd-Chemie Polska Sp. z o.o., (Süd-Chemie Polska Ltd. of Gdańsk), ul. Mariana Chodackiego 33, 80-555 Gdańsk, tel. +48 58 343 73 94, fax. +48 58 343 73 93, www.sud-chemie.com.pl — *foundry, drilling and construction bentonite.*

BERYLLIUM

Overview

The main primary source of **beryllium** (**Be**) is ***beryllium mineral***, occurring predominantly in pegmatite- and greisene-type deposits, from which it is recovered in a form of **beryllium concentrate** containing 11% BeO. The second its source is ***bertrandite ore***, which forms a unique deposit in the **Spor Mts.** (the USA). Both beryllium concentrate and bertrandite ore are processed into **beryllium hydroxide**, and then to **beryllium metal**, **beryllium oxide**, and **beryllium alloys**.

Beryllium mineral has been utilized since ancient times, as ***gems*** (***emeralds***). Now **beryllium commodities** are used mainly in armaments, and in the electronic, electrotechnical, and nuclear power industries. **Beryllium** is also an important alloy additive for copper, nickel, and aluminum.

Sources

Poland has no ***beryllium ore*** deposits. Somewhat higher concentrations have been found in the ***ash of hard coals*** from the **Upper Silesian Coal Basin** (approximate reserves of 97,000 t Be), but no recovery method has been developed. Pegmatite occurring near **Bielawa** and **Dzierżoniów** (Lower Silesia) contains ***beryllium minerals***.

Production

There is currently no production of ***beryllium concentrates*** or ***beryllium*** in Poland.

Trade

Domestic demand is satisfied by irregular imports of ***beryllium commodities*** (metal, powders) – up to 35 kgpy, and continuous supplies of ***beryllium products***, varying widely from 138 to 704 kgpy. Moreover, in 2010 a huge re-exports of beryllium products occurred that exceeded by almost six times imports volume (Tab. 1). In the years of 2010–2011 the sole supplier of ***beryllium commodities*** was Kazakhstan, while in 2013 imports came from the USA. In the case of ***beryllium products*** the main importation sources were: the European Union countries, Kazakhstan, and the US, while huge re-exports in 2010 were directed to Belgium and Switzerland.

The trade balances of ***beryllium commodities*** and ***products*** have been negative in recent years (Tab. 2) and depended on the volume of imports, especially in 2013 in the case of ***beryllium products***, what strongly influenced the unit value of imported beryllium commodities (Tab. 3).

Tab. 1. Beryllium statistics in Poland

kg

Year	2009	2010	2011	2012	2013
Beryllium commodities[1] **CN 8112 12**					
Imports=Consumption[a]	–	35	27	–	1
Beryllium products CN 8112 19					
Imports	177	293	337	138	704
Exports	–	1,713	–	–	–
Consumption[a]	177	-1,420	337	138	704

[1] metal, powders

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Value of beryllium commodities and products trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Beryllium commodities[1] **CN 8112 12**					
Imports=**Balance**	–	**-289**	**-285**	–	**-1**
Beryllium products CN 8112 19					
Exports	–	63	–	–	–
Imports	140	147	171	93	1,898
Balance	**-140**	**-84**	**-171**	**-93**	**-1,898**

[1] metal, powders

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit value of beryllium commodities and products imports to Poland

Year	2009	2010	2011	2012	2013
Beryllium commodities[1] **CN 8112 12**					
PLN/kg	–	8,249	10,549	–	1,048
USD/kg	–	2,683	3,655	–	330
Beryllium products CN 8112 19					
PLN/kg	791	502	508	675	2,696
USD/kg	258	168	173	206	873

[1] metal, powders

Source: ***The Central Statistical Office (GUS)***

Consumption

Domestic demand is met mainly by imported final products containing ***beryllium*** (probably a few tons of Be per year). Recently, ***beryllium commodities*** and ***products*** are important, being imported in considerable amounts (Tab. 1, 2). These are probably electronic components, which find use in computer and data communications industries.

BISMUTH

Overview

Bismuth (**Bi**) is extracted primarily from ***bismuth-bearing ores*** of ***lead***, ***copper***, and ***tin***, and sporadically from separate deposits of ***bismuth ores***. As a result the supply of bismuth is strongly correlated with the production of other metals.

For hundreds of years **bismuth compounds** have been used to treat gastric disorders. The pharmaceutical and cosmetic industries continue to be the main consumers. Since the beginning of the 19^{th} century, **bismuth metal** has been used as a component of printer's metals. It is a basic component of low melting alloys used in the production of fuses, thermometers, etc.

Sources

There are no perspectives for the discovery of ***bismuth ore*** deposits in Poland. The slight admixtures of ***bismuth*** (about 2 ppm, to a maximum of 1,000 ppm in Kupferschiefer horizon) occur in ***copper ore*** deposits in the **Fore-Sudetic Monocline**.

Production

Bismuth has not been recovered from the only possible source – ***copper ore***.

Trade

Demand has been satisfied by imports of ***bismuth metal***, ***powders*** and ***scrap***. In the years 2009–2013 the importation volume varied between 18 and 34 tpy, coming mainly from Belgium, Germany, France, and Italy, while the United Kingdom, China, Serbia, and Spain were smaller suppliers (Tab. 1). Over the same period the exportation ranged from 0.6 to 3.0 tpy (Tab. 1), and main recipients were Ukraine, Slovakia, Hungary, and the US. The trade balances of ***bismuth commodities*** have been always negative (Tab. 2). The unit values of their imports in USD/t have not reflected the prices fluctuations on international markets (Tab. 3).

Consumption

Bismuth metal is applied in metallurgy (low melting alloys) and in electronics. ***Bismuth compounds*** were used in cosmetics and pharmaceuticals, as antiseptic agents, and also as medicament in gastropathy. However, these drugs have been eliminated in favour of antibiotics and other modern therapeutic agents. The detailed end-use structure of ***bismuth metal*** and ***bismuth compounds*** in Poland is not available.

Tab. 1. Polish imports of bismuth[1], by country — CN 8106

t Bi

Year	2009	2010	2011	2012	2013
Imports	**17.6**	**32.6**	**22.9**	**23.7**	**34.0**
Belgium	11.2	8.1	4.6	13.0	23.4
China	2.1	–	0.0	–	2,0
France	0.2	10.6	–	0.0	0.0
Germany	2.2	2.1	3.1	4.0	4,0
Italy	0.2	0.2	4.5	5.0	1.0
Netherlands	–	2.1	5.3	0.0	–
Serbia	–	–	–	–	1.0
Spain	1.0	4.7	–	–	1.2
United Kingdom	0.7	4.8	5.4	1.6	1.1
Exports	**0.6**	**2.7**	**3.1**	**2.2**	**3.0**
Consumption[a]	**17.0**	**29.9**	**19.8**	**21.5**	**31.0**

[1] metal, powders, scraps

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Value of bismuth[1] trade in Poland — CN 8106

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	44	197	251	176	214
Imports	1,010	1,467	1,848	2,178	2,593
Balance	**-966**	**-1,270**	**-1,597**	**-2,002**	**-2,379**

[1] metal, powders, scraps

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit values of bismuth[1] imports to Poland — CN 8106

Year	2009	2010	2011	2012	2013
PLN/t	57,386	44,933	80,692	91,916	76,196
USD/t	18,853	14,818	27,955	28,050	24,329

[1] metal, powders, scraps

Source: ***The Central Statistical Office (GUS)***

BORON

Overview

The most important minerals of **boron** (**B**) are borates of Mg, Ca, Na, and K, particularly ***borax***, ***colemanite***, ***ulexite***, ***kernite***, and others. They have been in use since ancient times, but large-scale consumption commenced in the 19th century, to provide chemicals needed by industries that manufacture glass and ceramics, pharmaceuticals, cosmetics, and chemicals. Boron is an indispensable element in NIB magnets (Neodymium – Iron – Boron). These powerful magnets are utilized in computers' hard drives, cell phones, medical equipment, toys, motors, wind turbines and audio systems (e.g. speakers). Boron is also used to control nuclear reactions and to modify electrical properties of silicon and germanium semiconductors.

Sources

Boron minerals (boracite, ascharite, and others) occur in unmined ***potassium salts*** accompanying the ***Kłodawa salt*** deposit in the **Kujawy** region. They contain 0.01–0.09% B. The reserves are estimated at 6,000 t B.

Production

Boron minerals are not produced in Poland.

Trade

Domestic demand for ***boron minerals*** and ***compounds*** was met by imports, which varied significantly year by year, from dozens to over thousand tpy (Tab. 1). Until 2011 it comprised in over 90% by ***boric acid*** imported from Turkey, while since 2012 Finland emerged as the second major supplier. ***Natural sodium borates*** and ***boric acid*** were also imported from Italy, and — on irregular basis — from Belgium, Germany, the Netherlands, Peru, and most recently – from Spain (Tab. 2). In 2012 there was also registered the occasional exportation of ***boric acid*** to the USA. In the last two years the deficit in boron minerals and compounds trade deepened significantly, following the growth in importation (Tab. 3). Another boron commodity imported to Poland was ***boron metal***, the majority of which originated from Germany (Tab. 2). Its recent deliveries jumped to almost 16,000 and 11,300 t respectively. In the last two years the negative trade balance of ***boron metal*** deepened to -281,000 PLN in 2013 (Tab. 3).

Tab. 1. Boron commodities statistics in Poland

Year	2009	2010	2011	2012	2013
Boron minerals [t] **CN 2528 00**					
Imports	1,435	1,869	1,535	1,580	2,070
Exports	–	0	–	8	0
Consumption[a]	1,435	1,869	1,535	1,572	2,070
Boron, metal [kg] **CN 2804 50 10**					
Imports = Consumption[a]	161	267	124	15,783	11,348

[1] natural boric acid

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Polish imports of boron commodities, by country

Year	2009	2010	2011	2012	2013
Boron minerals CN 2528 00 [t]	**1,435**	**1,869**	**1,535**	**1,580**	**2,070**
Belgium	–	–	21	19	–
China	–	–	1	0	–
Finland	–	–	12	1,084	918
Germany	24	–	1	–	–
Italy	44	25	54	39	10
Netherlands	–	–	–	13	2
Peru	–	–	–	20	–
Spain	–	–	–	–	22
Turkey	1,367	1,844	1,446	405	1,118
Boron, metal CN 2804 50 10 [kg]	**161**	**267**	**124**	**15,783**	**11,348**
China	–	–	3	–	–
Germany	158	101	–	15,752	11,168
Japan	–	1	–	–	–
Netherlands	–	–	–	–	80
Switzerland	–	–	4	–	3
United Kingdom	2	160	101	2	2
USA	–	3	16	29	95
Others	1	2	–	–	–

Source: ***The Central Statistical Office (GUS)***

Over the last five years the unit values of ***boron minerals*** importation to Poland varied according to the volume of deliveries and countries of the commodities origin (Tab. 4). In 2012 the unit costs of ***natural borates*** and ***boric acid*** achieved the highest values, exceeding 700 USD/t, with a 12% reduction last year. In the case of ***boron metal*** the importation unit values dropped distinctly to 5 and 8 USD/t in 2012-2013 from almost 250 USD/kg in 2009.

Tab. 3. Value of boron commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Boron minerals CN 2528 00					
Exports	0	0	0	10	0
Imports	2,254	2,170	2,246	3,709	4,135
Balance	**-2,254**	**-2,170**	**-2,246**	**-3,699**	**-4,135**
Boron, metal CN 2804 50 10					
Exports	0	0	0	0	0
Imports	650	76	22	272	281
Balance	**-650**	**-76**	**-76**	**-272**	**-281**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Unit values of boron commodities imports to Poland

Year	2009	2010	2011	2012	2013
Boron minerals CN 2528 00					
PLN/t	1,571	1,161	1,463	2,347	1,998
USD/t	485	380	504	722	635
Boron, metal CN 2804 50 10					
PLN/kg	786	284	175	17	25
USD/kg	247	90	61	5	8

Source: ***The Central Statistical Office (GUS)***

Consumption

The consumption pattern of boron commodities in Poland is difficult to ascertain. Nevertheless, it is assumed that the majority of ***boron compounds*** is utilised in the construction industry (as a component of insulation and reinforcement fibre glasses, borosilicate glass, and in frits and glazes of ceramic goods), as well as in detergents manufacturing (as a component of washing powder). They are also added as an essential micronutrient to fertilizers in the plant farming. In 2013 the consumption of ***natural boron compounds*** in Poland exceeded 2,000 t, after two years of stabilization at around 1,500 tpy (Tab. 1). The demand for ***boron metal*** jumped to almost 16,000 t in 2012 and over 11,000 t in 2013 from much lower levels in the previous years, probably as a result of green energy development, e.g. wind farms construction in Poland.

BROMINE

Overview

Bromine (**Br**) is a non-metal belonging to the halides, widely found in nature. The main sources of bromine are ***salt brines*** containing ***bromides***, ***salt lakes***, and ***sea brines***. ***K-Mg chloride salts*** are of less importance.

The principal contemporary applications of **bromine** are the production of flame retardants, sanitary preparations as well as agriculture, the petrochemicals industry, drilling, etc.

Sources

Bromine and ***iodine/bromine brines*** of possible commercial significance occur in many places around the country, particularly in the vicinity of hydrocarbon deposits. Some Zechstein and older Paleozoic waters contain 2-3 g/l of ***bromine***. However, until now only Tertiary ***brines*** have been utilized. The **Łapczyca** deposit, east of Cracow (static resources of ca. 32 Mm^3) and the **Dębowiec III** deposit in western Carpathians (resources of 74,13 m^3/h), are of primary importance. Total investigated domestic resources are estimated at 7,200 t of ***Br*** and 32.20 Mm^3 of ***iodine-bromine brines***, while static resources in the so-called **Gdów bay**, i.e. on the area of 49 km^2 are estimated at ca. 76 Mm^3.

Production

There is no domestic pure ***bromine*** production. Only ***cosmetic*** and ***curative salts*** enriched in Br and J are obtained by simple pan evaporating method from Miocene highly saturated brines of the **Łapczyca** deposit by the **Iodine-Bromide Brine Processing Plant Salco**. These brines are extracted from the depth of 1,200 m below the ground level. Between 2009 and 2012 the salt production increased slowly, up to 902 t in 2012 (Tab. 1). In 2013 production decreased to 750 t. Small amounts of such salt have been also occasionally obtained from the **Dębowiec** deposit. The recovery of ***bromine*** and ***iodine*** from brines and salty waters, including those which are discharged into rivers and streams by some health resorts (e.g. Rabka) and by the coal mines of the Upper Silesian Coal Basin, has been under examination.

Tab. 1. Iodine-bromide salt production in Poland

t

Year	2009	2010	2011	2012	2013
Production	874	870	893	902	750

Source: ***producer's data***

Trade

As ***bromine*** is not produced in Poland, all the domestic demand is satisfied by imports. In the years 2009-2011 the volume of deliveries ranged between 6 and 17 tpy, while in 2012 it soared to 66 t and decreased again to 35 t in 2013. Ukraine has been regular and almost exclusive supplier of bromine to Poland (Tab. 2). Reported exports in the range of 4-10 tpy, predominantly to the Czech Republic and Hungary, has been probably the re-exports of the commodity surpluses (Tab. 2). The trade balance of ***bromine*** was consistently negative (Tab. 3).

Tab. 2. Bromine statistics in Poland — CN 2801 30 90

t

Year	2009	2010	2011	2012	2013
Imports	**6**	**17**	**11**	**66**	**35**
Ukraine	6	17	11	66	32
Italy	0	0	0	0	3
Others	0	0	0	0	0
Exports	**5**	**10**	**7**	**4**	**5**
Czech Republic	2	7	2	1	0
Hungary	3	3	4	2	4
Others	–	0	1	1	1
Consumption[a]	**1**	**7**	**4**	**62**	**30**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Value of bromine trade in Poland — CN 2801 30 90

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	72	136	143	96	159
Imports	74	193	185	1,313	681
Balance	**-2**	**-57**	**-42**	**-1,217**	**-522**

Source: ***The Central Statistical Office (GUS)***

In the years 2009-2013 the unit values of ***bromine*** imports to Poland almost doubled (in PLN/t). In USD/t these values increased by ca. 47%, which corresponded to the world prices (Tab. 4).

Tab. 4. Unit value of bromine imports to Poland — CN 2801 30 90

Year	2009	2010	2011	2012	2013
PLN/t	11,966	11,130	16,356	19,772	19,259
USD/t	3,995	3,643	5,942	6,106	6,156

Source: ***The Central Statistical Office (GUS)***

Consumption

Bromine is utilized basically in the form of compounds, for the production of flame retardants and sanitary preparations, in the pharmacy and cosmetics. In 2013 the apparent consumption decreased to 30 tons as a result of huge Ukrainian deliveries (Tab. 2).

Companies involved in bromine commodities production in Poland, as of December 2013

- Zakład Przeróbki Solanek Jodowo-Bromowych Salco S.C. (Iodine-Bromide Brine Processing Plant Salco), 32 744 Łapczyca 445, tel. +48 14 6127519, fax. +48 14 6127922, www.salco.pl - *curative and cosmetic iodine-bromide salts*.

CADMIUM

Overview

Cadmium (**Cd**) is recovered as a byproduct of ***zinc*** refining, due to its association with zinc in concentrates of ***sphalerite*** (ZnS) and related sulphide ore minerals. Cadmium is used primarily for Ni-Cd batteries, while other uses, e.g. corrosion resistant coatings, pigments in thermoplastics, ceramics, glazes, etc. are limited due to cadmium toxicity.

Sources

Cadmium occurs as an associated element in the ***zinc*** and ***lead ores*** of the **Silesia-Cracow** deposits (0.01–0.05% Cd). The reserves of ***cadmium*** amount to 22,900 t, including around 3,740 t in deposits currently operated (as of 31 December 2013).

Production

The only domestic manufacturer of metallic cadmium is the **Miasteczko Śląskie Smelter**. ***Refined cadmium 99.95%*** is recovered from the waste Zn-Cd alloy generated in zinc rectification, as well as from cadmium-bearing slime coming from **ZGH Bolesław** zinc smelter. Upon 2009-2013 the production of refined cadmium varied from 530 to 370 tpy (Tab. 1).

Another important cadmium commodity produced in Poland is ***cadmium oxide*** (min. 98% CdO). It has been manufactured at the **Oława Smelter**, since 2008 being a division of **ZM Silesia (Impexmetal Group)**. In recent years the output of CdO has been approaching 40 tpy (except 2011) (Tab. 1). The plant basically has utilized scrapped FeCd plates from giant NiCd accumulators, delivered by the **MarCo Ltd.** of **Rudniki**, and to much smaller extent — from ***metallic cadmium*** manufactured at **Miasteczko Śląskie Zinc Smelter**, as well as spent portable small-size NiCd batteries. Since 2008 the major Oława Smelter' customer has been the Czech's Bochemie a.s. of Bohumil — the producer of accumulator masses etc. That has helped to survive the cadmium plant in new market circumstances, i.e. after implementation of the UE directive **REACH — Registration, Evaluation, and Authorization of Chemicals** in Poland (June 2007). According to current regulations referring to spent batteries management, their manufacturers are required to take responsibility for used rechargeable batteries and either recycle or dispose them in environmentally sound manner. As a result a number of companies involved in collecting of NiCd batteries emerged, e.g. **Reba**, **PMS Barnicki**, **Eurobac**, **Dol-Eko**, **Pro-Ekol**, **GLOB**, **Clean Environment**, **Polish Recycling Group Proeko**, **Ekola**, **Rebis**, and many others.

Tab. 1. Cadmium commodities statistics in Poland

t

Year	2009	2010	2011	2012	2013
Cadmium: metal, powder CN 8107 20, 8107 90					
Production	534	451	526	370	460
Imports	1	1	2	4	1
Exports	497[r]	449	526	370	437
Consumption[a]	38[r]	3	2	4	24
Cadmium waste and scrap CN 8107 30					
Imports	–	–	–	1	–
Exports	5	31	49	22	–
Cadmium oxide CN 2825 90 60					
Production	31	36	29	40	40
Imports	0	0	18	8	1
Exports	31	36	45	46	36
Consumption[a]	0	0	2	2	5

Source: ***The Central Statistical Office (GUS)***

According to the EU directive **2006/66/EU** the index of NiCd batteries collection until 2012 should reach 25%, while until 2016 — 45%, min. 50-55% of which is expected to be recycled.

Trade

Due to the development of domestic ***refined cadmium*** production, its importation to Poland has become insignificant. Small supplies, ranging in recent years from 1 to 4 tpy, originated basically from western European countries, i.e. France, Germany, Spain, and – on irregular basis – the USA (Tab. 1). Simultaneously, the exportation of cadmium, constituting the majority or even 100% of the **Miasteczko Śląskie**' output, varied from 370 to 530 tpy. Its principal recipients were China and Belgium. The trade balances of cadmium have been positive and have ranged from ca. 2 to 5 million PLN per annum (Tab. 2). Another important cadmium trade commodity used to be ***cadmium oxide*** (Tab. 1). Its exportation, which almost decayed in 2006-2007, in the following years revived, ranging recently from 36 to 46 tpy. As a consequence, the value of cadmium oxide turnover exceeded 330,000 PLN in 2012 and 300,000 PLN last year (Tab. 2). An issue worth noting was the decay in 2013 regular previous exportation of ***waste and scrap of unwrought cadmium and its powders*** from Poland that until 2012 ranged from 20 to 50 tpy (Tab. 1). Its only recipient was Germany.

The unit values of ***cadmium metal*** exportation varied significantly depending on the volume of sales and the world price trends. They increased spectacularly in 2010 due to high cadmium international prices, which in the subsequent years declined as the market conditions for metals deteriorated (Tab. 3).

Tab. 2. Value of cadmium commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Cadmium: metal, powder CN 8107 20, 8107 90					
Exports	4,887[r]	5,265	4,686	1,842	2,653
Imports	80[r]	67	84	108	119
Balance	**+4,807[r]**	**+5,198**	**+4,602**	**+1,734**	**+2,534**
Cadmium oxide CN 2825 90 60					
Exports	242	275	642	531	322
Imports	3	1	386	199	18
Balance	**+239**	**+274**	**+256**	**+332**	**+304**

[1] in 2008 the trade value of exports was given for **CN 8107**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit value of cadmium exports from Poland — CN 8107 20, 8107 90

Year	2009	2010	2011	2012	2013
PLN/t	8,359[r]	11,728	8,832	5,036	6,073
USD/t	2,699[r]	3,841	3,002	1,543	1,935

Source: ***The Central Statistical Office (GUS)***

Consumption

The detailed consumption structure of ***cadmium*** in Poland is unknown. The demand is met mainly by domestic suppliers. ***Cadmium commodities*** used to be utilised in the production of bearing alloys, low-melting alloys, and soldering alloys, as well as pigments and coloring agents for special grades of glass. Another cadmium's main end-use has been in batteries but this sector has been in decline – nickel-cadmium batteries for use in laptop computers and mobile phones are being phased out in favour of lithium-ion units. In recent years worries over toxicity have spurred various legislative efforts, especially in the EU, to restrict the use of cadmium in most of its end-use applications. In PVC, jewellery and soldering it has been banned since 2011. ***Cadmium oxide*** used to be utilised for the production of ***cadmium pigments*** at one of the major domestic manufacturer of chemicals — **Permedia S.A.** of **Lublin**, but this commodity usage has been ceased. The largest recipient of cadmium oxide made in Poland has been the **Bochemie Group** of the Czech Republic, which utilises that compound for manufacturing of accumulator masses.

Companies involved in cadmium commodities production in Poland, as of December 2013

- Huta Cynku Miasteczko Śląskie (Miasteczko Śląskie Zinc Smelter), 42–610 Miasteczko Śląskie, ul. Hutnicza 17, tel. +48 32 2888444, fax +48 32 2851687, www.hcm.com.pl — *refined cadmium.*

- ZM Silesia S.A., Oddział Huta Oława (Metallurgical Plant Silesia Joint Stock Company, Oława Smelter Division), 55–200 Oława, ul. Sikorskiego 7, tel. +48 71 3187301, fax +48 71 3134035, hutaolawa.pl — *cadmium oxide*.

CALCIUM

Overview

Calcium (**Ca**) is one of the most common elements in the lithosphere. **Calcium metal** containing at least 98% Ca is obtained in course of electrolysis of **fused calcium chloride** or by the aluminothermal method (roasting a mixture of ***pure calcium oxide*** with ***aluminum powder*** at 1,300°C). **Calcium compounds** are produced from calcium minerals and rock, not from calcium metal.

Calcium is applied as a reducing agent in the production of uranium and as a source of hydrogen (***calcium hydride***), which is used in meteorology for sounding balloons. Due to its application in the nuclear industry, calcium is considered a strategic metal.

Sources

In spite of large reserves of ***limestone*** and ***calcite*** in Poland, ***calcium*** is not recovered.

Production

Calcium is not produced in Poland.

Trade

Domestic demand is entirely covered by variable imports of ***calcium metal*** originated mainly from China, and/or from Western Europe, Canada, Russia and Slovakia (Tab. 1). In the last five years, there were recorded re-exports of calcium metal: in the period 2009–2010 at the stable level of 16–17 tpy, but in the years 2011–2012 it increased significantly, up to the record of 260 t in 2012, with a slight reduction to 185 t in 2013 (Tab. 1). Exports of ***calcium metal*** were directed mainly to Czech Republic, Romania (especially in 2012–2013), Hungary, Slovakia, and a few other countries. In 2009 and in the years of 2012–2013 re-exports exceeded the importation quantities, so apparent consumption of ***calcium metal*** in Poland remained negative. In the years of 2009–2011 the trade balances of ***calcium metal*** were increasingly negative (Tab. 2), depending on the volume and value of imports, as well as on the volume and value of re-exports recorded in the period 2009–2010 (Tab. 3). Due to high exports volume recorded in the years of 2012–2013 the trade balance turned into positive values (Tab. 2), despite the quite high difference between unit values of imports and exports recorded by Central Statistical Office (Tab. 3).

Consumption

The consumption pattern in Poland cannot be ascertained due to the lack of data. In recent years, it probably has not exceeded a few tons per year. In the years 2009 and 2012–2013 the apparent consumption was negative (Tab. 1).

Tab. 1. Calcium metal statistics in Poland — CN 2805 12

t Ca

Year	2009	2010	2011	2012	2013
Imports	12.6	30.2	110.2	183.4	78.8
Exports	17.4	15.6	52.6	259.5	185.1
Consumption[a]	**-4.8**	**14.6**	**57.6**	**-76.1**	**-106.3**

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Value of calcium metal trade in Poland — CN 2805 12

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	164	137	515	2,476	1,739
Imports	194	387	1,291	2,335	998
Balance	**-30**	**-250**	**-776**	**+141**	**+741**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit value of calcium metal imports to Poland — CN 2805 12

Year	2009	2010	2011	2012	2013
PLN/t	15,397	12,842	11,712	12,732	12,658
USD/t	4,890	4,324	3,991	3,874	4,034

Source: ***The Central Statistical Office (GUS)***

CARBON BLACK

Overview

Carbon black consists of fine grains of carbon created by the incomplete combustion of ***acetylene***, ***natural gas*** (currently the main source) and ***naphthalene***, ***oils***, etc. This provides carbon black that can be used as a black pigment and in the rubber industry (90–95% of the total consumption).

Sources

The main sources for ***carbon black*** production are natural gases. Acetylene, naphthalene, and others are of minor importance.

Production

The largest ***carbon black*** producer in Poland is currently **Orion Engineered Carbons** of Jasło. Until 2011 this plant was known as **Evonik Carbon Black Polska**, being a subsidiary of German chemical company **Evonik Industries** (main shareholder — **RAG** of **Essen**). In July 2011 Evonik sold its all carbon back business to **Rhone** capital group of the USA, which established **Orion Engineered Carbons Group**. Polish plant has become a part of this company. The company has operated modernized and enlarged plant, former Carbon Black Production Unit of the Jasło Oil Refinery. One production line was modernized, and another new production line was constructed. As a result, in the first decade of the 2000s the domestic production of carbon black developed to the level reported for the last time in the 1980s. Lower domestic demand in 2009 resulted in its decline to ca. 27,800 t. In the years 2010–2011 the production recovered to ca. 45,000 t. In 2012 r. it was sharply reduced to 11,100 t, while in 2013 it approached ca. 32,000 t (Tab. 1).

Tab. 1. Carbon black statistics in Poland — CN 2803

'000 t

Year	2009	2010	2011	2012	2013
Production	27.8	34.7	45.0	11.1	32.0
Imports	127.7	264.3	286.6	276.2	298.6
Exports	53.4	125.9	147.6	150.9	219.4
Consumption[a]	102.1	173.1	184.0	136.4	111.2

Source: ***The Central Statistical Office (GUS)***

Trade

Poland has been a net importer of ***carbon black***. Until 2009 purchases covering carbon black demand stabilized at 70–74 ktpy. The rest of imported carbon blacks, and probably some part of the domestic production, was exported. In the years 2010-2013 the situation radically changed. ***Carbon black*** trade volumes achieved the record volumes in 2013: imports rose up to ca. 298,600 t, while exports (mainly re-exports) to 219,400 t (Tab. 1). As a consequence, net imports rose to 138,400–139,000 t in 2010–2011, and decreased to 125,300–79,200 t in 2012–2013. A part of carbon black purchased between 2010 and 2012 was probably stored as stocks (data not available). In the years 2010–2013 the largest increases of importation were reported in the case of cheap grades from Russia (ca. 79% of imports in 2013). Minor quantities came from the Czech Republic, Ukraine, Hungary, Sweden, and Germany (Tab. 2). Simultaneously, Polish companies started to be important traders of cheap Russian, Czech, Ukrainian and Hungarian carbon black on the European market. The largest recipients of carbon black from Poland were Germany, France, the Czech Republic, Luxembourg and Slovakia (Tab. 3).

Tab. 2. Polish imports of carbon black, by country — CN 2803

'000 t

Year	2009	2010	2011	2012	2013
Imports	**127.7**	**264.3**	**286.6**	**276.2**	**298.6**
China	0.0	0.1	1.2	1.6	1.1
Czech Republic	19.2	60.3	71.4	55.6	29.5
France	2.4	2.9	2.1	1.1	1.2
Germany	4.3	6.5	3.7	3.0	8.5
Hungary	6.7	10.3	22.2	14.9	3.5
Italy	2.4	0.9	1.8	1.5	1.7
Netherlands	0.3	0.2	0.1	0.0	0.0
Russia	76.1	145.2	155.9	178.3	234.6
Sweden	4.7	25.7	3.7	2.1	1.7
Thailand	0.0	0.3	1.2	1.1	0.8
Ukraine	9.3	10.5	20.8	16.2	14.5
United Kingdom	0.3	0.2	0.2	0.1	0.1
Others	2.0	1.2	2.0	0.7	1.4

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Polish exports of carbon black, by country — CN 2803

'000 t

Year	2009	2010	2011	2012	2013
Exports	**53.4**	**125.9**	**147.6**	**150.9**	**219.4**
Austria	11.3	4.1	4.3	2.3	4.1
Belgium	0.7	1.8	1.7	1.7	1.6
Brazil	0.1	0.0	0.0	0.1	2.2

Czech Republic	8.6	17.8	13.5	4.9	38.9
Finland	–	0.1	1.8	1.3	2.5
France	8.2	14.6	17.0	16.8	17.1
Germany	13.0	48.8	55.8	64.5	62.4
Hungary	0.6	0.9	4.1	3.0	3.6
Italy	1.1	2.1	4.6	7.3	8.1
Latvia	0.1	3.0	0.0	0.1	0.1
Luxembourg	0.0	7.9	10.2	11.8	15.2
Netherlands	0.8	5.1	6.9	7.0	8.1
Portugal	0.1	0.0	0.3	3.2	4.2
Romania	0.4	–	0.3	2.7	17.0
Slovakia	6.0	10.1	12.2	4.4	12.3
Slovenia	0.0	7.3	8.9	7.5	7.1
South Africa, Republic of	0.2	0.0	0.8	–	0.1
Spain	0.4	0.2	0.3	4.8	10.3
Sweden	0.1	1.3	1.5	1.5	0.6
USA	0.0	–	0.0	3.2	0.0
Others	1.7	0.8[r]	3.4	2.8	3.9

Source: ***The Central Statistical Office (GUS)***

The trade balance of ***carbon black*** in Poland has been constantly negative (Tab. 4). In the years 2010-2012 it deepened by ca. 91% due to rapid growth of imports volume and some growth of imports unit values, partly limited by higher exports unit values and some exports volume growth. In 2013 the exportation rapidly rose, but its unit values were distinctly lower, so trade deficit was reduced by 8% (Tab. 5).

Tab. 4. Value of carbon black trade in Poland — CN 2803

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	158,258	478,799	733,828	808,864	897,902
Imports	326,730	744,930	973,647	1,130,411	1,194,072
Balance	**-168,472**	**-266,131**	**-239,819**	**-321,547**	**-296,170**

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Average unit values of carbon black trade in Poland — CN 2803

Year	2009	2010	2011	2012	2013
Exports unit values					
PLN/t	2,965.3	3,803.5	4,972.2	5,359.9	4,092.3
USD/t	971.3	1,264.1	1,695.6	1,640.4	1,302.5
Imports unit values					
PLN/t	2,559.4	2,819.0	3,397.3	4,092.3	3,999.6
USD/t	836.1	935.9	1,154.2	1,253.2	1,271.7

Source: ***The Central Statistical Office (GUS)***

Consumption

Carbon black is used primarily in the rubber industry as ***filler***. The consumption volume of carbon black is strongly correlated with the production of ***rubber products*** (especially synthetic rubber).

Companies involved in carbon black production in Poland, as of December 2013

- Orion Engineered Carbons Sp. z o.o. w Jaśle (Orion Engineered Carbons Ltd. of Jasło), ul. 3 Maja 83, 38–200 Jasło, tel. +48 13 446 63 90, fax. +48 13 446 64 97, www.orioncarbons.com — *carbon black*.

CEMENT

Overview

Cement is an important binding agent in concrete and mortars, and one of the critical materials in the construction industry. **Portland cement** is currently the most important type of cement. An important semi-product for the production of Portland cement is **cement clinker**, which is obtained by fusing a mixture of finely ground raw materials in a kiln at a temperature of about 1,400°C. The basic raw materials required for this production are, in order of importance, ***carbonate rocks*** (***limestone*** and ***marl***), ***clay materials*** (***clay***, ***silt***), and ***iron ore***. The clinker is ground with small amounts (typically 3–4%) of calcium sulfate, usually ***gypsum*** or ***anhydrite***, to make Portland cement. Apart from the most common **Portland cement without additives**, a growing importance of **Portland cements with additives** is observed. Such additives, e.g. ***blast furnace slag***, ***blast furnace ash***, ***silica dust***, ***flow dust*** from power stations, ***tuff***, ***pozzolan***, and others, are used in these grades production. Other grades of cement are of less importance. The most common are: **aluminous cement**, **Sorel cement**, **Roman cement**, etc.

Sources

Primary sources

The basic primary raw materials for the production of ***cement clinker*** and — consequently — ***cement*** are: ***limestones***, ***marls***, and ***clays***. Their deposits are geologically widespread and abundant in Poland. The ***limestone*** and ***marl*** deposits ***for cement industry*** are located mainly in the central and southern part of the country, where the majority of cement plants operate. The total resources of 70 deposits recognized for this industry amounted to 12,794 Mt (as of 31 December 2013), including 4,133 Mt in 18 developed deposits (with two mined periodically: Podgrodzie and Strzelce Opolskie I). The largest deposits are located in the Lubelskie voivodeship (3.3 billion t of Cretaceous chalk and marls) and the Świętokrzyskie voivodeship (2.2 billion t, mainly of Devonian and Jurassic limestones). Large resources occur also in the Łódzkie and Mazowieckie voivodeships (1.9 and 1.5 billion t, respectively), while the smaller ones in the Kujawsko-Pomorskie voivodeship (northern Poland), as well as Opolskie and Śląskie voivodeships (southern Poland).

Clay deposits ***for cement industry*** are recognized in the same regions as limestone and marls. There are 28 deposits with proven resources above of 276 Mt (as of 31 December 2013). In last two years only the **Izbica V**, **Lechówka dz 104/1**, **Lechówka dz. 102/1, 99** deposits were extracted while in 2013 the only last two of the above mentioned deposits were operated. The level of such temporary exploitation indicates that secondary materials are the principal source of alumina-bearing raw materials for the cement industry.

Gypsum and ***anhydrite*** are important additives, which regulate binding time of cements. Their total consumption for this purpose rose to 834,100 t in 2011, about 55% of which was made by ***synthetic gypsum*** (***FGD gypsum***). Since 2009 the quantity of synthetic gypsum has exceeded the amount of natural gypsum used in the cement industry. Data for 2012 and 2013 are not available.

Secondary sources

The importance of secondary raw materials in the cement industry has been constantly growing. In the largest quantities have been consumed: ***fly ash*** from power plants (above 2 Mtpy), ***blast furnace slag*** (1.5-2 Mtpy), ***iron-bearing wastes*** (dusts, sludges, siderite and others, in the amount of 150,000-250,000 tpy), ***limestone wastes*** (mining and processing) from deposits operated by limestone companies (in the amounts of 600,000-800,000 tpy), ***carbonaceous shale***, ***FGD gypsum*** and others. Their shares in the production of cement have been increasing year by year to more than 4.4 Mt in 2011 (data for the years 2012 and 2013 are not available).

Cement plants have utilized industrial wastes not only as a raw material in the production of cement clinker and cement, but also as an ***alternative fuel*** for clinker burning. In 2004, almost 201,000 t of alternative fuels were spent, while in 2011 about 1,227,000 t. Their share in fuel generation in cement plants rose from less than 2% in 2001 to over 40% in 2011.

Production

The occurrence of the majority of ***limestone*** and ***marl*** deposits ***for cement industry*** in the central and southern parts of the country determined the location of cement plants (Tabs. 1 and 2). In 2010, there were 11 ***cement plants*** operating full production lines (including cement clinker kilns), and one **Górka** plant — the sole producer of high-alumina cement (the production based on limestones and imported bauxite and alumina). At the market there is also a cement mill - **Ekocem** in Dąbrowa Górnicza belonging to the **Górażdże Group**, and three terminals: **Warszawa** belonging to **Dyckerhoff Group** and two marine ones — in **Gdynia** and **Szczecin** belonging to **Cemex Group** (Tab. 2). The **Dyckerhoff Group** has also operated a cement mill located in **Detmarovice** in the territory of the Czech Republic close to Polish border.

Tab. 1. Cement clinker and cement statistics in Poland

'000 t

Year	2009	2010	2011	2012	2013
Cement clinker CN 2523 10					
Production	10,659	11,768	13,629	11,807	10,855
Exports	129	83	44	100	148
Imports	38	100	20	8	11
Consumption[a]	10,568	11,785	13,605	11,715	10,718

Cement CN 2523 21–90					
Production	15,537	15,812	18,993	15,919	14,831
• *portland cement without additives*	*5,168*	*5,285*	*6,853*	*5,828*	*5,950*
• *portland cement with additives*	*9,000*	*8,645*	*9,634*	*7,840*	*7,806*
• *metallurgical cement*	*1,369*	*1,592*	*1,238*	*1,127*	*1,350*
Exports	439	445	381	330	441
• *portland cement*	404	423	363	302	*420*
• *metallurgical cement*	35	22	18	28	*21*
Imports	494	595	991	690	752
• *portland cement*	*473*	*568*	*972*	*674*	*650*
• *metallurgical cement*	*21*	*27*	*19*	*15*	*102*
Change of stocks	*-130*	*-44*	50	83	.
Consumption	15,462	15,918	19,653	16,362	15,142

Source: ***The Central Statistical Office (GUS), Association of Cement Producers***

Almost all currently operating cement plants, as a result of the privatization process, were taken over by large international cement companies (Tab. 2). The largest shares in the domestic cement market have had: **HeidelbergCement** (24%), **Lafarge** (22%), **CRH** (16%), **Cemex** (14%), **Polen Zement** (10%), **Dyckerhoff** in the structure of **Buzzi Unicem's** (9%), **Miebach Projekt** (4%), and **Nowa Huta** (<2%). After a period of privatization and multiple changes in ownership structure, since June 2010, the owner of the last mentioned plant is the **Cement plant Kraków Nowa Huta Ltd**.

At present, all cement plants operating in Poland have been practically completely modernised, with the best available technologies applied. This resulted in increasing share of dry method of clinker production to 98%. In 2011 in the Polish cement industry there were 18 lines of dry method (including one reserve) and 4 lines of wet production method. The production capacity of dry furnaces amounted to approximately 15.5 mln tpy of clinker, while the wet kilns - only 0.5 mln tpy. The cement production potential could reach 24 Mtpy. However, due to disadvantageous market conditions, rising energy and fuel prices, and restrictions resulting from emissions trading, future expansion of the production capacity is not expected.

In the last five years the production of cement and clinker showed substantial fluctuations (Tab 1). A significant decrease in the cement production by almost 10% to 15.5 Mt was recorded in 2009, while in the production of clinker – it was a fall of over 14% to 10.6 Mt (Tab 1). The year 2010 brought a slight recovery in the construction industry, while in 2011 a real boom was recorded. It was a consequence of the accumulation of many beneficial economic effects associated with the use of EU funds for infrastructure development and many investments associated with preparation of EURO 2012, which resulted in the record production of cement of around 19 Mt (20% increase as compared to 2011) and clinker - more than 13.6 Mt (Tab. 1). However, the next two years showed a significant slowdown, particularly evident in the second half of 2012 and the first haft of 2013, when the production declined to only 14.8 Mt in 2013, i.e. the lowest level in the last five years (Tab. 1).

Tab. 2. Structure of cement industry in Poland in 2013

Mt

Main owner	Company	Cement plants	Primary raw materials		Production	
			Deposits	Output	Clinker[1]	Cement[1]
• **HeidelbergCement** (Germany)	**Górażdże Cement S.A.**	Górażdże	Górażdże **(l)**, Opole-Folwark **(m)**, Strzelce Opolskie **(l)**	3.42	2.97	4.39
	Ekocem Sp. z o.o.	Ekocem (Dąbrowa G.)[2]	–			
• **Lafarge** (France)	**Lafarge Cement S.A.**	Małogoszcz	Leśnica-Małogoszcz **(l)**	7.87	2.84	4.13
		Kujawy	Barcin-Piechcin-Pakość **(l)**			
• **CRH** (Ireland)	**Grupa Ożarów S.A.**	Ożarów	Gliniany-Duranów **(m)**	3.37	2.57	3.05
		Rejowiec	Rejowiec **(m)**			
• **Cemex** (Mexico)	**Cementownia Chełm S.A.**	Chełm	Chełm **(ch)**	2.32	1.95	2.44
	Cementownia Rudniki S.A.	Rudniki	Latosówka-Rudniki II **(l)**, Rudniki-Jaskrów **(l)**			
	Cem-Con Szczecin, CBC Gdynia	Szczecin[3], Gdynia[3]	–			
• **Dyckerhoff/Buzzi Unicem's** (Italy/Germany)	**Cementownia Nowiny Sp. z o.o.**	Nowiny	Kowala **(l)**	1.66	1.06	1.52
		Warszawa[3]	–			
• **Polen Zement** (Germany)	**Cementownia Warta S.A.**	Warta	Działoszyn-Trębaczew **(l)**, Niwiska Górne-Grądy **(l)**	2.78	1.72	1.92
• **Miebach Projekt** (Germany)	**Cementownia Odra S.A.**	Odra	Odra II **(l)**	0.66	0.38	0.82
• **Cementownia Kraków Nowa Huta** (KEM)	**Cementownia Nowa Huta**	Nowa Huta	Purchase of raw materials	–	0.08	0.34
• **Mapei** (Italy)	**Cementownia Górka Sp. z o.o.**	Górka	Purchase of raw materials and imports of bauxite	–	0.05	0.05

[1] *data from 2011 - the most recent data available from the* ***Association of Cement Producers*** *at the time of publication preparation*

Legend: **(ch)** — chalk, **(l)** — limestone, **(m)** — marl

[2] milling plants only

[3] land or marine terminal

Source: ***Association of Cement Producers****,* ***Mineral Deposits Datafile****,* ***Central Statistical Office*** *(GUS)*

The structure of the cement production is dominated by ***Portland cement with additives*** (**CEM II**), which share amounted to 51-56% of sales in the last two years. ***Portland cement without additives (CEM I***) constituted about 32-41%, while metallurgical cement (CEM III) - only 7-9%. Due to large investments in the construction industry the demand for cement of high strength parameters has been increasing year by year. This has also resulted in increase of bulk cement sales, which has exceeded 81% in recent years.

Trade

The ***cement clinker*** has been exported in smaller amounts than cement. The level of clinker exports in the last five years ranged from 44 to 171 ktpy (Tab. 3). The main importers of Polish clinker have been our eastern and southern neighbours: the Czech Republik, Slovakia, and Ukraine (Tab. 3).

Tab. 3. Polish cement clinker exports, by country — CN 2523 10

'000 t

Year	2009	2010	2011	2012	2013
Exports	**129**	**83**	**44**	**100**	**148**
Austria	0	–	0	–	–
Czech Republic	96	70	43	72	138
Estonia	–	–	–	–	–
Germany	1	–	1	2	0
Latvia	–	–	–	–	–
Lithuania	–	3	0	0	2
Slovakia	12	–	0	–	–
Ukraine	19	9	–	26	7

Source: ***The Central Statistical Office (GUS)***

The recent level of cement clinker importation has not exceeded 100,000 tpy. The exception was its rapid growth in 2010. The major and most regular supplier has been Germany. In 2010 the Czech Republic appeared as the most important supplier due to very low unit values of clinker from this country (Tab. 4). The growth in imports resulted in negative trade balance of cement clinker, with an exception for 2010 (Tab. 4), when it was positive (Tab. 7).

Tab. 4. Polish cement clinker imports, by country — CN 2523 10

'000 t

Year	2009	2010	2011	2012	2013
Imports	**37**	**100**	**20**	**8**	**11**
Czech Republic	10	82	–	–	–
Germany	27	18	17	8	3
Slovakia	–	–	0	–	7
Ukraine	–	–	3	–	1

Source: ***The Central Statistical Office (GUS)***

Poland has traditionally exported ***cement*** to many countries. During last four years the volume of sales ranged between 330,000 and 440,000 tpy. Similarly as in case of clinker, the main importers of cement from Poland in recent years have been neighbouring countries, especially the Czech Republic, Germany, Russia, and Slovakia (Tab. 5), although in 2009-2010 the significant amounts of cement were also sold to Finland, Italy and Hungary.

Tab. 5. Polish exports of cement, by country — CN 2523 21–90

'000 t

Year	2009	2010	2011	2012	2013
Exports	**439**	**445**	**381**	**330**	**441**
Austria	5	9	9	3	3
Belgium	1	0	2	2	2
Belarus	2	1	1	4	2
Czech Republic	106	165	116	69	87
Finland	49	4	–	–	0
Germany	69	0	56	58	94
Hungary	19	1	1	1	1
Italy	23	22	24	21	18
Latvia	0	0	1	3	4
Lithuania	0	0	0	0	1
Netherlands	0	0	1	1	1
Norway	4	1	0	0	0
Russia	43	48	88	93	115
Slovakia	114	123	76	60	102
Sweden	0	0	0	0	4
Ukraine	1	1	1	1	1
United Kingdom	0	0	0	0	0
Others	3	10	5	14	6

Source: ***The Central Statistical Office (GUS)***

The last five years, except for 2009, brought a significant increase in imports of cement, to over 500 kt, with a maximum of 991 kt in 2011. This growth caused that the share of foreign suppliers in the domestic market reached more than 5% in 2011, and the volume of imports exceeded the volume of exports in the analyzed period, resulting in negative trade balance of this material. The exception was 2009, when the level of imports was the lowest (Tabs. 5-7). Regarding imports, the ***special types*** and the ***highest grades of cements*** predominated, which were purchased mainly from Germany (over 37%), Slovakia and Belarus (significant decrease in deliveries in 2012-2013), as well as from the Czech Republic (Tab. 6).

The average unit values of both imported and exported ***cement clinker*** have been distinctly higher than these of the commodities produced in the country (Tab. 8). The average unit values of ***Portland cements*** imports were usually 13-16% lower than domestic

Tab. 6. Polish imports of cement, by country — CN 2523 21–90

'000 t

Year	2009	2010	2011	2012	2013
Imports	**494**	**595**	**991**	**690**	**752**
Belgium	2	1	1	0	1
Belarus	120	137	107	15	33
Croatia	1	0	0	0	0
Czech Republic	23	87	249	146	102
Denmark	51	58	73	75	83
France	3	4	5	4	4
Germany	208	195	367	247	233
Lithuania	1	25	39	30	46
Russia	0	0	–	–	–
Slovakia	85	83	149	172	247
Ukraine	–	4	0	–	–
Others	1	1	1	1	3

Source: ***The Central Statistical Office (GUS)***

Tab. 7. Value of cement and cement clinker trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Cement clinker CN 2523 10					
Exports	28,241	16,199	7,915	18,046	25,056
Imports	13,100	17,621	5,373	2,309	3,247
Balance	**+15,141**	**-1,422**	**+2,542**	**+15,737**	**+21,809**
Cement CN 2523 21–90					
Exports	188,889	172,838	183,328	195,097	224,468
Imports	168,385	174,930	275,304	204,357	216,533
Balance	**+20,504**	**-2,092**	**-91,976**	**-9,260**	**+7,935**

Source: ***The Central Statistical Office (GUS)***

prices, with the exception for 2009 (Tab. 8). The average unit values of ***Portland cements*** exports, which until 2009 were typically lower than these of domestic origin, in 2012 rose significantly to above 611 PLN/t (Tab. 8). The average unit values in imports of metallurgical cements usually higher than exports and production ones (in 2009 almost threefold), in 2013 was significantly reduced to the lowest level in this five-year period (Tab 8).

Consumption

The financial crisis, effects of which began to be felt at the end of 2008, caused a significant slowdown of growth in the construction industry, and the drop in cement

Tab. 8. Average unit values of cement and cement clinker production and trade in Poland

Year	2009	2010	2011	2012	2013
Cement clinker CN 2523 10					
Production average unit values					
— PLN/t	122.7	131.8	145.4	147.8	145.6
— USD/t	39.4	43.8	49.1	45.4	46.1
Exports average unit values					
— PLN/t	218.6	195.8	178.5	181.0	169.9
— USD/t	72.1	64.3	63.2	54.9	54.0
Imports average unit values					
— PLN/t	347.7	175.6	270.0	292.4	286.5
— USD/t	111.2	58.1	92.3	89.4	91.2
Portland cement CN 2523 29					
Production average unit values					
— PLN/t	286.0	260.9	271.6	266.2	270.2
— USD/t	91.8	86.7	91.7	81.7	85.5
Exports average unit values					
— PLN/t	444.7	398.6	487.3	611.1	520.4
— USD/t	143.8	131.5	168.0	187.0	165.2
Imports average unit values					
— PLN/t	283.7	229.8	234.3	231.6	226.3
— USD/t	91.0	74.9	80.5	71.3	71.7
Metallurgical cement CN 2523 90 10					
Production average unit values					
— PLN/t	215.2	196.6	.	277.5	248.6
— USD/t	69.1	65.3	.	85.2	78.7
Exports average unit values					
— PLN/t	261.7	210.3	327.2	305.4	273.7
— USD/t	81.1	68.2	113.2	93.5	86.6
Imports average unit values					
— PLN/t	786.4	440.3	372.6	327.4	247.0
— USD/t	249.8	144.7	127.6	100.6	78.4

Source: ***The Central Statistical Office (GUS)***

consumption by over 10%, to 15.6 million tons in 2009 (Tab. 1). In 2010 the slight recovery of cement consumption was recorded, while in 2011 it jumped to more than 19.6 Mt due to intensification of structural investment and implementation of projects related to EURO 2012. However, in the second half of 2012, after the closure of the football championships, a significant slowdown in the dynamics of development of the construction industry was recorded, resulting in an annual cement consumption of 16.3 Mt, i.e. more than 17% lower than in the record 2011. This declining trend was even more deepened in the first half of 2013. Despite the fact that in the last quarter of the year a number of investments were launched, resulting in growth of demand for cement, its consumption in 2013 was the lowest in the last five years (15.1 Mt). Per capita consumption resulting from this level was 382 kg – the rate much lower than in the record 2011, but higher than the average of around 298 kg per capita for the residents of the EU. The 2013 was a second consecutive year when the majority of EU countries reported declines in cement consumption. In 2012 it referred to almost all countries, except Estonia and Latvia, while in 2013 a group of countries which reported an increase in consumption included Lithuania, Denmark, Austria, Hungary, the United Kingdom, Switzerland, Luxembourg, and Norway. The most acute decreases, although less severe than in 2012, were felt in Spain and Portugal (approx. -19% per each), Italy (-15%), and Greece (-10%).

Companies involved in cement production in Poland, as of December 2013

- Górażdże Cement S.A. w Choruli (Górażdże-Cement Joint Stock Co. of Chorula), ul. Cementowa 1, Chorula, 45–076 Opole, tel. +48 77 4530291, fax +48 77 4468103, www.gorazdze.pl — *clinker and cement* (Górażdże cement plant and Ekocem cement mills).
- Lafarge Cement S.A. w Małogoszczy (Lafarge Cement Polska Joint Stock Co. of Małogoszcz), ul. Warszawska 110, 28–366 Małogoszcz, tel. +48 41 3854100, fax +48 41 3854101, www.lafarge-cement.pl — *clinker and cement* (Małogoszcz and Kujawy cement plants).
- Grupa Ożarów S.A. w Ożarowie (Grupa Ożarów Joint Stock Co. of Ożarów), Karsy 77, 27–530 Ożarów, tel. +48 15 8391100, fax +48 15 8391108, www.ozarow.com.pl — *clinker and cement* (Ożarów and Rejowiec cement plants).
- Cemex Polska Sp. z o.o. w Warszawie (Cemex Polska Ltd. of Warsaw), Al. Jerozolimskie 212A, 02–486 Warszawa, tel. +48 22 5714100, fax +48 22 5714101, www.cemex.pl — *clinker and cement* (Chełm and Rudniki cement plants, Cem-Con Szczecin and Chełm Bałtyk Gdynia cement mills).
- Cementownia Nowiny Sp. z o.o. w Sitkówce (Nowiny Cement Plant Ltd. of Sitkówka), 26–052 Sitkówka-Nowiny, tel. +48 41 3466000, fax +48 41 3466488, www.dyckerhoff.pl — *clinker and cement* (Nowiny cement plant, Warszawa, Wysoka cement mills).
- Cementownia Warta S.A. w Trębaczewie (Warta Cement & Lime Works Joint Stock Co. of Trębaczew), Trębaczew, 98–355 Działoszyn, ul. Przemysłowa 17, tel. +48 43 8413003, fax +48 43 3111322, www.wartasa.com.pl — *clinker and cement* (Warta cement plant).
- Cementownia Odra S.A. w Opolu (Odra Cement Plant Joint Stock Co. of Opole), ul. Budowlanych 9, 45–202 Opole, tel. +48 77 4020899, fax +48 77 4542860, www.odrasa.eu — *clinker and cement* (Odra cement plant).

- Cementownia Kraków Nowa Huta Sp. z o.o. (Kraków Nowa Huta Cement Plant Ltd), ul. Cementowa 2, 31–983 Kraków, tel./fax +48 12 6810542, www.cementowniakrakow.pl — *clinker and cement* (Nowa Huta cement plant).
- Górka Cement Sp. z o.o. (Górka Cement Plant Ltd.), 32–540 Trzebinia, ul. 22 Lipca 58, tel. + 48 32 6121069, fax. +48 32 6323450, www.gorka.com.pl — *high-alumina cement* (Górka cement plant).

CESIUM

Overview

The main source of **cesium** (**Cs**) is ***pollucite***, which occurs mainly in pegmatitic deposits. **Pollucite concentrates**, containing approx. 20% Cs_2O, are obtained as co-products in the processing of ***beryllium-*** and ***lithium-bearing ores***. Pollucite concentrate is chemically transformed into **cesium chloride** or **cesium hydroxide**, then electrolytically reduced to **cesium metal**. Another way to obtain this metal is to reduce molten **cesium hydroxide** with ***calcium metal*** or ***magnesium metal***.

The primary applications of **cesium**, usually as compounds, are in electronics, photo-electric equipment, the glass-making industry, chemistry, the production of synthetic rubber, and the manufacture of basic batteries resistant to low temperatures.

Sources

Poland has no ***cesium-bearing*** mineral deposits.

Production

There is no production of ***cesium commodities*** in Poland.

Trade

Domestic demand is entirely satisfied by imports, which are not recorded by the **Central Statistical Office** (**GUS**).

Consumption

The structure of demand for ***cesium*** and ***cesium compounds*** in Poland is not known. They are probably utilised in the electronics, glass-making, and chemical industries.

CHALK AND RELATED PRODUCTS

Overview

Chalkstone (**whiting chalk**) is a sedimentary rock composed mainly of very fine calcite skeletons (ca. 0.001 mm). It is used in its natural state or washed. Commercial **washed chalk**, also known as **technical chalk**, has numerous applications. The best quality grades are used in the production of pharmaceuticals, cosmetics, paper, rubber, chemicals, ceramic whiteware, paint and varnishes, putty, and stoppers. Inferior grades are utilized in cement production and agriculture. Two main substitutes for higher grades of chalk are: **ground calcium carbonate** (**GCC**) obtained from high purity ***limestone***, ***marbles*** or ***calcite***, and **precipitated calcium carbonate** (**PCC**) produced in reaction of ***lime milk*** and gaseous CO_2. The current world production of GCC and PCC surpasses over ten times the world natural chalk supply.

Sources

Chalk occurs in Cretaceous in the eastern part of the **Lublin Plateau** (Chełm region). Chalk from the **Chełm** deposit is classified as the ***limestone*** for the cement industry and mined for the needs of the **Chełm** and **Rejowiec** cement plants (see: **CEMENT**), being also partly utilized in the construction, agriculture, and chemical industries.

Chalk is known also in isolated Cretaceous floats in Quaternary clay sediments in the **Podlasie** area (NE Poland), particularly in the **Kornica** and **Mielnik** regions. These deposits are rather small, but the raw material is utilized in accordance to its specific properties. There are 19 recognized deposits, including 7 deposits being in operation (as of 31 December 2013). Around 92% of the total resources, i.e. 36.4 Mt, are in the **Kornica** region, while only 8% in **Mielnik** region.

Production

In spite of the presence of large, easily accessible deposits of ***chalk*** in Poland, the production is not very well developed. Currently, it is carried on almost entirely by **Omya Ltd.** of **Warsaw**, a subsidiary of Swiss company **Omya**. It operates the **Mielnik** mine and plant, which have been modernized in the late 1990s. The mining output and production increased eight times between 2000 and 2007, to over 96,000 t, with visible reduction in the next three years to ca. 50,000 tpy. Since 2011 it has recovered, amounting to 91,500 t in 2013. The plant has produced ***technical chalk*** and ***whiting chalk***, up to 10,000 tpy per each one. Lower quality ***fodder chalk*** and ***fertilizer chalk*** have constituted the majority of the total production.

A few smaller deposits of chalk in the **Kornica** region have been occasionally exploited by private individuals. Raw material from these deposits has been used only for ***fertilizer chalk, fodder chalk*** and low-quality ***whiting chalk***. Their combined production - from 4 small mines - rose to ca. 46,000 t in 2012. The largest producer in this region is **Koszelowskie Zakłady Kredowe** in **Koszelówka**. The total production of ***chalk products*** on the basis of ***chalk*** recently has varied in the range 60-140 ktpy (Tab. 1).

Deficiency of domestic natural chalk products resulted in development of production of so-called "chalk" (precisely: ***ground calcium carbonate — GCC***), obtained in course of milling of high quality ***limestone***. The total production of ground calcium carbonate in Poland increased to ca. 780,000 t in 2008, with reduction by 35% in the next two years and revival back to over 780,000 t in 2013 (Tab. 1). Some lime works are the main producers of GCC grades, e.g. ***technical chalk*** (used mainly as filler in chemical and ceramics industry) — the **Trzuskawica Lime Works**, the **Lhoist Bukowa**, the **Lhoist Opolwap**; ***whiting chalk*** — the **Lhoist Bukowa**; and — in the largest amounts — ***fodder chalk*** in the **Trzuskawica Lime Works**, the **Lhoist Bukowa** and the **Lhoist ZW Wojcieszów**. Other important producers of GCC grades are: the **Labtar** of **Tarnów Opolski**, **ZPSM Minerał** of **Wałcz**, **APG** of **Sokołów** near Kielce, **Techmot** of **Opole**, **JARO** of **Jaroszów**, and others.

Tab. 1. Statistics of chalk and related products[1] in Poland — CN 2509

'000 t

Year	2009	2010	2011	2012	2013
Mining output[2]	79.5	58.9	112.0	131.8	137.5
Production, total	676.8	500.0	614.4	741.7	782.0
Imports	45.8	91.9	98.9	153.4	175.5
Exports	2.7	4.9	4.5	6.3	6.5
Consumption[a]	719.9	587.0	708.8	891.8	951.0

[1] total production of chalk and GCC, production of PCC is not included

[2] mining output of chalk from Mielnik deposit and smaller deposits near Kornica

Source: ***The Statistical Office (GUS), Mineral Resources Datafile***

The production of ***precipitated calcium carbonate*** (***PCC***) in Poland is a separate topic. Since the mid-1990s, **Minerals Technologies Inc.** (**MTI**) — the world leader in the production of PCC for the paper industry — has operated the so-called satellite PCC plant near the largest Polish paper plant in **Kwidzyn** (currently: **Specialty Minerals Poland Ltd.**). It is believed that its production capacity has amounted to 50,000 tpy. The plant supplies PCC not only to Kwidzyn plant, but also to some minor paper plants.

Trade

Chalk of various quality, as well as high quality ***GCC*** and ***PCC*** grades have been traditionally imported. For many years, mainly ***washed chalk pieces*** or ***powder*** had to be imported, traditionally from **Rügen** (Germany). In 2010, it constituted ca. 60% of total imports of chalk and related products (item **CN 2509**) to Poland, with reduction to less than 50% in recent years. Supplies of lower quality chalk from Denmark (except 2009) and - recently – from the UK – have been also substantial (Tab. 2). Since 2009 the importation of ***GCC*** and marginal amounts of ***PCC*** varied between 9,400-11,700 tpy. Slovenia, France and Spain have been the main suppliers (Tab. 2).

Tab. 2. Polish imports of chalk and related products, by country — CN 2509

'000 t

Year	2009	2010	2011	2012	2013
Imports	**45.8**	**91.9**	**98.9**	**153.4**	**175.5**
Denmark	0.0	24.9	32.1	58.2	61.0
France	2.1	2.8	2.5	2.5	2.7
Germany	35.0	55.3	47.1	56.6	84.4
Slovenia	5.3	5.8	5.0	5.1	4.8
Spain	1.7	1.5	0.7	1.3	1.1
United Kingdom	0.6	0.5	10.3	28.8	20.1
Others	1.1	1.1	1.2	0.9	1.4

Source: ***The Central Statistical Office (GUS)***

Exports of ***chalk and related products*** from Poland have minor importance, but since 2010 it has risen to 4,500-6,500 tpy (Tab. 1). The majority of these has been probably ***GCC*** from **Trzuskawica** and/or **Bukowa** lime plants.

The trade balances of these commodities have been constantly negative. In 2013 it increased to 29.0 million PLN (Tab. 3). Average unit values of ***chalk and related products*** imports to Poland have been variable, depending on various share of cheaper chalk from Germany (<60 USD/t), Denmark and the UK (<35 USD/t) in total imports. Unit values of ***GCC*** grades imported from other countries have ranged from 120 to 700 USD/t. Unit values of imported ***chalk and related products*** are a few times higher than average prices of domestic grades, varying between 30-40 USD/t (Tab. 4). Prices of domestic ***fodder chalk*** from Opole and Kielce vicinity have amounted to 70–100 PLN/t (25–40 USD/t), while ***technical chalk*** (***GCC***) prices — even over 250-300 PLN/t (90-100 USD/t).

Tab. 3. Value of chalk and related products trade in Poland — CN 2509

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	1,418	2,104	2,157	6,325	2,876
Imports	15,080	20,908	21,377	27,086	31,902
Balance	**-13,662**	**-18,804**	**-19,220**	**-20,761**	**-29,026**

Source: ***The Central Statistical Office (GUS)***

Consumption

Domestic demand for all grades of ***natural chalk*** and ***ground calcium carbonate*** in Poland has ranged between under 600,000 and 950,000 tpy (Tab. 1). However, it should be emphasized that the consumption of higher grades of natural chalk and GCC (whiting, technical) has amounted to only ca. 100,000-120,000 tpy, whereas the consumption of fodder and fertilizer chalk has made the balance. Technical chalk and GCC is utilised as

Tab. 4. Average unit values of domestic and imported chalk grades — CN 2509

Year	2009	2010	2011	2012	2013
Average production unit values					
PLN/t	96.2	121.1	114.7	112.1	118.7
USD/t	30.6	39.8	39.6	34.1	37.7
Average imports unit values					
PLN/t	329.4	227.6	216.3	176.6	181.8
USD/t	104.9	74.7	74.9	53.7	57.7

Source: ***The Central Statistical Office (GUS)***

filler in the paper, paint and coatings, plastic, rubber, ceramic and chemical industries. Further development of these industries will result in growth in consumption of these grades.

PCC plant in Kwidzyn has practically covered the demand of the Polish paper industry for PCC, and will continue to do it in the nearest future.

Principal companies involved in chalk and related products production in Poland as of December 2013

- Omya Sp. z o.o. w Warszawie, Zakład w Mielniku (Omya Ltd. of Warsaw, Mielnik Plant); 17–307 Mielnik, ul. Przemysłowa 1, tel. +48 85 6565080, fax +48 85 6577275, www.omya.pl — *whiting, technical, fodder and fertilizer chalk.*
- Koszelewskie Zakłady Kredowe w Koszelówce (Koszelówka Chalk Works of Koszelówka), 08-205 Kornica, Koszelówka 9A, tel./fax +48 83 3588786, www.kzkpolska.com — *fertilizer chalk, fodder chalk, technical chalk.*
- Zakłady Przemysłu Wapienniczego Trzuskawica S.A., Zakład Sitkówka (ZPW Trzuskawica Joint Stock Co., Sitkówka Plant), 26–052 Sitkówka, tel. +48 41 3469130, fax +48 41 3469139, www.trzuskawica.pl — *technical chalk (GCC), fodder chalk.*
- Zakłady Wapiennicze Lhoist S.A. w Tarnowie Opolskim (ZW Lhoist Joint Stock Co. of Tarnów Opolski), 46–050 Tarnów Opolski, ul. Świerczewskiego 5, tel. +48 77 4516376, fax +48 77 4516377, www.lhoist.pl — *technical chalk (GCC), fodder chalk.*
- Lhoist Bukowa Sp. z o.o. w Bukowej (Lhoist Bukowa Ltd. of Bukowa), 29–105 Krasocin, ul. Osiedlowa 10, tel. +48 41 3889105, fax +48 41 3889106, www.lhoist.pl — *technical chalk (GCC), whiting chalk (GCC), fodder chalk.*

CHROMIUM (CHROMITES)

Overview

The only sources of **chromium** (**Cr**) are deposits of ***chromites***, mainly of magmatic, occasionally of latheritic types. Chromium is traditionally used as an alloy constituent of steel (with **ferrochromium** as intermediate), and in alloys with other metals. **Chromites** also find application in the chemical and refractory industries, as well as in foundries. However, the producers of refractory materials have been using less chromite due to technological and environmental limitations.

Sources

Poland has no deposits of ***chromites***, nor any prospects for their discovery.

Production

Due to the lack of deposits, no ***chromite*** production has been carried out in Poland. Until the end of 1998 imported ***metallurgical chromites*** were processed into ***ferrochromium*** at the **Łaziska Smelter**, but later on this production was stopped due to the economic reasons.

Moreover, since 2012 **Łaziska Smelter** has been in a state of bankruptcy, and in the years 2012–2013 performed manufacturing services for **RE Alloys Ltd.** in Łaziska Górne. In 2013, basing on the imported high-carbon ***ferrochromium***, the production of high-carbon ***ferrosilicochromium*** was started, the output of which reached 10,100 t (Tab. 1).

Trade

Domestic demand for chromium commodities has been satisfied by imports, mainly of ***chromites***. In the years 2010–2013 their imports stabilized at the level of 27–32 ktpy, while in 2009 it was only 11 kt (Tab. 1). Recently, the main imports sources have been the Republic of South Africa, and — except for 2009 — the Czech Republic (dealer), with small amounts coming from Kazakhstan, Turkey and Pakistan, partly through German and Dutch brokers (Tabs. 1 and 2). Surpluses of stocks were exported mainly to the Czech Republic, Slovakia, Ukraine and Romania.

Another imported chromium commodity has been ***ferrochromium*** purchased in variable amounts: from 5,700 to 19,000 tpy (Tab. 1). In 2013 5,500 t of imported high-carbon ***ferrochromium*** was utilised for the production of high-carbon ***ferrosilicochromium***. The ***chromium metal*** was also imported in variable amounts from Russia, Western Europe, China, the US and - in 2009 - from Slovakia (Tab. 3).

Tab. 1. Chromium commodities statistics in Poland

'000 t

Year	2009	2010	2011	2012	2013
Chromites CN 2610					
Imports	11.5	27.6	31.8	27.3	29.6
Exports	0.1	0.4	3.6[r]	0.5	0.4
Consumption[a]	11.4	27.2	28.2[r]	26.8	29.2
Ferrochromium CN 7202 41–49					
Production	–	–	–	–	–
Imports	5.7	7.9	7.7	9.4	19.3
Exports	0.4	0.7	0.3	0.5	0.7
Consumption[a]	5.3	7.2	7.4	8.9	28.7
Ferrosilicochromium CN 7202 50					
Production	–	–	–	–	10.1
Imports	0.1	0.5	0.0	0.1	–
Exports	–	0.1	–	–	8.9
Consumption[a]	0.1	0.4	0.0	0.1	1.2
Chromium metal and powder [t] CN 8112 21					
Imports	98.1	55.8	81.6	46.4	81.9
Exports	98.3	26.5	13.3	0.0	48.7
Consumption[a]	-0.2	29.3	68.3	46.4	33.2
Sodium dichromate CN 2841 30					
Imports	1.9	1.8	1.1	0.7	0.8
Exports	0.3	0.1	0.0	0.0	0.1
Consumption[a]	1.6	1.7	1.1	0.7	0.7

Source: ***The Central Statistical Office (GUS), producer's data***

The trade balance of ***chromites*** in Poland is negative, as the demand is met entirely by imports (Tab. 4). The trade balance in ***ferrochromium*** in 2009 amounted to almost -29 million PLN. In the years 2010–2013 the deficit deepened, resulting from increased imports, especially in 2013, when it reached almost -87 million PLN (Tab. 4). The value of trade in other ***chromium commodities*** is of minor importance, except for ***ferrosilicochromium*** in 2013, when huge exports turned the trade value positive of 60 million PLN. The total balance of ***chromium commodities*** trade in Poland has been negative, i.e. ca. 53 million PLN in 2009, but in the period 2010–2011 increased to 79.3 million PLN, with a decrease to 48 million PLN in 2013 (Tab. 4). The critical influence had unit values of their imports to Poland (Tab. 5), which depended mostly on the quantity of purchased material, their sources and quality.

Tab. 2. Polish imports of chromites, by country — CN 2610

'000 t

Year	2009	2010	2011	2012	2013
Imports	**11.5**	**27.6**	**31.8**	**27.2**	**29.6**
Albania	–	–	0.0	–	0
Austria	–	–	–	–	1.1
China	–	0.3	–	–	–
Czech Republic	0.2	16.6	17.9	15.2	13.5
Germany	1.6	1.6	1.9	0.6	1.2
India	–	0.2	–	–	–
Italy	0.0	0.2	0.2	0.0	–
Kazakhstan	0.4	0.6	–	–	–
Netherlands	1.1	0.4	0.5	0.7	2.9
Oman	0.2	0.3	0.1	0.1	0.4
Pakistan	–	–	–	1.3	0.6
South Africa, Republic of	7.6	7.1	9.4	7.9	9.8
Turkey	0.4	0.2	1.7	1.2	0.1
United Arab Emirates	–	0.1	–	0.1	–

Source: ***The Central Statistical Office*** *(GUS)*

Tab. 3. Polish imports of chromium metal and powder, by country — CN 8112 21

t

Year	2009	2010	2011	2012	2013
Imports	**98.1**	**55.8**	**81.6**	**46.4**	**81.9**
Belgium	7.5	2.0	52.2	1.0	23.0
Bulgaria	–	–	–	1.1	–
China	2.0	–	–	5.0	1.0
Czech Republic	–	–	–	0.0	–
France	–	0.0	0.1	4.0	3.0
Germany	2.5	6.8	16.5	10.5	9.9
Italy	2.6	6.5	2.0	8.3	15.7
Netherlands	2.0	27.5	5.0	–	–
Russia	3.0	–	3.5	11.0	20.5
Slovakia	69.2	–	–	–	–
Spain	–	2.0	–	0.0	–
Sweden	8.0	2.0	–	–	8.5
United Kingdom	0.1	8.0	2.1	5.2	0.0
USA	1.2	1.0	0.2	0.3	0.3

Source: ***The Central Statistical Office*** *(GUS)*

Tab. 4. Value of chromium commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Chromites CN 2610					
Exports	210	551	3,418	1,076	618
Imports	16,961	18,365	28,953	26,815	26,177
Balance	**-16,751**	**-17,814**	**-25,535**	**-25,739**	**-25,559**
Ferrochromium CN 7202 41–49					
Exports	2,214	4,202	2,192	4,304	3,846
Imports	31,114	47,216	50,448	55,589	90,693
Balance	**-28,900**	**-43,014**	**-48,256**	**-51,285**	**-86,847**
Ferrosilicochromium CN 7202 50					
Exports	–	69	–	–	60,236
Imports	213	998	158	142	–
Balance	**-213**	**-929**	**-158**	**-142**	**+60,236**
Chromium metal and powder CN 8112 21					
Exports	326	701	516	380	274
Imports	967	1,191	2,167	1,518	1,849
Balance	**-641**	**-490**	**-1,651**	**-1,138**	**-1,575**
Chromium wastes and scrap CN 8112 22					
Exports	947	13,566	7,265	5,583	9,246
Imports	1,349	7,855	4,425	1	386
Balance	**-402**	**+5,711**	**+2,840**	**+5,582**	**+8,860**
Sodium dichromate CN 2841 30					
Exports	1,240	375	159	202	945
Imports	7,928	8,784	6,901	3,785	3,989
Balance	**-6,688**	**-8,409**	**-6,742**	**-3,583**	**-3,044**

Source: ***The Central Statistical Office (GUS)***

Consumption

The Polish demand for ***chromites*** decreased as a result of ending the ***ferrochromium*** production at the **Łaziska Smelter** in 1998, and — having minor importance — steady decline in chromite consumption in the refractory sector.

In recent years a particularly important role in demand has played the **Alwernia Chemical Plant** near Cracow, which has consumed ca. 8,000–12,000 tpy of chromites. Currently the **Alwernia Chemical Plant** has produced ***chromium trioxide*** (green) and ***basic chrome sulphate***. Information on production volumes of mentioned above

Tab. 5. Unit values of chromium commodities imports to Poland

Year	2009	2010	2011	2012	2013
Chromites CN 2610					
PLN/t	1,474.3	665.4	909.2	983.8	882.8
USD/t	473.9	221.0	308.2	310.4	281.1
Ferrochromium CN 7202 41–49					
PLN/t	5,430.1	5,960.0	6,554.9	5,911.4	4,698.9
USD/t	1,743.9	1,991.6	2,247.5	1,813.0	1,495.7
Ferrosilicochromium CN 7202 50					
PLN/t	4,438	2,165	8,756	1,918	6,769
USD/t	1,417	745	3,200	600	2,160
Chromium metal and powder CN 8112 21					
PLN/t	9,861.2	21,353.2	25,550.8	32,710.6	22,578.7
USD/t	3,098.5	7,040.6	9,044.1	9,962.9	7,220.3
Sodium dichromate CN 2841 30					
PLN/t	4,230.6	4,850.1	6,057.3	5,518.2	4,836.3
USD/t	1,336.5	1,611.9	1,988.7	1,690.1	1,524.3

Source: ***The Central Statistical Office (GUS)***

chromium compounds is not available, but the total production has been estimated at ca. 12,000 tpy Cr_2O_3. Around 500–2,000 tpy of ***chromium trioxide*** has been exported.

The chromite consumers in the refractory sector are the **Ropczyce Magnesite Works** and the **ArcelorMittal Refractories Ltd.** in Kraków, utilizing a total of several thousand tpy of chromites. These chromites have been used for the production of ***chromite-magnesite*** and ***magnesite-chromite refractories***, the production of which has been constantly declining. Foundries have also consumed small quantities of non-metallurgical chromite.

Company involved in chromium commodities production in Poland, as of December 2013

- Zakłady Chemiczne Alwernia S.A. w Alwerni (Alwernia Chemical Plant Joint Stock Co. of Alwernia), ul. Olszewskiego 25, 32–066 Alwernia, tel. +48 12 2589135, fax +48 12 2832188, www.alwernia.com.pl — *chromium trioxide (green), basic chrome sulphate*.

CLAYS AND RELATED MATERIALS FOR BUILDING CERAMICS

Overview

Raw materials for building ceramics ("red" ceramics) are provided by many **clay minerals**, such as ***clay***, ***loam***, ***mudstone***, and ***shale***, as well as ***clay loess*** and waste materials from coal and ore mines. The suitability of these materials depends on their plasticity after they are mixed with water. If the plasticity is too high, the mix is corrected by adding such ingredients as sand, crushed brick, and — lately — fly ash and sawdust. Of particular value are the moderately plastic materials, free from such detrimental ingredients as marl, pyrite, or water-soluble sulfides, which cause stains on the surface of the final product. After firing, the body of the product should be porous but strong, and resistant to atmospheric influences.

Sources

Poland is rich in ***clay minerals for building ceramics***. Throughout the country there are over 1,219 deposits, the total resources of which were approximately 2,043 Mm^3 (as of 31 December, 2013). However, ca. 36% of the entire domestic resources were recognized in the **Legnica Eastern Field** ***lignite*** deposit, where clays occur in interlayers and overburden. Resources of developed deposits have amounted to ca. 13% of the total domestic reserve base. Generally speaking, large deposits have been recognized in the southern and central part of Poland (a few types of Tertiary clays), with minor importance of northern Poland (Quarternary clays).

In recent years, ***fly ash*** from power plants and central heating plants has also been used in the production of building materials. Many manufacturers utilize fly ash, even up to 80% by weight of the technological batch mix. ***Slag*** and ***slag-ash mixes***, as well as ***waste from hard coal*** and ***lignite mines***, are also used to manufacture building ceramics (provided they meet the quality requirements, particularly in respect to radioactivity and heavy metal content).

Production

The mining output of ***clays for building ceramics*** declined sharply from almost 3.3 Mm^3 in 2008 to only ca. 1.5 Mm^3 in 2013, in consequence of falling domestic demand for building ceramics (Tab. 1). The clays mining production is concentrated in Świętokrzyskie, Dolnośląskie, Pomorskie, Śląskie, Małopolskie, Mazowieckie, and Podkarpackie voivodeships. In recent years, output of clays in all voivodeships has strongly fluctuated (Tab. 1).

Tab. 1. Mining output of clay minerals for building ceramics in Poland

'000 m^3

Year	2009	2010	2011	2012	2013
Mining output, total	**2,640**	**2,157**	**2,309**	**1,835**	**1,518**
Dolnośląskie	257	261	209	266	228
Małopolskie	201	283	284	167	140
Mazowieckie	241	272	284	134	58
Opolskie	169	75	116	104	117
Podkarpackie	289	186	353	138	192
Pomorskie	179	169	150	207	109
Śląskie	390	236	232	187	170
Świętokrzyskie	409	269	286	328	195
Warmińsko-Mazurskie	80	72	31	16	10
Wielkopolskie	67	86	69	65	105
Other 6 voivodeships	358	248	295	223	194

Source: ***Mineral Resources Datafile***

The mining output of ***clays for building ceramics*** only partly reflected the changes in the building ceramics production, because the share of secondary materials used in this production was increasing. Mining has been conducted by large ***ceramics enterprises*** (often with the participation of foreign investors), as well as small ***brickyards***. Extracted clays have been entirely used in plants located in the vicinity of the deposits (see: **Consumption**).

The most important deposits of clays for building ceramics, currently extracted, are as follows:

- **Kąty Wrocławskie I**, **Kunice III** and **Paczków** in southwestern Poland;
- **Gnaszyn**, **Patoka**, **Czerwone Osiedle**, and **Sierakowice** in the Upper Silesia;
- **Wola Rzędzińska**, **Oleśnica 1**, **Kolbuszowa-Kupno, Markowicze**, and **Hadykówka** in southeastern Poland;
- **Przysieka Stara, Brzostów**, **Pałęgi** and **Chełsty** in central Poland;
- **Tadeuszów-Rudzienko,** and **Lewkowo Stare** in northeastern Poland;
- **Lębork** and **Nowa Wieś Lęborska** in northwestern Poland.

Trade

The ***raw materials*** for red ceramic production, due to transportation costs and their common occurrence, are generally not traded internationally, and are only of local or regional importance. However, ceramic construction materials such as ***bricks***, ***tiles***, etc. are traditionally traded, mainly between neighboring countries.

Consumption

Ceramic building materials include a very broad range of products used primarily in residential and industrial construction. Generally speaking, they may be divided into ***non-fired materials***, obtained by processing sand-lime mixes in autoclaves (see: **SAND FOR**

LIME-SAND PRODUCTS AND CELLULAR CONCRETE), and ***fired materials***. The latter include ***sintered products — stoneware for sewage systems*** and ***acid-proof stoneware***, ***stoneware tile*** (see: **CLAYS, CERAMIC AND REFRACTORY**), ***clinker brick*** and ***pavement brick*** — and ***porous products***: ***light building aggregates*** (see: **AGGREGATES, MINERAL**) and ***wall and roof elements***. The last group, due to the color of the burnt products, is called ***"red ceramics".*** The most important are ***thick-walled wall elements*** (e.g. common brick), and ***thin-walled wall elements*** (such as hollow brick, cavity brick, cored brick, hollow masonry units, ceramic wall plates, structural tiles), ***roofing materials*** (such as various roofing tiles, e.g. pantile, plain tile, ridge tile), ***thin-walled floor tiles*** (e.g. structural-floor tiles), and ***thin-walled drainage pipes*** of various diameters and lengths, preferably used for pipe drainage purposes in land improvement work.

Production of ***building ceramics*** in Poland, after significant reduction being a result of crisis in the construction sector in the beginning of the decade, reported significant development, especially in 2007 and 2008. It was especially well seen in case of ***structural-wall tiles, face bricks***, as well as of ***ceramic roofing tiles***. Due to last crisis in the construction sector, their production in 2009 was almost 20% lower than in 2007. After temporary recovery in 2010 and 2011, it diminished again in 2012 and 2013 (Tab. 2).

Tab. 2. Production of building ceramics in Poland

million units

Year	2009	2010	2011	2012	2013
Ceramic wall elements, total[1]	**1,763**	**1,865**	**1,995**	**1,688**	**1,597**
• *Face bricks*	*267*	*238*	*241*	*185*	*131*
• *Structural-wall tiles*	*1,438*	*1,575*	*1,662*	*1,469*	*1,423*
Structural floor tiles	**6**	**10**	**12**	**10**	**10**
Ceramic roofing materials	**127**	**159**	**162**	**152**	**142**
Drain pipes	**0**	**1**	**1**	**1**	**1**

[1] calculated as ordinary brick units

Source: ***The Central Statistical Office (GUS)***

The domestic building ceramics industry in the last twenty years changed profoundly, due to important technological improvements, large investments (also greenfield plants) and concentration of the building ceramics production, which has been conducted both by domestic and foreign investors. The most important foreign investors in this industry included:

- Austrian company **Wienerberger** (the largest building ceramics producer in the world) with the largest plants in **Lębork**, **Złocieniec**, **Toruń**, **Dobre** near Mińsk Mazowiecki, **Zielonka** near Warsaw, **Konin-Honoratka**, **Gnaszyn** near Częstochowa, **Kraków-Łęg** and **Kraków-Zesławice**, **Kolbuszowa-Kupno**, **Oleśnica** near Staszów, **Kunice** near Legnica and **Jankowa Żagańska** (currently the largest building ceramics producer in Poland, over 60% of domestic production, mainly ***structural-wall tiles*** and ***clinker bricks***, but also ***ceramic roofing tiles***);

- Austrian company **Leier** with large plants in **Wola Rzędzińska** near Tarnów and **Markowicze** near Biłgoraj, delivering mainly ***structural-wall tiles*** and ***ceramic structural floor tiles***;
- German company **Roeben** with a modern plant in **Środa Śląska** near Wrocław, the largest domestic producer of ***ceramic roofing tiles*** and significant producer of ***clinker brick***;
- Irish company **CRH** (being also important cement, aggregates, and concrete producer), owner of **CRH Klinkier** group with plants in **Patoka** near Lubliniec, **CERG** in **Gliwice**, and **Gozdnica** near Żary (the largest domestic producer of ***clinker products***), but also owner of **Cerabud Krotoszyn** with three plants: **Brzostów** and **Witaszyce** (***structural wall-tiles***) and **Krotoszyn** (***roofing elements***);
- French company **Monier** (previously: **Lafarge Dachy**) with large plant of ***ceramic roofing tiles*** in **Przysucha**.

Among domestic investors in the building ceramics industry, the most important is — undoubtedly — **Wacław Jopek Building Ceramics Plant**, which currently operates four plants: in **Bytom** (***ceramic roofing tiles***), **Radziejowice** near Warsaw (***face bricks***), **Paczków** (***structural-wall tiles***), as well as in **Sierakowice** near Gliwice (***clinker brick***). Other important brick producers are: **Cerpol-Kozłowice** in **Kozłowice** near Olesno (plants in Kozłowice, Krotoszyn and Brzostów), **Lewkowo** near Białystok, **Hadykówka** near Rzeszów, as well as the only plant utilizing clayey waste after hard coal beneficiation — **Ekoklinkier** in **Bogdanka** near Lublin.

Imports of ***structural bricks***, ***wall*** and ***floor tiles***, dynamically rose to almost 1 Mt in 2007 and over 800,000 t in 2008, due to temporary deficit of such products on the domestic market being a result of increased demand. However, in the last years they were reduced to less than 300,000 tpy (Tab. 3). The main suppliers were Germany, Slovakia, Latvia, and the Czech Republic. Exports of such products have started to recover since 2011 (Tab. 3). They were sold primarily to Ukraine, Russia, and Lithuania. In the case of ***roofing tiles*** and ***other roofing elements***, exports exceeded 110,000 t in 2013 (Tab. 3). These products, manufactured in a few modern plants in western Poland, were sold mainly to Germany, the Czech Republic and — recently — the UK and Ukraine. Imports of ***roofing ceramic elements*** were very substantial, jumping to almost 290,000 t in 2011, with 25% reduction in the next two years (Tab. 3). They were imported primarily from Germany, Latvia, Slovakia, the Czech Republic, and Hungary.

Tab. 3. Building (structural) ceramics trade in Poland

‘000 t

Year	2009	2010	2011	2012	2013
Structural wall- and floor tiles, bricks CN 6904					
Imports	450.1	477.8	441.3	355.8	272.2
Exports	68.1	52.4	69.5	76.6	94.3
Roofing tiles and other roofing elements CN 6905					
Imports	229.5	268.7	289.2	235.4	216.7
Exports	76.2	85.1	105.5	107.6	113.4

Source: ***The Central Statistical Office (GUS)***

The trade balances of ***structural bricks, wall-*** and ***floor tiles***, as well as of ***roofing tiles*** and ***other roofing elements***, have been negative for many years. In 2009 and again in 2012-2013 it was improved due to lower imports and increasing exports volumes. In 2010-2011 the trade balance achieved record negative values as a result of significant, temporary growth of building ceramics importation to Poland (Tab. 4).

Tab. 4. Value of building (structural) ceramics trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Structural wall- and floor tiles, bricks CN 6904					
Imports	107,592	107,397	96,231	84,567	68,526
Exports	25,061	19,120	26,815	32,895	39,270
Balance	**-82,531**	**-88,277**	**-69,416**	**-51,672**	**-29,256**
Roofing tiles and other roofing elements CN 6905					
Imports	192,306	212,854	261,434	219,851	197,854
Exports	57,964	59,767	80,518	86,898	96,164
Balance	**-134,342**	**-153,087**	**-180,916**	**-132,953**	**-101,690**

Source: ***The Central Statistical Office (GUS)***

Principal companies involved in manufacturing of building ceramics products in Poland, as of December 2013

- Wienerberger Ceramika Budowlana Sp. z o.o. (Wieneberger Building Ceramics Ltd.), ul. Ostrobramska 79, 04–175 Warszawa, tel. +48 22 5142100, fax +48 22 5142103, www.wienerberger.pl.
- Leier Polska S.A. w Woli Rzędzińskiej (Leier Polska Joint Stock Co. of Wola Rzędzińska), 33–150 Wola Rzędzińska 155A, tel. +48 14 6313700, fax +48 14 6313600, www.leier.pl.
- Roeben Polska z o.o. w Środzie Śląskiej (Roeben Polska Ltd. of Środa Śląska), ul. Rakoszycka 2, 55–300 Środa Śląska, tel. +48 71 3978100, fax +48 71 3978111, www.roben.pl.
- CRH Klinkier Sp. z o.o. w Gliwicach (CRH Klinkier Ltd. Of Gliwice), ul. Pszczyńska 309, 44–100 Gliwice, tel. +48 32 2394100, fax +48 32 2394102, www.crh-klinkier.pl.
- Fabryka Ceramiki Budowlanej Wacław Jopek (Wacław Jopek Building Ceramics Plant), ul. Łokietka 10, 41–935 Bytom, tel. +48 32 3969105, fax +48 32 3969104, www.jopek.pl.
- Cerpol-Kozłowice Sp. z o.o. w Kozłowicach (Cerpol-Kozłowice Ltd. of Kozłowice), ul. Nowa 4, 46–310 Gorzów Śląski, tel. +48 34 3593067, fax +48 34 3593087, www.kozlowice.pl.
- Zakład Ceramiki Budowlanej Ekoklinkier w Bogdance (Ekoklinkier Building Ceramic Plant of Bogdanka), Bogdanka, 21–013 Puchaczów, tel. +48 81 4625591, fax +48 81 4625634, www.ekoklinkier.pl.

- Monier Sp. z o.o., Zakład w Skrzyńsku (Monier Ltd., Skrzyńsko Plant), Skrzyńsko, ul. Przemysłowa 25, 26–400 Przysucha, tel. +48 48 6708700, fax +48 48 6708701, www.monier.pl.

CLAYS, CERAMIC AND REFRACTORY

Overview

Ceramic and **refractory clays** are a large and diverse group of clayey raw materials, where ***kaolinite*** is the main clay mineral, with minor importance of other clay minerals — ***illite*** and ***smectites***. Ceramic clays from various deposits represent much differentiated quality parameters. Depending on their quality parameters and mineralogical composition, they can find diverse applications in the ceramic industry, e.g. in the production of ceramic tiles, sanitaryware, semi-vitreous china-ware, stoneware goods, chamotte refractories, etc.

In Poland three groups of ceramic clays are commonly distinguished: **white-firing clays** (**ball clays**), **stoneware clays** (**clays for the production of stoneware**), and **refractory clays**. This results from their confirmed technological suitability. However, this classification should be applied flexibly, as e.g. refractory clays can be utilized not only for the production of chamotte refractories, but also for e.g. ceramic tiles and sanitaryware manufacturing.

White-firing clays (**ball clays**), sometimes also called **kaolinite clays**, are the most noble varieties of ceramic clays. They are commonly utilized in the production of ***faience and gres porcellanato tiles***, ***semi-vitreous china-ware***, and ***sanitaryware***, sometimes also for the manufacture of ***china-ware goods***. They should be characterized by contents of Fe_2O_3+TiO_2 not exceeding 2.0–2.5%, and minimum bending strength of 1.5 MPa. Their main component is kaolinite, with dickite, illite, fine-grained quartz and — sometimes — muscovite as other important minerals.

Stoneware clays are the group of clays with very good sintering properties in the range of 1,000–1,300°C. They show very small water absorption after firing at 1,300°C (max. 4%) and high bending strength after drying (>2 MPa, very plastic varieties >3 MPa). Traditional applications of stoneware clays in the production of such stoneware goods as: ***sewage pipes***, ***sanitary products***, ***chemical stoneware***, ***pottery***, are of decreasing importance. Increasing amounts of such clays are consumed for ***ceramic tiles*** of color body.

Refractory clays are represented by kaolinite or kaolinite-illite clays. They are traditionally used for the production of ***chamotte refractories***, but recently also for ***ceramic tiles*** and ***sanitaryware*** manufacturing. Depending on Al_2O_3 content, there are four grades distinguished — $\mathbf{G_1}$-$\mathbf{G_4}$ — with refractoriness between 1,650 and 1,750°C. These clays usually contain 2–3% of iron. Kaolinite content in the best grades (e.g. G_1) commonly exceeds 70%, with illite and fine-grained quartz as remaining important minerals. **Refractory shale** is non-plastic kaolinite rock, related to **refractory clay** and of similar refractory properties. Such a shale is suitable for refractory applications, i.e.

the ***chamotte*** production. Currently, they are not produced in Poland and do not have economic importance.

Sources

White-firing clays (***ball clays***) occur in lenses and irregular seams in Cretaceous clayey-sandy rocks near **Bolesławiec** in the Lower Silesia. There are 6 recognized deposits of total economic resources of 59.0 Mt (as of 31 December 2013), with one — **Janina I** — currently extracted. These clays frequently occur together with ***stoneware clay***, and — sometimes — with ***refractory clay*** that accompany lignite in **Turów** and **Bełchatów** deposits, but their resources have not been estimated. Since 2006, sandy-clay sediments from **Czerwona Woda** deposit (recognized as ***foundry sand*** deposit) have been utilized in the production of white-firing clay raw material.

Deposits of ***stoneware clay*** are very common in Poland. They occur primarily in the northern periphery of the **Świętokrzyskie Mountains** (e.g. ***Baranów clays*** of Triassic age near Suchedniów, ***Opoczno clays*** of Jurassic age near Opoczno and Przysucha), and in the **Lower Silesia** (so-called ***Bolesławiec clays*** of Cretaceous and Tertiary age near **Bolesławiec**, some varieties of so-called ***Poznań clays*** of Tertiary age near **Żary** and **Wrocław**). Additionally, stoneware-type clay accompanies ***lignite*** in **Turów** and **Bełchatów** deposits. The total resources of ***stoneware clays*** in Poland amounted to 77.4 Mt, 7% of which in 2 deposits operated (as of 31 December 2013). The sources for the production of stoneware ceramics have been also deposits of raw material classified as ***clay for building ceramics***, e.g. **Chełsty** near Opoczno, **Kozów**, **Pałęgi**, and **Szkucin** near Końskie, **Patoka** near Lubliniec, **Ołdrzychów** and **Słowiany** near Bolesławiec, **Gozdnica** and **Jasień** near Żary.

In Poland deposits of ***refractory clay*** are known and exploited in the **Lower Silesia** region (near Strzegom, Bolesławiec, Żary, and Turoszów), as well as in the NE part of the **Świętokrzyskie Mountains**. The total resources of refractory clays amounted to 54.6 Mt (as of 31 December 2013). The most important are four deposits of the so-called ***Jaroszów clay*** in the **Strzegom** area, containing plastic clays of G_1-G_4 types characterized by good sintering properties. Only one of them — **Rusko-Jaroszów** — has been exploited. These deposits together comprise 80% of refractory clay resources in Poland. The deposits of refractory clays in other regions — near **Żary** in the Lower Silesia and near **Opoczno** in the Świętokrzyskie Mountains — contain only G_3-G_4 types of ***refractory clays***. Resources of ***refractory shale***, which were recognized only in the **Nowa Ruda** ***hard coal*** deposit (the Lower Silesian Coal Basin), amounted to 11.2 Mt. Due to liquidation of **Nowa Ruda Hard Coal Mine**, these resources were deleted in 2000. Refractory shale also occurs in some ***coal*** deposits in the Upper Silesian Coal Basin, e.g. **Ziemowit** (1.4 Mt of uneconomic resources) and **Siersza**.

Production

Ekoceramika's mine and processing plant in **Suszki** nearby the **Janina I** deposit (Tab. 1) is the largest ***white-firing clays*** producer in Poland, delivering ***beneficiated*** (***washed***) ***white-firing clay JB1W***. Its production has varied between 30 and 40 ktpy in recent years. Since 2006, also **BZMO** has produced ***washed white-firing CWW clay*** in its **Czerwona Woda** plant. The output has ranged 10,000-12,000 tpy in recent years. ***White-***

firing clays from the **Turów** lignite deposit have been extracted irregularly. They have been dumped and sold as white-firing varieties of ***raw TG-3 clay*** in variable amounts. A small part of them has been also processed at **Surmin-Kaolin** plant in **Nowogrodziec**, where they have been blended with some kaolin semi-products to manufacture ***white-firing clay granulate*** in ***TC1/WB*** grade. In recent years this production amounted to 2,000-3,000 tpy. In recent years the total domestic supplies of ***white-firing clays*** in Poland declined from 70,000 tpy to ca. 35,000 tpy (Tab. 2).

Tab. 1. Mining output of ceramic and refractory clays in Poland

'000 t

Year	2009	2010	2011	2012	2013
White firing clays (ball clays)	142	160	131	94	136
Refractory clays	98	71	109	92	87
Stoneware clays					
Stoneware clays	162	185	215	177	205
Clays for building ceramics with properties of stoneware clays ['000 m^3][1]	212	194	179	175	113

[1] used — in the large part — for stoneware goods production (mainly stoneware tiles)

Source: ***Mineral Resources Datafile***

Tab. 2. Ceramic and refractory clays statistics in Poland

'000 t

Year	2009	2010	2011	2012	2013
Production					
White firing clays (ball clays) **CN 2507 00 80**	41.7	69.8	48.4	35.0	35.0
Stoneware clays[1] **CN 2508 30**	646.2	721.1	1,291.6	736.5	512.6
Refractory clays **CN 2508 40**	114.7	81.7	136.4	118.9	117.5
Imports					
White firing clays (ball clays) **CN 2507 00 80**	9.4	13.4	9.2	15.7	13.1
Refractory clays[2] **CN 2508 30**	212.6	248.2	313.6	259.5	256.5
Stoneware clays **CN 2508 40**	71.5	77.4	125.0	133.5	139.1
Exports					
White firing clays (ball clays) **CN 2507 00 80**	0.0	1.1	1.2	0.7	0.0
Refractory clays **CN 2508 30**	11.7	14.2	13.9	9.9	11.8
Stoneware clays **CN 2508 40**	12.0	14.9	13.7	11.8	13.7

Burnt refractory clays CN 2508 70 10					
Production[3]	35.0	25.2	37.7	30.6	37.3
Imports	4.0	7.3	6.5	8.5	5.8
Exports	0.2	0.3	0.4	0.5	0.3
Consumption[a]	38.8	32.2	43.8	39.1	42.8

[1] the production sold, reported by the Central Statistical Office as ***Common clays (for building etc.)*** — **PKWiU 08122250**

[2] probably the majority of the importation constitute ball clays, reported under this item by mistake

[3] The production of **JARO** only

Source: ***The Central Statistical Office (GUS), producers' data***

Recently, the mining output of ***stoneware clays*** has varied between 162 and 225 ktpy. Extraction of **Gozdnica, Kraniec, Zebrzydowa** and **Paszkowice** deposits was abandoned, while in 2008 new **Zebrzydowa Zachód** mine (**Ekoceramika Co.**) was opened (Tab. 1). For the production of ***stoneware*** and ***clinker products***, large amounts of clays from deposits of raw material classified as ***clay for building ceramics*** have been used, e.g. ***red Triassic clays*** from **Patoka** near Lubliniec, **Chełsty** near Opoczno, **Kozów**, **Pałęgi** and **Szkucin** near Końskie, as well as ***Mio-pliocene Poznań clays*** from **Ołdrzychów** near Bolesławiec, **Gozdnica**, and **Jasień** near Żary. The total mining output from these deposits that in 2009 approached 290,000 m^{3}py (over 570,000 tpy), was reduced to 113,000 m^3 in 2013. Moreover, increasing amounts of ***refractory clays*** have been utilized in the production of stoneware ceramics, i.e. ca. 90% of clays from **Kryzmanówka** mine in **Zapniów** (until 2009, when the mine was closed down) and ca. 50% of clays from **Rusko-Jaroszów** mine.

The official statistics of the domestic production of ***stoneware clays*** are not available. The Central Statistical Office reports production of the item **PKWiU 08122250 —** ***Common clays (for building etc.)***, which includes also ***clays for building ceramics***. The latter ones are — in general — consumed on site in the adjacent ceramic plants. On the contrary, the majority of ***stoneware clays*** production is sold by their producers to consumers. Therefore, data on sold production of clays reported under the item **08122250** can illustrate the probable level of the domestic production of ***stoneware clays***. It has varied between ca. 510 and 740 ktpy in recent years (Tab. 2).

The extraction of ***refractory clays*** has been decreasing as a result of reduced demand for ***chamotte refractories***, in spite of their increasing consumption in non-refractory applications (Tab. 1, 2). In the last five years their output varied between 71 and 109 ktpy. From 2009 the whole supplies have come from **Rusko-Jaroszów** deposit operated by **JARO** of **Jaroszów**. Clays of G_1 and G_2 types have constituted over 60% of the raw clay production. **Kryzmanówka** (**Zapniów**) deposit in the Świętokrzyskie Mountains, operated by **F. Jopek Ceramika Co.**, which provided clays mostly for the production of ***gres ceramic tiles*** and ***sanitaryware***, was stopped in 2009. ***Refractory shale*** (***raw and burnt***) has not been produced in Poland since 1980. This type of clay has been mined together with ***hard coal*** in some **Upper Silesian** coal mines (e.g. **Ziemowit** mine — ca. 100,000 tpy), but after beneficiation of the coal the shale has been dumped as a waste material. ***Burnt refractory clay*** is an important intermediate product for the production of ***chamotte refractories***. **JARO** of **Jaroszów** has been its sole domestic producer. In recent years the level of its production has been reduced to 25-38 ktpy (from as much as 54 kt in 2007) due to high energy prices and crisis in the steel industry - the main consumer of chamotte refractories (Tab. 2).

Trade

In the case of clay commodities, international trade has been reported only for ***white-firing clays*** (***ball clays***) and the best grades of ***refractory clays***. ***Stoneware clays*** turnover has been of marginal importance due to their abundant domestic resources and supplies. ***Refractory clays*** trade statistics are reported under the item **CN 2508 30** (***refractory clays***), while ***white-firing clays*** (***ball clays***) trade should be included in the item **CN 2507 00 80** (***kaolinitic clays***). Only a small portion of ***white-firing clays*** imports to Poland is reported under the item **CN 2507 00 80**. Imports of ***white-firing clays*** from Ukraine are registered in the position **CN 2508 30** (***refractory clays***), while their deliveries from Germany and the Czech Republic — under the item **CN 2508 40** (***other clays***).

For over a dozen years until 2009, the systematic increase in ***ceramic clays*** importation to Poland was observed as a result of the growing appetite of ***ceramic tile*** and ***ceramic sanitaryware*** producers for ***white-*** and ***light-firing clays***. Also ***refractory industry*** imported some amounts of competitive Ukrainian ***refractory clays***. In 2009 the total deliveries of ***ceramic clays*** (including refractory clays) to Poland were reduced by 32% (as compared to 430,500 t in 2008), primarily due to the crisis in the building materials industry. In the following years they recovered to a record 447,800 t in 2011, with some reduction in 2012 and stabilization in 2013 (Tab. 3). It is estimated that over 90% of that was consumed by the ceramic tile and sanitaryware industries, while up to 10% (30,000–40,000 tpy) — by the refractory industry. In recent years the major suppliers have been Ukraine and Germany (93-95% of total deliveries), while the minor — the United Kingdom, the Czech Republic, the US, and — occasionally — Italy, Spain, Portugal and others (Tab. 3). Ukrainian clays, which originated basically from Donieck region, were delivered mainly by two companies: **Vesco** and **Donbas Clays**, while German clays — by **Stephan Schmidt Meißen** and **Kaolin und Tonwerke Seilitz-Löthain** (**WBB Group**) located in Saxony region. The principal deliveries from the United Kingdom came from **WBB Minerals** and **Imerys**, from the Czech Republic — **LB Minerals** (**Lasselsberger Group**). Imports of ***burnt clay*** have varied between 4,000 and 8,500 tpy in recent years, coming from Ukraine, the Czech Republic, the US, France and Germany (Tab. 2).

Some small amounts of ***ceramic clays*** have been also exported from Poland. These included mainly ***raw refractory clays*** from Rusko-Jaroszów mine (under 20,000 tpy), sold primarily to the Czech Republic, Germany, Hungary, Macedonia, and Switzerland, but since 2009 - also stoneware clay exported to Germany, Russia, and Ukraine (Tab. 4). Marginal amounts of ***burnt refractory clays*** have been also exported (Tab. 2).

The trade balance of all groups of ***ceramic clays*** has been constantly negative. In recent years, following the increase in importation, the trade deficit has deepened, approaching – in a total - 115 million PLN/y in 2012 and 2013 (Tab. 5).

Tab. 3. Imports of ceramic and refractory clays to Poland, by country

'000 t

Year	2009	2010	2011	2012	2013
Ceramic clays, total	**293.5**	**339.0**	**447.8**	**408.8**	**408.7**
China	–	–	0.6	0.4	–
Czech Republic	7.4	11.4	22.2	18.1	20.0
Germany	64.0	66.2	111.8	132.6	134.3
Italy	0.1	0.0	0.0	0.0	0.8
Portugal	3.6	0.2	–	–	–
Spain	1.7	1.6	2.1	2.5	1.5
Ukraine	209.2	250.4	306.4	251.1	243.8
United Kingdom	5.2	8.3	3.5	3.1	7.7
USA	1.8	0.4	0.4	0.5	0.4
Others	0.5	0.5	0.8	0.5	1.0
Ball clays (kaolinitic clays)[1] CN 2507 00 80	**9.4**	**13.4**	**9.2**	**15.7**	**13.1**
Czech Republic	0.2	0.2	0.3	0.9	0.3
Germany	2.2	4.1	4.4	11.1	4.1
Ukraine	0.3	0.3	0.2	–	–
United Kingdom	4.9	8.2	3.5	3.0	7.7
USA	1.6	0.3	0.3	0.4	0.4
Others	2.0	0.0	0.5	0.3	0.6
Refractory clays CN 2508 30	**212.6**	**248.2**	**313.6**	**259.5**	**256.5**
China	–	–	0.6	0.4	–
Czech Republic	1.0	0.7	0.7	0.8	0.2
Germany	4.5	7.3	10.2	11.1	12.5
Ukraine[2]	206.8	239.9	302.1	247.2	243.8
United Kingdom	0.3	0.0	0.0	0.0	0.0
Stoneware clays and other clays CN 2508 40	**71.5**	**77.4**	**125.0**	**133.5**	**139.1**
Czech Republic	6.2	10.5	21.2	16.5	19.5
Germany	57.3	54.8	97.2	110.4	117.7
Italy	0.0	0.0	0.0	0.0	0.0
Portugal	3.6	0.2	–	–	–
Spain	1.4	1.5	1.9	2.3	1.5
Ukraine	2.1	10.2	4.1	3.9	0.0
Others	0.9	0.3	0.6	0.4	0.4

[1] except for kaolin — CN **2507 00 20** (see: **KAOLIN**)

[2] the majority is supposed to be white-firing clays (ball clays), which are classified here by mistake

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Exports of ceramic and refractory clays from Poland, by country

'000 t

Year	2009	2010	2011	2012	2013
Ceramic clays, total	**23.7**	**30.2**	**28.8**	**22.4**	**25.5**
Czech Republic	5.1	9.5	8.0	4.1	6.9
Germany	12.4	5.4	10.7	10.0	12.6
Hungary	0.2	0.1	0.2	0.2	0.1
Macedonia	0.3	0.3	0.2	0.2	0.2
Russia	3.2	9.1	2.1	0.6	0.2
Switzerland	0.8	0.9	1.3	0.9	0.7
Ukraine	–	3.6	4.6	5.1	4.6
Others	0.9	1.3	1.7	0.8	0.2
Ball clays (kaolinitic clays)[1] CN 2507 00 80	**0.0**	**1.1**	**1.2**	**0.7**	**0.0**
Belarus	–	–	–	0.5	–
Czech Republic	0.0	0.8	1.1	0.2	–
Others	0.0	0.3	0.1	0.0	0.0
Refractory clays CN 2508 30	**11.7**	**14.2**	**13.9**	**9.9**	**11.8**
Czech Republic	5.1	8.7	6.9	3.9	6.9
Germany	5.1	3.9	5.0	4.7	3.8
Hungary	0.2	0.1	0.2	0.2	0.1
Macedonia	0.3	0.3	0.2	0.2	0.2
Switzerland	0.8	0.9	1.3	0.9	0.7
Others	0.2	0.3	0.3	0.0	0.1
Stoneware clays and other clays CN 2508 40	**12.0**	**14.9**	**13.7**	**11.8**	**13.7**
Germany	7.3	1.5	5.6	5.3	8.8
Russia	3.2	9.1	2.1	0.6	0.2
Ukraine	–	3.6	4.6	5.1	4.6
Others	1.5	0.7	1.4	0.8	0.1

[1] except for kaolin — CN **2507 00 20** (see: **KAOLIN**)

Source: ***The Central Statistical Office (GUS)***

In recent years average unit values of ***raw refractory clay*** exportation from Poland have varied between 120 and 150 USD/t, with a jump to 184 USD/t in 2011 (Tab. 6). Average unit values of ***raw refractory clay*** and ***white-firing clays*** imported to Poland under the item **CN 2508 30** increased to 99 USD/t in 2013, primarily due to huge increase of the price of previously cheap Ukrainian grades. Unit values of ***stoneware clays*** imports, reported in the item **CN 2508 40** and coming primarily from Saxony (Germany), have usually ranged 75–85 USD/t, with significant reduction to 70 USD/t in the last two years. Unit values of ***kaolinite clays*** imports, reported in the item **CN 2507 00 80** and coming primarily from the UK — have been typically a few times higher (Tab. 6). The average unit values of ***burnt refractory clay*** importation that in 2009 exceeded 380 USD/t, in the following years were reduced by over 20% (Tab. 6).

Tab. 5. Value of trade of ceramic and refractory clays in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Ball clays (kaolinitic clays) CN 2507 00 80					
Exports	20	467	700	174	19
Imports	5,657	7,193	6,623	8,349	8,971
Balance	**-5,637**	**-6,726**	**-5,923**	**-8,175**	**-8,952**
Refractory clays CN 2508 30					
Exports	5,092	5,227	5,660	4,753	5,152
Imports	41,808	57,431	81,924	79,875	79,811
Balance	**-36,716**	**-52,204**	**-76,264**	**-75,122**	**-74,659**
Stoneware clays and other clays CN 2508 40					
Exports	2,809	6,841	7,434	6,701	5,133
Imports	18,897	17,657	30,561	30,622	30,558
Balance	**-16,088**	**-10,816**	**-23,127**	**-23,921**	**-25,425**
Burnt refractory clays and shale CN 2508 70 10					
Exports	107	177	173	236	188
Imports	4,711	6,997	5,903	7,984	6,058
Balance	**-4,604**	**-6,820**	**-5,730**	**-7,748**	**-5,870**

Source: ***The Central Statistical Office (GUS)***

Consumption

Ceramic clays are utilized for the manufacture of numerous ceramic products. The most important of them are: faience, porcelain, stoneware and clinker tiles, sanitaryware, semi-vitreous china-ware, other stoneware products, refractory chamotte products, refractory mortars, and mixes.

Ceramic tiles are the main ceramic products, where ***ceramic clays*** are currently used. These are both ***white-firing clays*** and ***stoneware clays***. However, the production of ***faience tiles*** — where ***white-firing clays*** with poor sintering properties are primarily used — has shown declining tendency. On the contrary, there is continuous increase in the manufacture of ***stoneware tiles*** (with stoneware clays as one of the main components), as well as ***porcelain tiles*** (***gres tiles***), where ***white-*** or ***light-firing clays*** with good sintering properties are applied. In Poland, both ***unglazed*** and ***glazed stoneware tiles*** and ***gres tiles*** has been produced. Their total output rose by 190% since 2000 to ca. 1.96 Mt in 2011, with 7% reduction in the next two years (Tab. 7). Production capacities of ceramic tiles exceeded 140 Mm^2py (over 2.2 Mtpy), including over 60 Mm^2py of ***gres tiles***. In 2013 the major domestic producers of ***ceramic tiles*** were: **Cersanit Capital Group**[1], which controls two ceramic tiles companies: **Opoczno I** operating 4 plants in Opoczno (total

[1] in January 2012 Cersanit changed the name into: Rovese.

Tab. 6. Average unit values of ceramic and refractory clays trade in Poland

Year	2009	2010	2011	2012	2013
Ball clays (kaolinitic clays) CN 2507 00 80					
Imports unit values					
— PLN/t	603.5	536.0	722.4	530.6	686.3
— USD/t	190.8	177.5	244.8	162.0	218.2
Stoneware clays and other clays CN 2508 40					
Imports unit values					
— PLN/t	264.3	228.2	244.5	229.3	219.8
— USD/t	85.3	75.8	83.0	70.3	70.0
Refractory clays CN 2508 30					
Exports unit values					
— PLN/t	437.0	366.9	544.3	479.7	437.7
— USD/t	139.4	121.6	183.9	147.3	139.2
Imports unit values					
— PLN/t	196.6	231.4	261.3	307.7	311.2
— USD/t	65.2	76.3	88.2	94.2	98.6
Burnt refractory clays CN 2508 70 10					
Imports unit values					
— PLN/t	1,163.6	952.3	911.6	940.2	1,043.5
— USD/t	385.9	314.7	313.3	289.3	331.9

Source: ***The Central Statistical Office (GUS)***

capacities of 27 Mm^2py), and **Cersanit III** in Wałbrzych (capacities of 19 Mm^2py), as well as **Paradyż Group** (5 plants of combined capacity of 38 Mm^2py in the Tomaszów Mazowiecki and Opoczno vicinity). Minor producers are: **Ceramika Tubądzin** (2 plants: in Tubądzin and Ozorków), **Ceramika Nowa Gala Capital Group** (**Ceramika Nowa Gala** in Końskie and **Ceramika Gres** near Końskie), **Końskie Capital Group** (plants: **Ceramika Końskie, Cer-Rol, CerArt Studio, Star-Gres**), **Polcolorit Capital Group** (**Polcolorit** and **Ceramika Marconi** plants in Piechowice near Jelenia Góra), **Cerkolor** (3 plants: in Parczówek, Czeladź and Żelachowice), and **Ceramika Pilch** in Jasienica. ***Clinker tiles***, produced on the basis of ***color stoneware clays***, are currently also included in the group of ***ceramic tiles***. They are offered by ca. 10 Polish factories, among which the largest are: **Cerrad** in Radom, **Ceramika Tarona** in Tarczyn near Warsaw, **Ceramika Przyborsk** near Bolesławiec, and **ZPC Przysucha** in Przysucha.

The development of domestic ***ceramic tile*** sector has resulted in reduced importation coupled with increased foreign sales in recent years. Since 2004, ceramic tiles exportation has regularly exceeded their imports. However, in 2009 due to economic crisis in the neighboring countries, tiles exports in 2009 dropped by almost 30%. In 2010 they visibly

Tab. 7. Ceramic tiles statistics in Poland - 6907 90 20–80, 6908 90 91–99

'000 t

Year	2009	2010	2011	2012	2013
Production, total	**1,758.6**	**1,789.4**	**1,960.2**	**1,836.9**	**1,828.3**
• Stoneware, gres and similar tiles, unglazed	284.5	343.0	421.1	380.4	417.1
• Faience tiles, unglazed	175.5	138.2	142.9	144.6	126.6
• Stoneware, gres and faience tiles, glazed	1,198.6	1,308.2	1,396.2	1,311.9	1,284.6
Imports, total	**191.8**	**188.5**	**191.3**	**179.5**	**191.6**
• Stoneware, gres and similar tiles, unglazed	34.0	34.2	29.1	27.4	34.3
• Faience tiles, unglazed	50.8	58.1	57.3	53.4	54.5
• Stoneware, gres and similar tiles, glazed	54.4	54.4	95.6	90.9	93.7
• Faience tiles, glazed	52.6	41.8	9.3	7.8	9.1
Exports, total	**329.5**	**433.8**	**518.8**	**586.7**	**712.5**
• Stoneware, gres and similar tiles, unglazed	91.5	129.4	48.7	55.9	78.8
• Faience tiles, unglazed	60.4	63.1	167.0	166.9	184.6
• Stoneware, gres and similar tiles, glazed	36.2	60.2	256.7	321.6	395.8
• Faience tiles, glazed	141.4	171.1	46.4	42.3	53.3
Consumption, total	**1,620.9**	**1,554.1**	**1,632.7**	**1,429.7**	**1,307.4**

Source: ***The Central Statistical Office (GUS)***

recovered, while in 2011-2012 it reached a record levels (Tab. 7). The main Polish tiles recipients have been: Romania, Slovakia, Germany (each over 10%), Ukraine, Russia, the Czech Republic, Lithuania, Hungary (each 6-9%), and over 20 other countries. Principal deliveries to Poland have come from Italy, China and Spain, with smaller quantities purchased from Germany and the Czech Republic. The share of imported tiles in the supplies on the domestic market has ranged 11-14% in recent years.

White-firing clays, along with ***kaolin*** and ***stoneware clays***, are also utilized in the production of ***ceramic sanitaryware***. Currently, there are seven producers of ***ceramic sanitaryware*** in Poland, but two of them dominate: **Cersanit I** (a part of **Cersanit Capital Group**, a plant in **Krasnystaw** with a capacity of 3.2 million pieces per year), and **Sanitec Koło** (3 plants in **Koło**, **Włocławek**, and **Ozorków**, total capacities of ca. 3.0 million pieces per year). Each of these companies has ca. 40% share in the domestic production. The other producers are: **Roca Sanitario** in **Gliwice**, **Hybner** in **Środa Wielkopolska**, **Deger Ceramika** in **Jezuicka Struga** near **Inowrocław,** and **Ceramika Pilch** in **Jasienica** near **Bielsko-Biała**. In recent years, due to decline of exportation and domestic demand, the sanitaryware production declined to 83,700 t in 2012, with some recovery in 2013 (Tab. 8). Among the principal recipients were Germany, France, the United Kingdom, Italy, Ukraine, Russia, the Czech Republic, Slovakia, Estonia, etc.

Tab. 8. Ceramic sanitaryware statistics in Poland — CN 6910

'000 t

Year	2009	2010	2011	2012	2013
Production	89.1	93.8	93.3	83.7	91.4
Imports	18.6	20.2	19.6	18.0	18.4
Exports	59.3	67.6	70.3	67.0	71.2
Consumption[a]	48.4	46.4	42.6	34.7	38.6

Source: ***The Central Statistical Office (GUS)***

The production of ***semi-vitreous china-ware***, i.e. ***table pottery goods*** and — in smaller amounts — ***fancy goods***, recently recovered to almost 2,000 tpy, primarily in Tułowice plant (**Ceramika Tułowice**). However, domestic market is still dominated by the Chinese ***semi-vitreous china-ware***, which were even partly re-exported from Poland to the Western European countries (Tab. 9).

Tab. 9. Semi-vitreous china-ware statistics in Poland — CN 6912 00 10,90

'000 t

Year	2009	2010	2011	2012	2013
Production	1.9	1.7	1.7	1.9	1.8
Imports	9.8	9.3	18.4	18.3	15.6
Exports	1.3	1.7	4.2	5.7	6.1
Consumption[a]	10.4	9.3	15.9	14.5	11.3

Source: ***The Central Statistical Office (GUS)***

Contrary to ***stoneware tiles***, the production of ***other stoneware products***, especially of ***acid-resistant*** and ***electrotechnical stoneware ceramics***, and ***sanitary stoneware goods***, has generally declined until 2010, with strong growth of ***chemical and electrotechnical stoneware*** production in 2011 (Tab. 10). The primary Polish ***stoneware*** manufacturers are: the **Bolesławiec Ceramic Plant** and smaller pottery manufactures in Bolesławiec area, delivering ***table and garden stoneware***, ***pots and barrels*** (so-called ***Bolesławiec ceramics***), the **Marywil Stoneware Plant** in **Suchedniów** and the **Ziębice** plant, specialized in ***acid-resistant stoneware goods*** as well as ***stoneware sewage pipes***. The trade in these commodities has been marginal, with exception of ***pottery***.

Tab. 10. Other stoneware goods production in Poland

'000 t

Year	2009	2010	2011	2012	2013
Chemical and electrotechnical stoneware	0.6	0.8	7.5	7.3	8.4
Pottery	0.6	0.7	0.6	0.6	0.7
Sewage pipes, sanitary products	1.1	0.8	1.4	1.7	1.7

Source: ***The Central Statistical Office (GUS)***

In recent years the consumption of ***raw refractory clay*** in Polish refractory industry has been estimated at 110–130 ktpy, with ca. 70–90 ktpy coming from domestic sources, and 30-40 ktpy from abroad. ***Raw refractory clay*** produced in Poland was consumed in 50% in the burnt refractory clay production (entirely in **JARO**), and in another 50% — directly in the refractory industry. Both raw and burnt refractory clays are used mainly for the production of ***chamotte products*** — ***bricks*** and ***shapes*** (Tab. 11), as well as for ***refractory mortars*** and ***mixes***. Demand for ***raw refractory clay*** in the refractory industry in 2009 and 2010, due to crisis in the iron and steel industry, fell probably by a half, i.e. to 50,000-60,000 tpy, while demand for ***burnt refractory clay*** also by almost a half, to ca. 32,000 tpy. In the years 2011-2013, the demand recovered by almost 30% due to improvement of the situation in the iron and steel industry and other industries being main chamotte refractories consumers.

Tab. 11. Production of the main chamotte refractories in Poland

'000 t

Year	2009	2010	2011	2012	2013
Chamotte bricks	35.5	37.4	40.4	47.3	50.2
Chamotte shapes[1]	7.7	7.7	7.6	10.4	7.8

[1] crucibles, nozzles, pipes etc.

Source: ***The Central Statistical Office (GUS)***

Major companies involved in the production of ceramic and refractory clays in Poland, as of December 2013

- Ekoceramika Sp. z o.o. (Ekoceramika Ltd.), 59–700 Bolesławiec, Suszki 80, tel. +48 75 7841120, fax +48 75 7841121, www.ekoceramika.pl — *white-firing and stoneware clays* (Janina and Zebrzydowa mines).
- Bolesławieckie Zakłady Materiałów Ogniotrwałych Sp. z o.o. (Bolesławiec Refractory Works Ltd.), 59–700 Bolesławiec, ul. Kościuszki 8, tel./fax +48 75 7323661, www.bzmo.com.pl — *white-firing clays* (Czerwona Woda mine and plant).
- Kopalnie Surowców Mineralnych Surmin-Kaolin S.A. (Surmin-Kaolin Minerals Mines Joint Stock Co.), ul. Kaolinowa 35, 59–730 Nowogrodziec, tel. +48 75 7350044, fax +48 75 7350043, www.surmin-kaolin.com.pl — *granulate of white-firing clays* (Nowogrodziec plant).
- JARO S.A. w Jaroszowie (JARO Joint Stock Co. of Jaroszów), 58–120 Jaroszów, tel. +48 74 8549810, fax +48 74 8558024, www.jaro.pl — *raw refractory clay, burnt refractory clay* (Jaroszów mine and plant).
- Glinkop Sp. z o.o. (Glinkop Ltd.), 26–330 Żarnów, Paszkowice 57A, tel./fax +48 44 7577012, www.glinkop.pl — *stoneware clays* (Chełsty mine).
- CRH Klinkier Sp. z o.o. Zakład Gozdnica (CRH KLinkier Ltd. Gozdnica Plant), ul. Fabryczna 1, 68–130 Gozdnica, tel. +48 68 3601922, fax +48 68 3601923, www.crh-klinkier.pl — *stoneware clay* (Gozdnica and Jasień mines).
- Patoka Industries Sp. z o.o. (Patoka Industries Ltd.), ul. Ceramiczna 23, 42–793 Ciasna, tel. +48 34 3538068, fax +48 34 3538017, www.crh-klinkier.pl — *stoneware clay* (Patoka mine).

COBALT

Overview

Cobalt (**Co**) occurs together with Ni and Cu in polymetallic ores, sometimes as an isomorphous admixture. It is occasionally obtained in the form of **Cu-Co** or **Ni-Co mixed concentrates**, but the principal method for the production of **cobalt metal** is the pyrometallurgical processing of ***Co-bearing copper*** and ***nickel concentrates***, ***pyrite***, and ***latheritic nickel ores***. It is also successfully recovered from ***Co-bearing slag***, ***matte***, or ***alloys***, which are hydrometallurgically processed into **cobalt hydroxide**. This is the raw material for the production of **cobalt metal**, **cobalt oxides**, and other **cobalt compounds**.

Currently, **cobalt** is utilized primarily as a metallic matrix for heat-resistant and soft paramagnetic alloys containing Cr, Mo, Ni, Nb, and W (rarely Mn, Ta, Ti, and V), which are used in the mechanical and electrotechnical industries. To a lesser extent it is applied for the production of chemical and ceramic compounds.

Sources

In Poland ***cobalt*** occurs as an accompanying element in ***copper ore*** deposits of the **Fore-Sudetic Monocline**. At the end of 2013 its total estimated reserves amounted to 121,500 t Co, including 96,930 t Co in deposits operated by the **KGHM Polska Miedź S.A.** Potential source of ***cobalt*** are deposits of ***hard coal*** in the **Upper Silesia Coal Basin** (approximate reserves of 400,000 t).

Production

The amount of ***cobalt*** in the output of ***copper ore*** has ranged from 1,510 to 5,050 tpy (1,660 tons in 2013). The richest in cobalt has been the ore extracted from the **Lubin-Małomice** deposit (82–250 g/t), the resources of which amounted to 41,900 t (as of the 31st December 2013). In course of the ore beneficiation, 130–930 ppm of Co passes into ***copper concentrate***. During smelting, approx. 80% of that amount is lost in converter slag, which contains 1–2% Co. Despite many years of research, no solution for ***cobalt*** recovery from shaft furnace slag of **Głogów I** and **Legnica** smelters has been implemented up to date. In a few years this secondary raw material will not be generated as shaft furnace technology is to be changed. The interest in treatment of cobalt-bearing tailings has revived with the commissioning of the new KGHM's subsidiary **KGHM Ecoren**, which has been established to process mining and metallurgical wastes, which contain many valuable elements, including ***rhenium***, ***cobalt***, and ***nickel***. In recent years the innovative technology for hydrometallurgical purification of ***raw nickel sulfate*** produced by the KGHM, with possible extraction of ***cobalt sulfate***, has been developed. Another forward-looking solution has been formulation of spherical powders of ***rhenium-based alloys*** with ***cobalt and nickel***. The potential recipients of these innovative products are the aerospace industry and space technology.

Trade

The demand for ***cobalt commodities*** in Poland has been covered by imports (Tab. 1). The principal suppliers of ***cobalt matte*** and ***powder*** have been Germany and the United States (Tab. 2). In the last five years the total deliveries ranged from 31 to 39 tpy, showing a declining tendency. Simultaneously, small amounts of ***cobalt matte*** and ***powder*** were exported (possible re-exports of excess shipments). Other commodities imported to Poland on regular basis have been ***cobalt oxide*** and ***hydroxide***. These compounds were brought basically from Finland and Belgium, and — incidentally — from the United Kingdom, Germany, Italy, Ukraine, and others (Tab. 3). In 2011 that usually two-digit deliveries rocketed to 110 tons due to occasional large importation from the United Kingdom. In 2010 and 2012 cobalt in the form of ***scrap*** and ***Co-bearing waste*** was also exported, mainly to the United Kingdom and Germany (Tab. 1).

Tab. 1. Trade in cobalt commodities

t

Year	2009	2010	2011	2012	2013
Cobalt oxide and hydroxide CN 2822 00					
Imports	14	18	110	15	18
Exports	6	8	3	1	3
Cobalt matte, cobalt raw, cobalt powders CN 8105 20					
Imports	39	34	33	33	32
Exports	1	4	3	1	3
Cobalt wastes and scrap CN 8105 30					
Imports	–	–	–	–	0
Exports	0	1	–	0	8

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Polish imports of cobalt, by country — CN 8105 20

t Co

Year	2009	2010	2011	2012	2013
Imports	**39**	**34**	**33**	**33**	**31**
Belgium	1	1	2	2	1
China	1	0	0	0	–
Canada	1	1	1	1	–
Finland	1	–	–	1	–

France	2	–	–	1	2
Germany	12	20	20	15	12
Ireland	–	–	–	–	1
Netherlands	11	3	3	2	3
United Kingdom	–	2	2	1	0
USA	9	7	4	9	12
Others	1	–	1	1	1

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Polish imports of cobalt oxide and hydroxide, by country — CN 2822 00

t

Year	2009	2010	2011	2012	2013
Imports	**14**	**18**	**110**	**15**	**18**
Belgium	1	3	6	4	7
Finland	10	8	12	5	5
Germany	–	0	–	0	2
Italy	–	6	8	5	3
Ukraine	–	–	11	–	–
United Kingdom	–	0	72	0	1
Others	3	1	1	1	0

Source: ***The Central Statistical Office (GUS)***

The combined trade balance of major ***cobalt commodities*** in Poland has been always negative. In the last three years the deficit in the trade of ***cobalt metal*** amounted to 3.9-4.5 million PLN/y, following the changes in volume and unit value of importation, as well as the metal price fluctuations (Tabs. 4, 5). The balances of ***cobalt oxide*** and ***hydroxide*** trade varied more widely, i.e. from -0.9 and -2.7 million PLN/y. Over the last five years financial results of ***cobalt scrap*** turnover were positive, particularly in 2013 (Tab. 4). However, this phenomenon should be negatively evaluated.

Tab. 4. Value of cobalt commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Cobalt oxide and hydroxide CN 2822 00					
Exports	547	838	309	137	269
Imports	1,473	1,929	3,050	1,420	1,476
Balance	**-926**	**-1,091**	**-2,741**	**-1,283**	**-1,207**
Cobalt matte, cobalt, cobalt powders CN 8105 20					
Exports	183	598	385	143	298

Imports	4,194	3,717	4,264	4,273	4,786
Balance	**-4,011**	**-3,119**	**-3,879**	**-4,130**	**-4,488**
Cobalt wastes and scrap CN 8105 30					
Exports	3	58	0	5	127
Imports	0	0	0	0	9
Balance	**+3**	**+58**	**0**	**+5**	**+118**

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Unit value of cobalt metal and cobalt oxide imports to Poland

Year	2009	2010	2011	2012	2013
Cobalt metal CN 8105 20					
PLN/t	107,530	109,309	128,421	128,324	151,923
USD/t	34,269	36,052	44,520	39,252	48,476
Cobalt oxide and oxide CN 2822 00					
PLN/t	105,184	108,961	27,729	95,323	81,560
USD/t	34,379	35,998	9,343	28,951	25,947

Source: ***The Central Statistical Office (GUS)***

Consumption

In Poland, ***cobalt metal*** is primarily utilised for the production of cobalt steel, cutting tools made of sintered carbides, etc. ***Cobalt oxides*** and ***hydroxides***, which are regularly imported in significant quantities, are utilized as ceramic pigments, for making overglaze and underglaze ceramic colors, and as drying agents for paints, varnishes and printer's ink. The end-use distribution of cobalt commodities in Poland is difficult to ascertain.

COKE

Overview

Coke is a solid substance containing 96–98% of C and small amounts of O_2, H_2, N_2, and S. It is obtained from the thermal decomposition of ***hard coal*** and, to a lesser extent, ***brown coal***, ***peat***, and heavy semi-products recovered from the processing of ***crude oil***. Of the greatest significance in the world economy is the **coke** produced in cokeries from ***coking coal***, the so-called **blast-furnace coke** and **foundry coke**. The main application of blast furnace coke is to reduce oxide iron ores. It is also widely used as a fuel in steel-making and non-ferrous metal smelters, as well as in foundries, lime production, etc. The lower grades of coke (**commercial coke**) are used to heat dwellings, greenhouses, etc.

Other types of coke include **pitch coke**, obtained from ***coal*** or ***peat pitch***; **petroleum coke**, made of the ***heavy residue of petroleum***; **peat coke**, produced in low-temperature ***peat*** carbonization plants; **semi-coke**, produced by low carbonization of ***brown*** and ***hard coal***; and others. These are used in the chemical industry to produce ***coal electrodes***, ***anode masses***, ***electrographite***, ***silicon carbide***, and many other products.

Production

Poland is among the leading manufacturers of ***coke*** from ***coking coal***. Due to decreasing domestic demand, especially in the steel-making industry, the production depends heavily on export contracts, which make currently 60–70% of sales. Higher demand of foreign consumers resulted in important increase of domestic ***coke*** production in 2006–2008 and again in 2010 after deep drop in 2009. In the years 2011–2012 domestic coke production was reduced by ca. 9%, while in 2013 it recovered to 2011 level. In 2013, in comparison to 2010, production of ***blast furnace coke*** decreased by 9%, production of ***commercial coke*** increased by 17%, and production of other types of coke, especially ***foundry coke***, decreased by 2% (Tab. 1).

There are presently 9 cokeries in operation, with total capacities of ca. 10.1 Mtpy of coke. They are located mainly near hard coal mines or steelworks. In 2011, significant consolidation processes took place. **Kombinat Koksochemiczny Zabrze** and **Wałbrzyskie Zakłady Koksownicze Victoria** were incorporated by State Treasury into **Jastrzębska Spółka Węglowa (JSW)**. Now, two strong coke producing groups are active. The largest one is **ArcelorMittal Poland** with **Zdzieszowice Unit — Coke Works Zdzieszowice** in **Zdzieszowice** and **Kraków Unit** — coke plant at the steelworks in Kraków. Their total capacities are 4.8 Mtpy of coke, including 4.2 Mtpy in Zdzieszowice Unit. The second group is **JSW** with **Koksownia Przyjaźń** of Dąbrowa Górnicza), **KK Zabrze** (three smaller cokeries — Jadwiga, Radlin, and Dębieńsko) and **WZK Victoria**,

Tab. 1. Coke statistics in Poland — CN 2704

'000 t

Year	2009	2010	2011	2012	2013
Production	7,091	9,738	9,377	8,893	9,360
— *blast furnace coke*	*5,305*	*7,200*	*6,417*	*5,979*	*6,527*
— *commercial coke*	*1,314*	*1,791*	*2,186*	*2,075*	*2,105*
— *other types*	*472*	*747*	*774*	*839*	*728*
Imports	55	137	147	138	179
Exports	4,813	6,683	6,492	6,391	6,600
Change in stocks	-360	134	55	23[r]	-79
Consumption	2,693	3,058	2,977	2,617[r]	3018

Source: ***The Central Statistical Office*** *(GUS)*

with total capacities of 4.5 Mtpy of coke, including 2.7 Mtpy in Przyjaźń plant and 1.3 Mtpy in KK Zabrze. In 2013, JSW group was consolidated, KK Zabrze was incorporated by Przyjaźń Coke Plant and **JSW KOKS** company was created in early 2014. These two groups together supply 92% of the domestic ***coke*** production, with higher share of ArcelorMittal Poland. There are two independent cokeries: **Częstochowa Nowa** coking plant at the steelworks in Częstochowa – capacity 0.6 Mtpy, and **CARBO-KOKS** of **Bytom** (at the steelworks in Bytom**) –** capacity 0.2 Mtpy. Their technical state is various. Up till now, almost all cokeries were partly modernized. Moreover, trzy new coke batteries were constructed in **Zdzieszowice** (2006), **Przyjaźń** (2007) and **Częstochowa Nowa** (2011) cokeries.

Trade

Since 2009, Poland became the world's largest exporter of ***blast furnace coke***. It was traditionally sold primarily to EU European countries, with Germany, Austria and Romania as the main customers, but periodically also to overseas customers, such as the US, Brazil, Algeria, and India or some non-EU European countries like Norway and Ukraine (Tab. 2). Imports of ***coke*** were marginal, recently coming primarily from the Czech Republic, Russia and Ukraine. The balance of ***coke*** trade is highly positive (Tab. 3), and correlates to exports volumes and unit values (Tab. 2, 4). So, in 2009 coke exports volume were reduced by over 20%, while unit values - reduced by 30% (in PLN/t terms), so positive trade balance was reduced by 45%, but it still amounted almost 3.3 billion PLN. In the years 2010–2011 situation reversed: exports volumes rose by 35%, unit values by 83%, and trade balance by 147% to over 8.0 billion PLN. However, in 2012–2013 exports unit values were reduced by 34%, while trade balance – by 33% to 5.3 billion PLN (Tab. 3).

Tab. 2. Polish exports of coke, by country — CN 2704

'000 t

Year	2009	2010	2011	2012	2013
Exports	**4,813**	**6,683**	**6,492**	**6,391**	**6,600**
Algeria	85	172	327	132	237
Austria	568	831	976	1,010	963
Belarus	18	34	45	50	50
Belgium	47	114	13	26	6
Bosnia and Herzegovina	–	–	–	10	17
Brazil	–	–	44	275	367
Canada	–	–	21	–	–
Croatia	0	4	6	9	3
Czech Republic	451	556	413	435	343
Denmark	9	20	14	8	19
Egypt	14	19	35	25	25
Finland	141	194	236	145	94
France	356	274	173	109	135
Germany	1,379	2,138	2,262	1,870	1,614
Hungary	0	6	7	7	0
Iceland	20	12	21	21	15
India	419	44	85	368	212
Iran	84	–	–	–	–
Italy	10	5	7	12	484
Lithuania	2	1	1	0	1
Mexico	14	9	76	87	93
Netherlands	19	25	43	36	4
Norway	138	220	239	272	252
Pakistan	99	48	28	30	28
Romania	521	826	672	759	689
Russia	0	4	23	67	61
Serbia	53	175	24	5	5
Slovakia	198	460	387	92	98
Slovenia	2	5	7	6	8
South Africa, Republic of	23	33	41	22	83
Spain	13	17	17	13	22
Sweden	17	87	37	27	20
Ukraine	107	151	97	448	573
United Kingdom	3	24	23	10	58
USA	–	170	86	–	–
Others	3	5^{r}	6	5^{r}	21

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Value of coke trade in Poland — CN 2704

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	3,293,094	6,943,693	8,135,876	6,358,049	5,448,120
Imports	35,019	87,264	99,329	102,238	103,808
Balance	**+3,258,075**	**+6,856,429**	**+8,036,547**	**+6,255,811**	**+5,344,312**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Average unit values of coke exports from Poland — CN 2704

Year	2009	2010	2011	2012	2013
PLN/t	684.2	1,039.0	1,253.3	994.9	825.5
USD/t	224.5	342.4	429.3	303.9	262.9

Source: ***The Central Statistical Office (GUS)***

Consumption

After long-term declining tendency, in the years 2001–2004 coke consumption in Poland stabilized at ca. 5 Mtpy. In 2005, next long-term decreasing tendency started, though some temporary growth was reported in the years 2006–2007, 2010 and 2013 (Tab. 5).

In the domestic structure of coke consumption, industry dominates (over 90%), while the rest is used in households, agriculture, transportation and construction, other users (trade, services, etc.).

Tab. 5. Structure of coke consumption in Poland

'000 t

Year	2009	2010	2011	2012	2013
Consumption	**2,693**	**3,058**	**2,977**	**2,616**[r]	**3,018**
• energy transformation	1,632	1,935	1,983	1,914	1,958
• direct consumption	777	809	994	1,006[r]	1,059
• balance losses and differences	284	315	–	-304[r]	–

Source: ***The Central Statistical Office (GUS)***

According to the world trends, industry remains the main consumer of coke. In 2013 it was used directly as fuel in the production process — 76% of total domestic use of coke as fuel. In the industry, iron and steel production, foundry and nonferrous metals production dominate. Other industrial uses are: manufacture of chemical products, production of cement, ceramics, glass, lime etc. Coke is also used as fuel in households.

By-products

An important by-product obtained in the course of coke production is ***raw coke-oven gas***, which after consecutive purification and cooling operations provides ***crude tar***, ***crude benzol***, etc., and ***purified coke-oven gas***. In 2012–2013 cokeries produced respectively: 3,800 and 4,100 Mm^3 of ***coke-oven gas***; 376,000 and 394,000 t of ***crude tar***; 103,000 and 111,000 t of ***crude benzol*** . The by-products are further processed, mainly at chemical plants.

Companies involved in coke production in Poland, as of December 2013

- ArcelorMittal Poland S.A. Oddział w Zdzieszowicach (ArcelorMittal Poland S.A., Zdzieszowice Unit); ul. Powstańców Śląskich 1, 47–330 Zdzieszowice, tel. +48 77 4841000, fax +48 77 4841414, www.poland.arcellormittal.com — *blast furnace coke, stabilized coke, foundry coke, commercial coke, crude benzol, crude tar, ammonium sulfate.*
- ArcelorMittal Poland S.A. Oddział w Krakowie (ArcelorMittal Poland S.A., Kraków Unit); ul. Ujastek 1, 30–969 Kraków; tel. +48 12 2902000, fax +48 12 2904023, www.poland.arcellormittal.com — *blast furnace coke.*
- Koksownia Przyjaźń Sp. z o.o. w Dąbrowie Górniczej (Przyjaźń Coke Plant Ltd. of Dąbrowa Górnicza); ul. Koksownicza 1, 42–523 Dąbrowa Górnicza; tel. +48 32 7575000, fax +48 32 7575010, www.przyjazn.com.pl — *blast furnace coke, stabilized coke, commercial coke, crude benzol, crude tar, sulfur.*
- Kombinat Koksochemiczny Zabrze S.A. w Zabrzu (Zabrze Coke and Coal Chemical Group Joint Stock Co. of Zabrze); ul. Pawliczka 1, 41–800 Zabrze, tel. +48 32 2711231, fax +48 32 2718207, www.kkzabrze.com.pl — *blast furnace coke, stabilized coke, foundry coke, commercial coke, crude benzol, crude tar, ammonium sulfate, sulfur.*
- Koksownia Częstochowa Nowa Sp. z o.o. w Częstochowie (Częstochowa Nowa Ltd. Coking Plant of Częstochowa); ul. Kucelińska 22, 42–200 Częstochowa; tel. +48 34 3231261, fax +48 34 3231271, www.koksownianowa.pl — *blast furnace coke, commercial coke.*
- Wałbrzyskie Zakłady Koksownicze Victoria S.A. w Wałbrzychu (Victoria Wałbrzych Coke Works Joint Stock Co. of Wałbrzych); ul. Beethovena 14, 58–302 Wałbrzych, tel. +48 74 8425440, fax +48 74 8425879, www.wzkvictoria.pl — *blast furnace coke, commercial coke, crude benzol, crude tar, ammonium sulfate.*
- CARBO-KOKS Sp. z o.o. w Bytomiu (CARBO-KOKS Ltd. of Bytom); ul. Konstytucji 61, 41–905 Bytom, tel. +48 32 7884661, tel./fax +48 32 7884662, www.carbo-koks.pl — *commercial coke, crude tar.*

CONCRETE AND CONCRETE PRODUCTS

Overview

Concrete is a building material consisting of mixed aggregate, cement and water. According to the European standard EN 206–1, the main types of concrete are distinguished: **ordinary**, **lightweight**, and **heavy**. The first has compact structure and bulk density range between 2,000 kg/m^3 to 2,600 kg/m^3; the second is characterized by bulk density between 800 kg/m^3 to 2,000 kg/m^3; the last, with density above 2,600 kg/m^3, is used mainly as radiation shielding (against gamma radiation, X-rays, neutron radiation). Its high volume density is obtained by utilizing ***heavy fillers*** (natural and artificial), e.g. barite, magnetite, ferrophosphorus, and lead.

Lightweight concrete is based on lightweight aggregates, e.g. made of ***ash-gravelite***, ***gravelite***, and similar materials or with special techniques aimed at increasing their porosity. The group is dominated by the ***autoclaved aerated concrete*** (**AAC**) with density range between 300 to 1,000 kg/m^3. The main ingredients used for its manufacture are: natural quartz sand or fly ash, burnt lime, and water, with small amounts of aluminum in form of powder or paste, which in contact with calcium hydrate generates the porous structure of concrete. The porous products are hardened in autoclaves in water vapour in the temperature of ca. 190^{o}C and pressure ca. 1.2 MPa. The autoclaved aerated concrete are good thermal insulators, are non-flammable, but have lower strength then ordinary concrete.

Sources

The typical components for ***concrete*** production are ***cement*** as a binding agent and various ***aggregates*** used as fillers. Type of concrete depends on specific gravity of aggregates, as well as on technology used. Various types of aggregates: natural ***sand & gravel***, ***crushed aggregates***, ***artificial aggregates***, and ***recycled aggregates*** are utilized for ***ordinary concrete*** production. In the case of ***lightweight concrete***, ***lightweight aggregates*** are used. For ***cellular concretes***, the basic aggregate is ***quartz sand***, often replaced by or mixed with ***fly ash***. Besides cement, quick lime is also utilized to their production.

Production

Total production of ***concrete products***, both ***ordinary*** and ***cellular***, after reaching a record level of 15.3 Mm^3 in 2011, was significantly reduced by nearly 13% to approx. 13.3 Mm^3 in 2012. The factors stimulating the growth in production until 2011 were projects in preparation for the EURO 2012, as well as investments in infrastructure (mainly road construction) financed from EU funds. However, the same factors contributed to the decline in concrete production in 2012, especially in the second half of that year immediately after the EURO 2012. Decreasing tendency of production deepened even more in the first half of 2013, but the second half of the year brought a partial economic recovery in construction, so that the year ended with nearly 3% increase in concrete production (Tab. 1). A similar fluctuations was observed in case of ***ready-mix concrete*** production, but due to the specific use of this product, mainly in large-building construction, there was a further deepening of the downward trend in their production in 2013 (Tab. 1).

Tab. 1. Concrete and concrete products statistics in Poland – CN 6810

Year	2009	2010	2011	2012	2013
Production [‘000 m^3]					
Concrete products	**12,955**	**14,019**	**15,309**	**13,342**	**13,783**
• wall products for building construction	6,121	6,694	6,828	6,023	6,037
— *including* lightweight concrete products	*4,668*	*4,599*	*4,831*	*4,313*	*4,293*
• *in which* AAC products	*4,403*	*4,409*	*4,553*	*4,085*	*4,081*
• concrete products for road construction	4,666	5,005	6,000	5,219	5,475
• prefabricated concrete elements for construction	2,168	2,320	2,481	2,100	2,271
Precast ready-mix concrete	**16,398**	**19,208**	**24,388**	**19,945**	**18,741**
— *including* ordinary ready-mix concrete	15,833	16,535	21,460	18,480	16,944
Imports [‘000 t]	**194**	**204**	**232**	**120**	**156**
Exports [‘000 t]	**449**	**279**	**314**	**430**	**556**

Source: ***The Central Statistical Office (GUS)***

The group of concrete products includes three significant subgroups, in respect to their production quantity, such as: wall concrete products, concrete products for road construction, and large and medium prefabricated elements for construction.

The group of ***wall products for building construction*** is the most significant in terms of production volume from among all subgroups of concrete products, but its share in the total supply decreased slightly in the last two years from 47% to 44%, due to the increased dominance of the production of paving stones due to the intensification of road construction projects. After 2009, when the production level decreased by over 13% to just over 6 Mm^3, in the next two years there has been a significant increase up to over 6.8 Mm^3 in the 2011 (Tab. 1). However, further years brought a significant reduction in production in this group to just over 6 Mm^{3}py. The similar trend was recorded in case of products from autoclaved aerated concrete (AAC), constituting almost 68% of all wall concrete products. The AAC products are currently manufactured in 30 plants. Seven plants use ***fly ash*** from the nearby power plants or heating plants in their production (Łagisza, Bielsko-Biała, Kozienice, Oświęcim, Skawina Warszawa i Stalowa Wola); the remaining plants (about 70% of domestic supply) utilize ***natural quartz sand***. The largest cellular concrete producers are: **Solbet** (leader with 33% share of market, production capacity reaching 2 Mm^3 per year, and with the largest plant in Poland and

Europe in Solec Kujawski), **Grupa Prefabet** (five plants, with combined production capacity over 1Mm^{3}py, currently in structure of Irish group **CRH**), **Xella Polska** (six plants) and **H+H Polska** (five plants). As a result of extensive modernization the capacity of domestic plants rose significantly to about 8 Mm^{3}py. In 2011, 30 plants of cellular concrete in Poland produced a total of 4.5 Mm^3 of AAC, of which 1.5 Mm^3 in five plants of **Solbet**. Almost all producers of cellular concrete products (12 companies), as well as the majority of large manufacturers of ordinary concrete products (20 companies), belong to **Concrete Production Association** (**SPB**), a member of **European Autoclaved Aerated Concrete Association** (**EAACA**), which promote the interests of producers of autoclaved aerated concrete (AAC) in 17 countries of Europe. Since 2007, **Concrete Production Association** is also the member of the ***Bureau International du Beton Manufacture*** (***BIBM***). In 2012 other association was created i.e. **Association of White Wall Materials Producers "White masonry work"**, focusing most of manufacturers of cellular concrete and sand-lime products (including Xella and Silikaty Group).

The second important group of products are ***products for road construction***, especially ***concrete paving stones*** made from vibropressed concrete, being a cheap alternative for granite pitcher and road clinker. It is estimated that their domestic production constitutes ca. 80% of the total output of ***concrete products for road construction***. Their total production level is difficult to ascertain because the **Central Statistical Office** reports the production only in companies with minimum 10 employees. Production of paving concrete bricks, registered by Central Statistical Office (item **236115020** of **PKWiU** nomenclature) showed a similar trend as for the whole concrete products sector during the analyzed period. However, in this group in 2011 the most significant increase of production of almost 20% was registered, due to the implementation of several infrastructure projects in road construction funded by the EU (Tab. 1). After a significant 13% decrease in production to a level of 5.2 Mm^3 recorded in 2012, the next year ended with a nearly 5% increase in supply to more than 5.4 Mm^3. The share of ***concrete products for road construction*** in the total supply of concrete products rose during last two years to almost 40%. In 1994, the producers of these products established the **Association of Pavement Blocks Producents** (**SPBKD**), which currently includes 24 producing companies, 9 supporting companies (in which 2 foreign). Development of concrete paving stones and cellular concrete production places Poland among their top manufacturers in Europe.

Production of large and medium ***prefabricated concrete elements for construction*** is a subject of the biggest fluctuation. Their share in total concrete products supply was reduced recently to ca. 15–16% (Tab. 1).

The total ***concrete mix*** supply (both concrete mix prepared and consumed directly in the construction site — so called ***household concrete***, and produced for commercial purposes — called ***ready-mix concrete***) is difficult to ascertain. The **Central Statistical Office** reports only the production of ***ordinary ready-mix concrete*** in companies with minimum 10 employees. The level of its production according to its data after two years period of growth associated with the implementation of road projects financed from EU funds and intensive preparations for EURO 2012 ended with a record result of 21.5 Mm^3 of ***ready-mix concrete*** and 24.4 Mm^3 for the the ***precast ready-mix concrete*** in 2011, it was reduced in 2012 to less than 18.5 Mm^3 and 20 Mm^3, respectively (Tab. 1). The year 2013 brought further deepening the downward trend of production in this group, although in the construction industry a slight recovery was observed, especially in the second half of the year (Tab. 1). According to estimates **SPBT** (producers association) production of concrete in Poland in 2012 could be higher reaching 19.5 Mm^3, and decreasing to 18 Mm^3 in 2013. For their production in 2013 about 14.4 Mt of cement was used, with an average content of cement 279 kg/m^3 of concrete. The grades structure of concrete production since 2011 has been dominated by a grades C25/30-C30/37 (52-54% of the sale), with minor share of lower strength concrete grades C16/20-C20/25 (19-22%) and high strength C35/45 grade (13-18%). Concrete with strength adequate for classes C25/30-C30/37 in recent years made about 57-59% of all concrete production in the European Union and more than 63% of the ERMCO Member States.

Currently, more than 950 concrete producers operate in Poland, including 220 companies associated in the ***Ready Mixed Producers Association*** (**SPBT**). This organisation has worked since 1999, and since 2001 is a member of **ERMCO** (***European Ready Mixed Concrete Organization***). Production of SPBT members reached above 41% the total ready mixed concrete supply during last years. The most important members are both large cement and concrete producers, belonging to international companies such as: **Bosta Beton**, **HeidelbergCement**, **Cemex Polska**, **Dyckerhoff**, **Lafarge**, **Thomas Beton**, and smaller ones, e.g.: **Agrobud** of Koszalin, **Elektrobet** from Lublin, **Rebet** of Białystok or **Wibro-Cem** from Lubartów.

Bosta Beton belonging to the Irish **CRH** concern, after overtaking of **Behaton** and **Schwenk**, ranked the leading place among domestic producers. The company operate 40 plants, mainly in central part of Poland. The second ranked is **Górażdże Beton** (a part of **HeidelbergCement** group) with 50 plants in the western, southern and central part of Poland (including 17 plants of **BT Topbeton** company). In **Cemex Polska**, ready-mix concrete is manufactured in 41 factories, including 6 mobile mixing plants, in almost all voivodeships except of Kujawsko-Pomorskie, Świętokrzyskie and Podkarpackie voivodeships. **Dyckerhoff Beton Polska** belonging to **Buzzi Unicem Group** has currently 26 plants in four divisions, mainly in southern and central Poland. **Lafarge Beton**, after overtake of **Res-Bet Rzeszów** and **BM Beton Rabowice** plants, is currently the owner of 30 stationary facilities and 3 mobile mixing plants. **Thomas Beton** is the owner of 13 facilities, located in Warsaw and northern Poland. The smaller potential have: **JD Trade Group** of Opole with 7 factories in Lower and Upper Silesia region and Warsaw, and **TH Beton** of Wrocław with five facilities in Upper Silesia, Lower Silesia and Małopolska voivodeships. Recently the mobile concrete mixing plants became more popular, because of possibility of a rapid delivery of ready-mix concrete into the construction of roads and highways.

Trade

The quality of some Polish concrete products, comparable to the quality of foreign products and certified for their conformity with foreign standards, has stimulated foreign trade. Exports after significant decrease in period of 2009-2010 rose to 430,000 t in 2012 and above 550,000 in 2013 (Tab. 1). The structure of concrete products exports changed significantly in 2013. After a period of dominance of ***prefabricated concrete elements for construction***, exported mainly to Germany and Latvia, in 2013 the largest, more than 44% share in exports had ***wall products for building construction***, sold mainly to Russia (52%), Slovakia (18%) and Ukraine (11%). In 2013 the ***prefabricated concrete elements for construction*** made 24% of exports and were sold mainly to Germany (42%) and Ukraine (29%). Imports, after a period of stabilization at the level of 190,000-230,000 tpy, decreased to 120,000-150,000 tpy in 2012-2013 (Table. 1). In the structure of imports in 2013, ***concrete paving stones*** dominated (almost 43% of supply) imported mainly from Germany (42%) and Slovakia (47%). Due to domination of exports over imports, the trade balance has remained positive (Tab. 2).

Tab. 2. Value of concrete products trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Imports	113,431	114,541	139,218	104,273	116,696
Exports	405,902	333,106	431,937	545,521	580,828
Balance	**+292,471**	**+218,565**	**+292,719**	**+441,248**	**+464,132**

Source: ***The Central Statistical Office (GUS)***

Consumption

The structure of ***concrete products*** consumption is not well known, but it is supposed to be similar to cement usage. The share of the non-residential building construction, as well as transport infrastructure has recently risen in the structure of concrete consumption. As consequence of technological changes in the construction sector, the development of ready-mix concrete market with the diminish of large concrete elements production could be noticed.

It is worth mentioning that ready-mixed concrete consumption in Poland decreased in 2013 to 0.47 m^3 per capita and came close to the average for the European Union ERMCO members (0.49 m^3 per capita).

COPPER

Overview

Copper (**Cu**) forms many minerals, of which ***copper sulfide*** is the most important. Its principal primary sources are ***copper ore*** or ***Cu-Zn-Pb***, ***Ni-Cu ore*** deposits. **Copper concentrates** or **mixed concentrates** obtained in course of flotation process are treated by pyrometallurgical and hydrometallurgical methods to extract **copper metal**. Considerable quantities of copper are also recovered by ***solvent extraction/electrowinning*** process (**SX/EW**) and from copper-bearing scrap and waste.

Copper is widely used in manufacturing of alloys with zinc, nickel, aluminum, beryllium, tin, silicon, and manganese. The main consumers, critical for overall demand, are electrotechnology and electronics.

Sources

The primary source of ***copper*** in Poland is ***sulfide ore*** rich in ***chalcocite***, ***bornite***, and ***chalcopyrite***, occurring in 14 deposits of stratoidal type. These deposits are located in the Lower Silesia in two geological units: the **North Sudetic Syncline** and the **Fore-Sudetic Monocline**. At the end of 2013 total resources of the ore were 1,762 Mt, with 33.8 Mt of contained metal. Around 82% of these resources were in deposits currently operated by the **KGHM Polska Miedź** — the only domestic producer of primary copper. The average content of metal in run-off-mine decreased from 1.68% in 2009 to 1.57% in 2013 owing to extraction of poorer parts of the deposit.

Copper ore contains many accompanying elements, e.g. ***silver***, ***gold***, ***arsenic***, ***lead***, ***zinc***, ***cobalt***, ***nickel***, ***vanadium***, ***molybdenum***, ***selenium***, ***rhenium***, and ***platinum***. At the end of 2013 the approximate resources of these metals were as follows: Ag — 103,182 t; Pb — 1,548,600 t; Co — 121,500 t; Ni — 56,380 t; V — 139,110 t; Mo — 68,710 t; Zn — 320,290 t. Among above mentioned elements, ***silver***, ***gold***, ***lead***, ***selenium***, ***nickel*** in the form of ***nickel sulfate***, ***platinum-palladium slime***, and ***rhenium***, have been recovered.

The share of ***old scrap*** utilized in the production of refined copper in KGHM has recently ranged 14-17% per year, whereas the amount of ***anode scrap*** (new scrap) re-charged to refining has approached 16–18% py in each of the KGHM' smelters. ***Scraps*** of ***copper*** and ***copper alloys*** (brass and bronze) were also processed at the **Będzin Smelter** (in liquidation) and **Dziedzice Metals Mill** (**Impexmetal Group**).

Copper Ore and Concentrates

Production

Copper ore has been extracted in the Lubin-Głogów Copper District at the following mining divisions of the **KGHM Polska Miedź**:

- **Lubin** (mining capacity over 7 Mtpy of ore) — the mine termination planned in 2030;
- **Polkowice-Sieroszowice** (capacity ca. 12 Mtpy, in course of build-out) — the life-span — 2040;
- **Rudna** (capacity over 12 Mtpy, the extraction at the depth of 1200 m) — probable end of production in 2025.

In recent years the content of metal in run-off-mine has ranged around 480,000 tpy, while the total output of copper ore amounted to ca. 30 Mtpy (Tab. 1). In 2004 KGHM was granted the concession (valid through 2054) for the extraction of the ore from new mining area — **Głogów Głęboki-Przemysłowy**, while for parts of the deposit recently operated, i.e. **Polkowice**, **Sieroszowice**, **Lubin-Małomice**, **Rudna** and **Radwanice-Wschód**, the concessions have been prolonged until 2063. The operation of the **Głogów Głęboki-Przemysłowy** should be launched in 2015. Full mining capacity is expected by 2020 and then it should provide around 25% of the total KGHM's copper ore output. There are also other the company's mining projects in progress, i.e. **Gaworzyce-Radwanice**, adjacent to Polkowice-Sieroszowice mining area, as well as **Synklina Grodziecka**. To expand existing resources, the KGHM's exploration activity is planned in other areas in Poland, i.e.: **Konrad, Retków-Ścinawa**, **Głogów**, **Kulów-Luboszyce**, as well as **Stojanów** (being an extension of **Weisswasser** deposit in Germany on the territory of Poland). According to the strategy of the **KGHM Polska Miedź Capital Group** until 2018, the company will be also involved in foreign copper projects such as: **Weisswasser** in Saxony/Germany, **Afton-Ajax** (***Cu-Au***) in Canadian British Columbia (acquired in 2010, recently 80% of shares), **Malmbjerg Molybdenum** (***Mo***) in Greenland, as well as **Quadra FNX Mining Ltd**. of Canada – after acquisition in 2012 renamed into **KGHM INTERNATIONAL** – that managed deposits and projects in the USA (***Cu-Au ore*** **Robinson**, ***Cu*** **Carlota**), Canada (***Cu-Ni-Au-Pt-Pd*** **Levack/Morrison**, ***Cu-Ni-Au-Pt-Pd*** **Podolsky**, ***Cu-Ni-Au-Pt-Pd*** **McCreedy West**), and Chile (***Cu-Au-Mo*** **Sierra Gorda** – launched in the mid-2014, and ***Cu*** **Franke**). In 2013 KGHM took over 100% stake of ***Cu-Ni-Au-Pt-Pd*** **Victoria** project from **Vale Canada** in return for 2.25% Net Smelter Return (NSR) royalty. Simultaneously **Vale** has committed to purchase and process the total run-off-mine in its plant **Clarabelle** in Sudbury.

Copper concentrates have been produced at three processing plants, forming the **KGHM's Division** called the **Ore Enrichment Plants** (production capacity of c.a. 1.9 Mtpy of concentrate), i.e.:

- **Lubin** — rated processing capacity of 7.8 Mtpy of ore;
- **Polkowice** — rated processing capacity of 9.1 Mtpy of ore;
- **Rudna** — rated processing capacity of around 16.3 Mtpy of ore.

In recent years the total production of concentrates has amounted to 425,000-429,000 tpy (Tab. 1). Thanks to successive replacement of flotation machinery (113 units between

Tab. 1. Copper ore and concentrate statistics in Poland — CN 2603 00

'000 t Cu

Year	2009	2010	2011	2012	2013
Mining output	499.5	480.6	479.3	479.3	481.8
Concentrate production	439.0	425.4	426.7	427.1	428.9
Imports of concentrate	23.4	11.4	14.3	17.7	43.5
Exports of concentrate	0.0	0.0	0.0	0.0	0.0
Concentrate consumption	462.4	436.8	441.0	444.8	472.4

Source: ***The Central Statistical Office (GUS), KGHM Polska Miedź S.A.***

2009 and 2013) the yield of copper in the concentrate improved, approaching 89.3% in 2013. As a result, copper content in the concentrate averaged 23.1% Cu (22.95% in 2012), varying between ca. 14% and 26% depending on the plant. The unit cost of the production of copper concentrate, which in 2011 was 0.63 USD/lbs, in 2012 more than doubled, reaching 1.34 USD/lbs, while in 2013 it achieved 1.78 USD/lbs. That was a consequence of the tax imposition on Cu-Ag ore mining since April 2012, as well as appreciation of the zloty (PLN) against dollar (from 3.26 in 2012 to 3.17 in 2013).

A small, additional output of copper-silver-bearing concentrates (ca. 1 Mtpy) has come from the KGHM's division — **Ecoren.** The source material for copper recovery have been spent bricks from metallurgical furnaces relining, at the Głogów, Legnica, and Cedynia smelters, which are replaced twice a year. Annually there have been 3 Mtpy of lining utilised. The material has been crushed down to 0.1 mm and processed in course of gravity separation and flotation. The mixed Cu-Ag concentrate is metallurgically treated at the KGHM smelters.

In course of copper ore processing there are huge amounts of tailings generated, ca. 93–94% of the overall mass of extracted ore. In recent years their volume has ranged from 20 to 26 Mtpy. The majority of these tailings are collected in the **Żelazny Most** settling pond (total area – 13.94 km^2, the capacity 700 Mm^3, possible expansion to over 1,100 Mm^3). Large portion of them (ca. 75%) is utilized for geological backfilling, heightening the pond's dams and sealing up its top.

Trade

The ***copper concentrates*** have been traded on a relatively small scale, supplementing their domestic supplies in order to utilize the smelters' production capacities (Tab. 1). In recent years their importation increased up to 43,500 tpy. The majority of deliveries have come regularly from Chile (46% of the total in 2013), joined by Morocco (43 and 28% in the last two years, respectively). Negligible quantities of copper concentrates were also exported. The trade balances were always negative, fluctuating within broad limits, from 211 to almost 800 million PLN per year (Tab. 2).

Consumption

In the last five years the apparent consumption of ***copper concentrates*** ranged from around 440,000 to 470,000 tpy (Tab. 1).

Tab. 2. Value of copper concentrates trade in Poland — CN 2603 00

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	46	8	2	21	1
Imports	288,235	211,119	356,878	329,440	799,764
Balance	**-288,189**	**-211,111**	**-356,876**	**-329,419**	**-799,763**

Source: ***The Central Statistical Office (GUS)***

Refined Copper

Production

Copper concentrates from KGHM's mining operations, as well as other ***copper-bearing materials*** (wastes, scrap), are smelted into ***copper blister/converter*** (98.5–99.0% Cu) and fire-refined into ***anode copper*** at the KGHM's copper smelters, i.e.:

- **Legnica** (shaft furnace technology); nominal capacity 132,000 tpy of ***anode copper*** graded at 99.2% Cu;
- **Głogów I** (shaft furnace technology); nominal capacity 220,000 tpy of ***anode copper*** graded at 99.0% Cu;
- **Głogów II** (flash smelting technology, to be updated); nominal capacity ca. 300,0 tpy of ***anode copper*** graded at 99.3% Cu;

In the analyzed period the total production of ***blister & converter copper*** increased from 515,000 t in 2009 to around 550,00 tpy in the subsequent three years, and then declined slightly by ca. 2% (Tab. 3). These supplies have been supplemented by imported blister copper (in the last three years from around 17,000 to 29,000 tpy). As a result, the production of ***anode copper*** at the KGHM' metallurgical units jumped from 574,000 in 2009 to 656,000 t in 2012, i.e. by around 14%, with a 2.6% reduction in 2013. The **Legnica** and **Głogów I** smelters have utilized the obsolete shaft furnace technology for the production of ***converter copper*** (98.5% Cu). However, these smelters are to be reconstructed in order to increase the output of copper to 600,000 tpy, and to reduce the unit production costs and negative impact on the environment. There have been thorough investment projects prepared that included: the replacement of the shaft technology by modern flash smelting process at the **Głogów I** smelter (the capacity of 250,000 tpy of ***blister copper***, starting from 2014), and a new furnace for copper scrap treatment, the construction of which has been planned in place of the old shaft furnace at the **Legnica** unit. The latter one, of the capacity of 135,000-200,000 tpy, should be launched in 2017. The third KGHM's metallurgical plant — the **Głogów II** has used flash smelting technology, based on a modified license of **Outokumpu Oy**, for direct one-stage smelting of concentrates into ***blister copper*** (98.7% Cu). Slag rich in copper (11–15% Cu) has been processed in an electric furnace to obtain additional quantities of ***blister copper***, which has also been treated in rotary anode furnaces to produce ***anode copper*** (99.3% Cu), with the average yield approaching 98%. The first phase of modernization of the flash smelting line including replacement of the old electric furnace into a new one at the **Głogów II** complex, which was carried out within three months of 2013, resulted in expansion of the capacity of concentrates metallurgical treatment into ***blister copper*** up to 863,000 tpy and improved recovery of accompanying elements, i.e. ***silver***, ***lead***, and ***rhenium***. The next phase of renovation has been scheduled for 2017.

Tab. 3. Copper-smelter production in Poland — CN 7402 00

‘000 t Cu

Year	2009	2010	2011	2012	2013
Blister and converter copper	**515.1**	**548.1**	**550.1**	**549.0**	**536.8**
— primary	457.5	469.7	481.9	466.7	458.8
— Secondary	57.6	78.4	68.2	82.3	78.0
Anode copper	**574.3**	**625.5**	**645.2**	**656.0**	**638.8**

Source: ***KGHM Polska Miedź S.A., the Central Statistical Office (GUS)***

Anode copper produced in both technologies is electrolytically refined (yield approx. 98%) at the following **KGHM**‘s metallurgical units:

- **Legnica —** capacity of around 93,000 tpy of Cu in ***cathodes*** (min. 99.99% Cu) and 35,000 tpy in ***continuous cast billets*** — also processes ***scrap*** (both new and old one);
- **Głogów I** and **Głogów II** — total capacity of 550,000 tpy of ***refined copper*** (min. 99.99% Cu) basically from its own ***anode copper***, but also from some ***old scrap*** (80,000, 110,000, and 99,000 tpy in the last three years, respectively, a total of three refineries).

Over the years 2009-2013 the KGHM’s production of ***refined copper*** (Tab. 4) increased from the lowest point of 503,000 t in 2009 to the highest one (ever recorded), i.e. 571,000 t in 2011, following the record LME copper quotations (8,811 USD/t). In 2012 and 2013 the production was slightly lower (by 1%) thanks to supplementary supplies of foreign copper-bearing raw materials (scrap, blister copper and imported concentrates) for the KGHM’s metallurgical units that resulted in the additional output of 147,000 and 135,000 t of refined copper, respectively. Around 20% of the total production has been sold to domestic customers, while the remaining 80% - to foreign recipients.

Tab. 4. Refined copper statistics in Poland — CN 7403 11–19

‘000 t Cu

Year	2009	2010	2011	2012	2013
Production	502.5	547.1	571.0	565.8	565.2
Imports	13.9	27.2	12.5	20.3	14.2
Exports	313.5	313.4	327.7	333.3	343.5
Consumption[a]	202.9	260.9	255.8	252.8	234.1

Source: ***The Central Statistical Office (GUS), KGHM Polska Miedź S.A.***

One of the company’s principal products obtained from copper cathodes has been high quality ***copper wire rod*** (a diameter of 8 mm) manufactured at the KGHM’s division - **Cedynia Copper Rolling Mill**, operating the **Contirod** installation (licensed by **Union Miniere**). In recent years its production has amounted to 230,000-240,000 tpy, around 60% of which has been sold abroad. Another high quality copper product manufactured at the mill has been ***oxygen-free copper rod — Cu-OFE*** (with the oxygen content reduced from 200 ppm to 3 ppm). It is suitable for the production of light-gauge wire of diameter even below 0.1 mm. The technology called **Upcast** has been licensed by the **Outokumpu**. Since 2010, when the Upcast installation reached its full capacity, the output of ***oxygen-free copper rod*** has ranged 13,000-15,000 tpy. Since May 2008 there has been also a new product offered, i.e. wire with silver additive ***CuAg(OF)*** characterized by increased heat and wear resistance. Its output has increased from 900 to 1,365 tpy.

Trade

Poland has been one of the world's leading exporters of ***refined copper cathodes***, and ***copper semi-products***, with ***copper wire rod*** being of primary importance (Tabs. 5 and 8). ***Copper cathodes*** (min. 99.99% Cu) manufactured at the KGHM's refineries have been quoted on the **LME** as ***Grade A copper*** under the brand names ***HML*** (**Legnica**), ***HMG-B*** (**Głogów II**) and ***HMG-S*** (**Głogów I**), as well as on **Shanghai Stock Exchange of Futures Contracts**. They have been sold by the company's trade agencies: **KGHM Metraco** supported by **KGHM Kupferhandels** in Vienna (in liquidation), **KGHM Polish Copper** in London (until 2011), and **KGHM** (**Shanghai**) **Copper Trading** in China.

Tab. 5. Polish exports of refined copper, by country

'000 t Cu

Year	2009	2010	2011	2012	2013
Exports	**313.5**	**313.4**	**327.7**	**333.3**	**343.5**
• ***cathodes*** **CN 7403 11**	***310.1***	***307.2***	***316.0***	***319.0***	***329.5***
• ***ingots for wire*** **CN 7403 12**	***2.2***	***4.9***	***8.6***	***9.3***	***6.0***
• ***continuous cast billet*** **CN 7403 13**	–	–	–	***0.3***	–
• ***other*** **CN 7403 19**	***1.2***	***1.3***	***3.1***	***4.7***	***8.0***
Austria	4.2	6.9	7.5	7.3	1.9
Belgium	1.2	3.0	1.1	6.0	–
Bulgaria	1.3	1.8	2.2	1.8	1.3
China	97.4	79.2	94.1	76.0	95.9
Czech Republic	2.6	0.7	0.2	0.2	2.3
Egypt	8.5	2.5	2.0	–	–
Finland	12.0	–	–	–	–
France	42.1	19.9	21.1	27.5	29.6
Germany	109.5	136.0	134.5	137.8	144.7
Italy	18.5	33.6	43.8	45.0	27.1
Korea Republic	–	–	1.3	2.7	0.2
Malaysia	–	–	1.0	3.0	13.1
Netherlands	7.3	–	3.0	9.4	–
Singapore	–	–	6.5	–	–
Slovakia	1.3	25.5	1.8	5.8	4.6
Sweden	–	–	–	–	0.6
Switzerland	1.0	1.1	0.2	0.1	0.0

Taiwan	1.0	0.6	0.3	0.2	0.2
Turkey	–	–	3.1	8.2	20.8
Ukraine	1.0	0.0	0.5	–	0.0
United Kingdom	1.4	–	–	–	0.4
Vietnam	–	–	–	1.3	–
Others	3.2	2.6	2.4	1.0	0.8

Source: ***The Central Statistical Office (GUS)***

In the last five years the foreign sales of ***refined copper*** from Poland have been systematically increasing, up to 343,500 t in 2013. Among numerous recipients of this commodity, Germany and China were the largest ones (Tab. 5).

The unit values of ***copper cathodes*** exportation from Poland have followed the changes in quotations of copper grade A on the LME. In 2011-2012 they were higher by 65 and 48% (USD/t), respectively, as compared to the critical 2009, while in 2013 they dropped by 7% owing to decrease in metal prices and reduced exchange rate USD/PLN (Tab. 6). Similar tendencies have been observed in the case of exported ***ingots for wire***.

Tab. 6. The unit values of refined copper exports from Poland

Year	2009	2010	2011	2012	2013
Cathodes CN 7403 11					
PLN/t	16,304	22,897	26,046	26,057	23,274
USD/t	5,378	7,630	8,889	7,972	7,418
Ingots for wire CN 7403 12					
PLN/t	15,803	23,919	26,625	26,640	23,893
USD/t	5,076	7,966	9,062	8,113	7,611

Source: ***The Central Statistical Office (GUS)***

Some quantities of ***refined copper***, in the range of 13,000-27,000 tpy, have been also imported to Poland. In recent years the major foreign suppliers have been Germany and the Czech Republic (Tab. 7). There have been also large amounts of ***nonrefined copper*** and ***copper scrap*** imported to Poland to supplement the domestic charge for refined copper manufacturing (Tab. 8).

Tab. 7. Polish imports of refined copper, by country

'000 t Cu

Year	2009	2010	2011	2012	2013
Total imports	**13.9**	**27.2**	**12.5**	**20.3**	**14.2**
• ***cathodes*** **CN 7403 11**	***13.1***	***24.8***	***11.7***	***15.3***	***12.9***
• ***ingots for wire*** **CN 7403 12**	–	–	–	***1.2***	***0.5***
• ***continuous cast billet*** **CN 7403 13**	***0.0***	***0.1***	***0.1***	***2.3***	***0.1***
• ***others*** **CN 7403 19**	***0.8***	***2.3***	***0.7***	***1.5***	***0.7***

Austria	–	1.2	0.1	0.1	–
Belgium	–	0.4	2.8	0.6	0.2
Chile	7.5	–	–	0.1	–
Czech Republic	–	10.9	2.0	7.3	4.2
Congo D. R.	2.5	1.0	1.9	1.0	0.3
Germany	1.0	10.8	2.4	7.6	4.6
Italy	–	–	0.3	0.2	1.0
Latvia	–	–	–	2.0	0.5
Laos	–	–	–	–	0.2
Luxembourg	–	–	–	–	0.3
Netherlands	–	–	–	–	0.5
Russia	0.6	0.3	–	0.1	0.2
Slovakia	–	–	–	0.4	0.3
Switzerland	–	–	–	–	1.7
Ukraine	0.7	0.8	0.2	–	–
Zambia	0.7	0.2	–	–	–
Zimbabwe	–	–	2.0	0.4	–
Others	0.9	1.6	0.8	0.5	0.2

Source: ***The Central Statistical Office (GUS)***

Tab. 8. Trade in selected copper commodities in Poland

t Cu

Year	2009	2010	2011	2012	2013
Copper-matte, precipitated CN 7401 00					
Imports	0	612	–	–	–
Exports	1,488	956	1,566	1,302	1,720
Nonrefined copper; copper anodes for electro-refining CN 7402 00					
Imports	44,672	15,068	23,580	22,847	17,481
Exports	23,538	2	2	4	4
Copper alloys CN 7403 21–29					
Imports	2,023	2,504	2,758	3,470	2,529
Exports	3,799	2,516	1,237	2,463	2,076
Copper wastes and scrap CN 7404 00					
Imports	15,467	24,075	26,872	53,622	49,668
Exports	53,456	71,215	59,537	49,216	58,936

Transitional copper alloys CN 7405 00					
Imports	385	483	163	105	98
Exports	2	2	65	99	148
Copper powders and flakes CN 7406 10, 20					
Imports	169	253	355	338	430
Exports	829	1,251	1,205	901	1,141
Copper wire rod CN 7408 11					
Imports	28,210	46,435	31,818	20,211	33,119
Exports	99,212	123,874	127,453	140,273	141,923

Source: ***The Central Statistical Office (GUS)***

Among the numerous copper commodities the highest revenues have been brought by ***refined copper***, ***copper wire rod***, and – until 2011 – ***copper scrap*** (Tab. 9). The balance of copper scrap turned negative in 2012, as the value of their purchase surpassed the one of the sale. The financial results of the turnover of the remaining copper raw materials have been of less influence on the total trade balance. In recent years the earnings from ***refined copper*** and ***copper wire rod*** exportation has increased most spectacularly, while the deepest deficit has been observed in the trade of ***copper anodes*** and ***copper scrap*** (in 2012 and 2013). Growth in exportation of ***transitional copper alloys***, recorded since 2011, coupled with their reduced foreign purchases, has resulted in positive values of trade balances (Tabs. 8, 9).

Tab. 9. Value of selected copper commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Copper-matte, precipitated CN 7401 00					
Exports	3,846	4,766	10,178	8,464	8,830
Imports	1	4,529	0	0	0
Balance	**+3,845**	**+237**	**+10,178**	**+8,464**	**+8,830**
Unrefined copper; copper anodes for electro-refining CN 7402 00					
Exports	434,796	60	330	341	320
Imports	750,422	346,994	668,635	608,492	404,662
Balance	**-315,626**	**-346,934**	**-668,305**	**-608,151**	**-404,328**
Refined copper CN 7403 11–19					
Exports	5,111,156	7,182,763	8,539,788	8,693,482	7,997,061
Imports	174,306	591,063	330,674	557,881	344,227
Balance	**+4,936,850**	**+6,591,700**	**+8,209,114**	**+8,135,601**	**+7,652,834**

Copper alloys CN 7403 21–29					
Exports	35,518	28,873	25,401	27,179	39,656
Imports	28,217	48,276	63,469	53,579	51,729
Balance	**+7,301**	**-19,403**	**-38,068**	**-26,400**	**-12,073**
Copper wastes and scrap CN 7404 00					
Exports	581,502	1,163,736	1,058,354	859,306	969,471
Imports	222,083	475,920	621,823	1,203,066	988,756
Balance	**+359,419**	**+687,816**	**+436,531**	**-343,760**	**-77,950**
Transitional copper alloys CN 7405 00					
Exports	54	2	2,253	3,174	4,507
Imports	5,762	10,620	4,817	3,206	3,141
Balance	**-5,708**	**-10,618**	**-2,564**	**-32**	**+1,366**
Copper powders and flakes CN 7406 10, 20					
Exports	28,199	41,561	45,712	34,526	41,171
Imports	5,813	8,812	13,946	13,050	16,400
Balance	**+22,386**	**+32,749**	**+31,766**	**+21,476**	**+24,771**
Copper wire rod CN 7408 11					
Exports	1,410,150	2,834,590	3,291,908	3,645,719	3,380,285
Imports	471,708	811,082	865,973	541,168	817,774
Balance	**+938,442**	**+2,023,508**	**+2,425,935**	**+3,104,551**	**+2,562,511**

Source: ***The Central Statistical Office (GUS)***

Consumption

The apparent consumption of ***refined copper***, which in 2009 decreased to merely 203,000 t as a consequence of increased exportation coupled with diminished production, in subsequent three years revived to 253,000-260,000 tpy, with a 7% reduction last year (Tab. 4). The principal consumer of ***refined copper*** in Poland has been the automotive industry, utilizing copper-made radiators, electronic control system and many other elements in the construction of cars. Considerable amounts of semi-products and copper alloys are utilized in the construction industry, e.g. in heating, air-conditioning and water supply systems, for facade and roofing etc. Other important copper-consuming branches have been metallurgy, the machine industry, telecommunications, computers, transportation, foundry engineering, chemical industry, medicine, cosmetics, etc. Semi-products, utilized in manufacturing of cables, wires, and other electric and electrotechnical products have been offered by **Cedynia Copper Rolling Mill**. ***Copper wire rod*** has been consumed at numerous domestic plants in the production of ***cables*** and ***wire*** for the mechanical and electrical engineering.

Copper, ***copper alloy products***, and ***semi-products*** for the metallurgical, machine, and transportation industries have been supplied by **Hutmen S.A.**, Wrocław (tubes, tube couplings, flat bars, rods, rolled sections, sleeves, cast alloys, wire), **WM Dziedzice**, Czechowice-Dziedzice (rods, tubes, flat bars), the **Będzin Smelter** in liquidation, Będzin (tubes, rolled sections, rods, brass sections), and **Non-ferrous Metals Mill Łabędy**, Gliwice (sheets, flats, bands). ***Semi-products for foundry*** have been produced mainly by the **Będzin Smelter** and **Hutmen**, as well as **WM Dziedzice**, though to a lesser extent.

Companies involved in copper production in Poland as of December 2013

- KGHM Polska Miedź S.A. w Lubinie (KGHM Polska Miedź Joint Stock Co.), Skłodowskiej-Curie 48, 59–301 Lubin, tel. +48 76 7478200, fax. +48 76 7478500, www.kghm.pl — *copper ore and concentrates, refined copper, copper wire rod and other semi-products*.

CORUNDUM AND EMERY

Overview

The mineral **corundum**, i.e. natural well-crystallized Al_2O_3, and **emery**, a metamorphic rock rich in corundum, were used for centuries as bulk grinding materials or shaped grinding tools. Natural deposits of corundum are rare. Synthetic **electrocorundum** is the main substitute for corundum, and predominates in abrasives and refractory applications.

The **pure crystals of corundum** are **gems**, e.g. colour-less ***leukosapphire***, red ***ruby***, blue ***sapphire***, and others (see: **GEMS**). Synthetic products — ***leukosapphire***, ***ruby***, ***sapphire***, and ***other varieties of*** Al_2O_3 — are of great significance for the production of bearing stones for precise instruments and jewellery.

Sources

There are no deposits of ***corundum*** and ***emery*** in Poland.

Production

Neither ***emery*** nor ***natural corundum*** has been produced in Poland. Until 2000, ***ordinary electrocorundum*** (brown fused alumina — ***BFA***, obtained from calcined bauxite) and ***high quality electrocorundum*** (white fused alumina — ***WFA***, obtained from alumina) were produced at the **Saint-Gobain Abrasives** in **Koło** (previously: **Korund Grinding Materials Factory**). Recently ***electrocorundum*** has not been manufactured in Poland, although its production at a level of 3,000–4,000 tpy in the years 2009-2013 has been reported by the **Central Statistical Office** (Tab. 1). It probably concerned imported semi-finished products, crushed and screened by the **Polmineral** of Aleksandrów Łódzki, and then sold as electrocorundum.

Tab. 1. Natural and artificial corundum statistics in Poland

Year	2009	2010	2011	2012	2013
Corundum and emery [t] **CN 2513 20**[1]					
Imports[2]	156	431	463	179	453
Exports[3]	89	138	35	184	168
Consumption[a]	67	293	428	-5	285
Electrocorundum [‘000 t] **CN 2818 10**					

Production	3.3	3.4	3.3	3.2	3.5
Imports	16.3	29.1	27.8	30.7	36.0
Exports	3.1	3.5	2.8	3.2	2.4
Consumption[a]	16.5	29.0	28.3	30.7	37.1

[1] corundum, emery, and garnet, crude and roughly trimmed

[2] amount was reduced by the probable garnets importation from India

[3] amount was reduced by the probable garnets re-exports to Russia

Source: ***The Central Statistical Office (GUS)***

Synthetic technical corundum stones and some ***synthetic corundum gems*** were occasionally produced at **Skawina** and other plants, but in negligible amounts.

Trade

Domestic demand for ***natural corundum*** and ***emery*** has been satisfied by imports. The level of importation of ***natural corundum*** and ***emery*** has varied between 156 and 463 tpy in the recent years (Tab. 1). The structure of imports has also been quite variable, with China, Turkey, and the United Arab Emirates as the main suppliers. On the contrary, some re-exports of these commodities were reported in the last years.

Imports of ***artificial corundum*** (***electrocorundum***) considerably increased, from 16,300 in 2009 to 36,000 tpy in 2013. Supplies were primarily of Chinese origin, with a smaller share of deliveries from Germany, Russia, Hungary, Austria and Slovenia (Tab. 2). The recent exportation of ***electrocorundum*** has varied between 2,400 and 3,500 tpy, being directed primarily to Germany and the Czech Republic (Tab. 3).

Tab. 2. Electrocorundum imports to Poland — CN 2818 10

'000 t

Year	2009	2010	2011	2012	2013
Imports	**16.3**	**29.1**	**27.8**	**30.7**	**36.0**
Austria	1.7	2.2	1.8	1.5	1.4
China	5.6	14.0	13.5	17.4	22.0
Czech Republic	0.3	0.4	0.2	0.0	0.1
Germany	2.3	2.9	3.2	3.6	2.9
Hungary	1.6	2.1	2.9	2.1	2.4
Russia	1.4	2.2	1.4	1.9	2.5
Slovenia	1.1	1.4	1.1	0.9	1.1
Ukraine	0.5	1.1	0.2	0.4	0.6
Others	1.8	2.8	3.5	2.9	3.6

Source: ***The Central Statistical Office (GUS)***

Until 2011 the trade balances in ***corundum*** and ***emery*** were negative. In 2012 and 2013 they had positive values despite relatively low volume of re-exports. This improvement was a result of very high unit prices of sold ***corundum*** and ***emery*** (probably higher

Tab. 3. Electrocorundum exports from Poland — CN 2818 10

'000 t

Year	2009	2010	2011	2012	2013
Exports	**3.1**	**3.5**	**2.8**	**3.2**	**2.4**
Czech Republic	1.4	1.3	0.8	1.1	0.8
Germany	1.4	1.5	1.6	1.3	0.9
Others	0.3	0.7	0.4	0.8	0.7

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Value of corundum and emery, and electrocorundum trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Corundum and emery CN 2513 20					
Exports[1]	133	139	61	1,741	1,838
Imports[2]	337	580	627	430	944
Balance	**-204**	**-441**	**-566**	**+1,311**	**+894**
Electrocorundum CN 2818 10					
Exports	5,084	5,478	3,752	4,721	4,030
Imports	70,064	104,296	111,066	121,798	132,589
Balance	**-64,980**	**-98,818**	**-107,314**	**-117,077**	**-128,559**

[1] value of exports was reduced by the probable garnets re-exportation to Russia

[2] value of imports was reduced by the probable garnets importation from India

Source: ***The Central Statistical Office (GUS)***

processed product were exported). The trade balance in ***electrocorundum*** has been consistently negative. The deficit increased from ca. 65 to 129 million PLN as a result of significant growth of imports (Tab. 4). The unit values of imported ***natural corundum*** and ***emery*** fluctuated between 443 USD/t and 734 USD/t in the years 2009-2013 (Tab. 5). The unit values of imported ***electrocorundum*** were much higher (1,1722–1,404 USD/t) due to substantial share in imports of expensive European grades, as well as relatively high prices of Chinese grades (due to antidumping procedure of the European Union). The average unit values of electrocorundum exports varied between 449 USD/t and 537 USD/t in the years 2009–2013 (Tab. 5).

Consumption

Corundum, ***emery***, and ***electrocorundum*** are utilized for manufacturing of the ***abrasive materials*** formed into ***grinding wheels*** and as ***abrasive blasting medium***. The total consumption of these two sectors has ranged from 10,000 to 30,000 tpy. The domestic production of ***abrasive materials***, primarily in the plants of **Saint-Gobain Abrasives** in **Koło**, **Andre Abrasives Articles** in **Koło**, and **Grinding Stick Factory** in **Grodzisk Mazowiecki**, has shown strongly increasing tendency in recent years.

Tab. 5. Average unit values of natural corundum and emery, and electrocorundum trade in Poland

Year	2009	2010	2011	2012	2013
Natural corundum and emery CN 2513 20					
Average imports unit values					
— PLN/t	2,159.7	1,345.2	1,355.7	2,406.7	2,085.2
— USD/t	695.1	443.3	464.0	733.9	662.0
Electrocorundum CN 2818 10					
Average imports unit values					
— PLN/t	4,304.1	3,588.5	3,996.7	3,965.6	3,687.6
— USD/t	1,403.5	1,188.8	1,375.9	1,209.0	1,171.9
Average exports unit values					
— PLN/t	1,618.1	1,533.4	1,352.7	1,469.4	1,686.0
— USD/t	528.0	518.8	462.3	448.8	536.7

Source: ***The Central Statistical Office (GUS)***

Moreover, ***electrocorundum*** is also used in the production of ***corundum refractories***, manufactured at the **Vesuvius Skawina** and **PCO Żarów** refractory factories (a few thousand tons per year). Small amounts of ***electrocorundum*** (***corundum***) ***molding sand*** are also used in foundries.

DIATOMITE AND RELATED MATERIALS

Overview

Diatomite and **diatomaceous earth** constitute a group of sedimentary rocks which contain ***opal*** (amorphous SiO_2) as the main mineral. These comprise mainly opal skeletons of ***diatoms*** and to a lesser extent those of other micro-organisms, e.g. ***radiolaria***. **Diatomaceous earth** is a loose, soft, and very porous rock. The various types of diatomaceous earth have different trade names, e.g. ***kieselguhr***, ***tripoli***, etc. **Diatomite** is a compact rock, the product of the partial recrystalization of opal, which results in increasingly less porosity. ***Moler*** — a variety of diatomite, containing up to 25% of clay — have also economic importance.

The applications of **diatomite** and **diatomaceous earth** are determined by their properties, including their characteristic porosity, absorbency, low thermal conductivity, heat resistance, and chemical neutrality. They are used as filtering agents and sorbents, carriers e.g. of catalysts and crop protection products, filling agents, thermal insulators, polishing agents, etc. The raw materials are usually characterized by a volume density of 0.3–0.9 g/cm^3, a porosity of over 60%, and a SiO_2 content of over 75% (often over 85%).

Siliceous earth is related silica raw material of minor importance. It is a product of chemical weathering of limestone-silica rock. It is used in some applications as a substitute for lower grades of diatomaceous earth and diatomite.

Other siliceous sedimentary rock is **grinding shale** (a variety of **mudstone**). The main constituent of that rock is ***quartz*** grains smaller than 0.005 mm, with admixtures of mica, hydromica, feldspar, etc. Due to considerable quantity of alkaline compounds (K_2O+Na_2O approx. 6%) and its low melting temperature, this shale is suitable for the glass-making and ceramic industries. The excellent grinding properties of this shale make it an ideal material for whetstones and other grinding tools used to grind copper shafts, print on fabrics, polish terrazzo, and grind other artificial stones based on Portland cement, as well as to machine lithographic stone.

Sources

Poland has no deposits of ***diatomite*** or ***diatomaceous earth***. A deposit of ***diatomite rock*** has been recognized in the eastern part of the Carpathian Mountains, at **Leszczawka**. This is not typical diatomite, because of its relatively low silica content (average 72%, rarely over 75% SiO_2), high volume density (average 1.42 g/cm^3), and rather low porosity (maximum 50%, average 28.5%). The total resources of four deposits in the **Leszczawka** area amounted to 10,019,000 t (as of 31 December 2013). Perspective resources of diatomite rock in the Leszczawka vicinity, in the **Borek Nowy** area (approx. 20 km to the west from Leszczawka), and in other areas, are estimated at ca. 100 Mt.

Deposits of ***siliceous earth*** are also known in Poland. In the Świętokrzyskie Mountains there are three abandoned deposits, while in the Lublin Plateau - one abandoned and one extracted deposit. The total resources of these five deposits were estimated at 2,223,000 t (as of 31 December 2013). The raw material in **Piotrowice** deposit contains 87% SiO_2 and 6.7% Al_2O_3+Fe_2O_3, with volume density 0.29 g/cm^3, which make it suitable for the chemical industry. The siliceous earth from other deposits, due to low quality, might be utilized exclusively in the production of insulation materials.

Grinding shale occurs in the ***hard coal*** deposit at the closed **Gliwice Hard Coal Mine**. Its inferred resources amounted to 123,000 t, but the attempt to extract this shale was failed.

Production

The **Górtech Specialized Mining Enterprise** of **Cracow** is currently the only domestic producer of diatomite rock. It has been operating the **Jawornik Ruski** mine since 1992. The mineral output is processed in a small plant, with a production capacity of 6,000 tpy, into ***2–5 mm*** and ***0.5–3 mm granulates*** for sorbents, as well as ***0–0.5 mm*** and ***0–1.0 mm dusts*** for insulation materials. Due to low quality of these products, the total production of **Górtech** has been very low: 500–700 tpy in recent years (Tab. 1). The extraction of the second deposit — **Leszczawka — pole Kuźmina** — operated by a local company **Alabaster Kańczuga**, was abandoned in 1998.

Tab. 1. Statistics of diatomite and related materials in Poland — CN 2512

'000 t

Year	2009	2010	2011	2012	2013
Production[1]	0.7	0.5	0.6	0.6	0.6
Imports	9.8	6.8	8.4	7.2	6.8
Exports	0.1	0.1	0.8	3.0	5.4
Consumption[a]	10.4	7.2	8.2	4.8	2.0

[1] production of diatomite rock

Source: ***The Central Statistical Office (GUS), producers' data***

Siliceous earth and ***grinding shale*** haven't been extracted in Poland. Exploitation of the **Piotrowice** ***siliceous earth*** deposit was abandoned in 1993, due to the poor quality of the rock and products (***insulation flour***). Moreover, in 2002 output of siliceous earth from small **Lechówka II** deposit was terminated.

Trade

The lack of high quality ***diatomite*** and ***diatomaceous earth*** has resulted in imports. The most prominent suppliers have been: Germany, Mexico, and the US, whereas deliveries from Denmark decreased considerably (Tab. 2). The level of imports has recently varied between 7,000 and 10,000 tpy. Exports of ***diatomite*** and ***diatomaceous earth*** were usually negligible, however in last two years it increased to 3,000–5,400 tpy (Tab. 1). The balance of trade in ***diatomite*** and ***diatomaceous earth*** has been constantly negative, varying from 10 to 13 million PLN (Tab. 3).

Tab. 2. Polish imports of diatomite and related materials, by country — CN 2512

'000 t

Year	2009	2010	2011	2012	2013
Imports[1]	**9.8**	**6.8**	**8.4**	**7.2**	**6.8**
Belgium	0.4	0.5	0.1	0.1	0.1
Czech Republic	0.0	0.3	0.3	0.3	0.1
Denmark	1.0	0.9	1.4	0.2	0.2
France	0.8	0.7	0.5	0.5	0.4
Germany	4.4	1.5	2.7	2.4	1.9
Mexico	2.1	1.6	0.6	1.2	1.6
Spain	0.4	0.5	0.6	0.8	0.8
USA	0.7	0.8	1.0	0.8	0.9
Others	0.0	0.0	1.2	0.9	0.8

[1] diatomaceous earth, diatomites, tripoli, moler, etc.

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Value of trade of diatomite and related materials in Poland — CN 2512

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	237	136	158	460	641
Imports	13,508	10,316	13,462	12,994	12,699
Balance	**-13,271**	**-10,180**	**-13,304**	**-12,534**	**-12,058**

Source: ***The Central Statistical Office (GUS)***

Unit values of imports of ***diatomite*** and ***related materials*** to Poland has varied between 440 and 590 USD/t as a result of changeable share of expensive ***diatomite*** from the US and Mexico (600–800 USD/t), cheaper Danish ***moler*** (300–400 USD/t), and German ***kieselghur*** (400–500 USD/t) in the imports structure (Tab. 4).

Tab. 4. Unit values of imports of diatomite and related materials to Poland — CN 2512

Year	2009	2010	2011	2012	2013
PLN/t	1,372.4	1,526.6	1,603.9	1,803.5	1,860.5
USD/t	439.2	502.3	549.3	549.2	590.2

Source: ***The Central Statistical Office (GUS)***

Grinding shale is imported incidentally from the Czech Republic, Germany, and other Western European countries (probably a few tpy), but quantitative information is not separately recorded by the **Central Statistical Office** (**GUS**).

Consumption

The precise structure of ***diatomite*** and ***diatomaceous earth*** consumption in Poland is difficult ascertain. In all likelihood the higher quality grades have been imported for filtering and purification of liquids in the chemical industry, and for the filtration of beer, wine, etc. Danish ***moler*** has been used for insulation materials production.

The ***diatomite-like products*** offered by **SPG Górtech** have a wide range of application, such as: ***granulate* —** in removal of petroleum residues from water, pesticide carriers, and bedding for domestic animals; ***dusts* —** for the production of thermalite brick and other heat and noise insulating materials, for polishing glass, and as a cleaning agent. The current low domestic demand for diatomite products is caused by a lack of knowledge regarding their possible applications. Domestic diatomite products are considered to be primarily absorbents of petroleum pollutants, used for emergency purification of surface waters in the event of cistern leaks or spillage.

Previously obtained ***siliceous earth*** was used primarily for insulation materials production.

Grinding shale is used to manufacture whetstones and other grinding tools. Detailed information is not available.

Companies involved in diatomite rock and related minerals production in Poland as of December 2013

- Specjalistyczne Przedsiębiorstwo Górnicze Górtech w Krakowie, Wydział Produktów Diatomitowych w Jaworniku Ruskim (Górtech Specialized Mining Enterprise of Cracow, Diatomite Products Unit in Jawornik Ruski), Jawornik Ruski, 37–751 Żohatyn, tel./fax +48 16 6725050, www.gortech.pl — *diatomite-like granulate and dust.*

DOLOMITE

Overview

The main constituent of **dolomite** — more correctly, **dolomite rock** — is mineral ***dolomite***, i.e. $CaMg[CO_3]_2$. Dolomites are sedimentary (**primary dolomite**) or metasomatic rocks (**secondary dolomite**). Under high pressures dolomite re-crystallizes into **dolomitic marbles**. Various transient forms are also common: **limestone dolomite** and **dolomitic limestone** (**dolostone**), which are intermediate forms between dolomite and limestone rocks, as well as **dolomitic clay** and **dolomitic marl**, intermediate forms between dolomite and clay.

Dolomite is more compact than limestone and more resistant to the influence of climatic and mechanical conditions. That is why it is used as **crushed stone**. Dolomite is also used in many other branches of industry, agriculture, and public utilities, for which reason **industrial dolomites** are distinguished from the previous types. The following grades are known: ***smelter*** (***blast furnace fluxes***), ***refractory***, ***ceramic*** and ***glass***, ***chemical***, and ***dolomites for agriculture*** (***dolomite fertilizers***), for water treatment, and as a nutrient.

Sources

Poland has a wealth of ***dolomite*** deposits, which are generally divided into two groups:

- ***Industrial dolomites for smelters***, the ***refractory*** industry, and ***ceramics***. As of 31 December, 2013, the resources of 12 deposits amounted to 334.5 Mt. These deposits are located mainly in the **Silesia-Cracow** region (11 deposits, including 3 in operation), and one deposit - in the **Lower Silesia** (**Rędziny**, in operation). Except for one deposit of dolomite for the ceramic industry (**Rędziny**), the raw material of remaining deposits is suitable for the production of smelter and refractory grades;
- ***Dolomites*** and ***dolomitic marbles for crushed stone production*** (classified as crushed and dimension stones deposits). As of December 31, 2013, the total resources of 48 deposits of ***dolomites*** (excluding dolomitic marbles) amounted to 1,106.1 Mt. These occur primarily in the **Silesia-Cracow** region (total of 18 deposits) and the **Świętokrzyskie Mountains** (total of 23 deposits). In the **Lower Silesia**, 12 deposits of ***dolomitic marbles*** occurring south-east of **Kłodzko** are counted as deposits of crushed and dimension stones, despite the quality of some of them is sufficient for the production of ***ceramic*** and ***glass grades***. Their total resources are 381.8 Mt.

Another source of dolomite is Triassic ***ore-bearing dolomite*** from ***Zn-Pb ores*** deposits in the **Silesia-Cracow** region, a by-product of ore processing.

Production

There are a lot of plants, which extract dolomite deposits, but their structure of production is much diversified. The majority of them do not generate wastes, because fine fraction is used for the production of Ca-Mg fertilizers. The total mining output of ***dolomite rock*** rose to ca. 16 Mt in 2011, with reduction to 13-14 Mtpy in the next two years (Tab. 1). Official production of ***dolomite raw materials*** (i.e. some industrial grades of dolomite) achieved the level of ca. 2.1 Mtpy in 2007-8, with distinct reduction to ca. 1.8 Mtpy in subsequent years (Tab. 1). The structure of ***industrial dolomite*** has been dominated by ***dolomite rock***. ***Dolomite grits*** and ***dolomite flours*** have been of minor importance.

Tab. 1. Dolomite[1] statistics in Poland — CN 2518 10

'000 t

Year	2009	2010	2011	2012	2013
Mining output	**12,721**	**12,183**	**16,065**	**13,194**	**13,956**
— Dolomitic marbles	732	731	808	821	841
— Dolomite	11,989	11,452	15,257	12,373	13,115
• *Małopolskie voivodeship*	*2,216*	*2,389*	*3,300*	*2,753*	*2,861*
• *Śląskie voivodeship*	*5,068*	*4,122*	*4,839*	*3,837*	*3,762*
• *Świętokrzyskie voivodeship*	*4,705*	*4,941*	*7,118*	*5,783*	*6,492*
Production	**1,749.6**	**1,727.3**	**1,795.0**	**1,762.7**	**1,864.5**
Imports	**140.0**	**133.2**	**98.2**	**132.7**	**117.0**
Exports	**31.8**	**36.4**	**35.7**	**33.7**	**35.4**
Consumption[a]	**1,857.8**	**1,824.1**	**1,857.5**	**1,861.7**	**1,946.1**

[1] excluding dead-burned dolomite

Source: ***The Central Statistical Office (GUS), Mineral Resources Datafile, producers' data***

The ***smelter*** and ***refractory grades of dolomite*** have been produced almost entirely by the only one Upper Silesian plant, i.e. the **Mining Dolomite Works** (**GZD**) in **Siewierz**, exploiting the **Brudzowice** deposit. This company has offered several grades of ***raw dolomite rock***, used as a fluxing agent at smelters and for the production of refractories (50–70% of the total production), as well as ***dolomite crushed aggregates*** (20–40%). ***Ca-Mg carbonate fertilizers*** have been produced from mining and processing wastes (ca. 10%). The GZD's total production has varied between 1.1 and 1.8 Mtpy in recent years, with decreasing share of industrial dolomite rock. The **Żelatowa Dolomite Mining and Roasting Plant** in **Chrzanów** was previously the second producer of industrial dolomite. Recently, this company has been providing 0.5–0.8 Mtpy of ***dolomite products***, but with only 15–25% of ***raw dolomite rock*** offered mainly as ***metallurgical*** and ***refractory grades***, 50–70% of ***dolomite crushed aggregates***, and 10–20% of ***Ca-Mg carbonate fertilizers***. The production of ***dead burned dolomite*** was ceased in 2003. Recently, ***metallurgical*** and ***refractory grades of dolomite*** have been also delivered also by other dolomite mines of Silesia-Cracow region, extracting deposits of ***dolomite for crushed aggregates production***, e.g. **Dolomit Ltd. Libiąż**, **Dolomit Dąbrowa Górnicza**, and **Promag Ltd. Żelisławice**.

Suppliers of ***dead burned dolomite*** for the refractory and ***calcined dolomite*** for the steel industry have based their production primarily on ***Siewierz metallurgical dolomite***. There are mainly: **ArcelorMittal Refractories** of **Cracow** (only ***dead burned dolomite***), **ZW Lhoist** (Sabinów Production Unit in Częstochowa), and **Chemokor Dąbrowa Górnicza**. In 2013 the production of ***dead burned dolomite*** amounted to 50,500 t, while of ***calcined dolomite*** — to only 350 t. Since 2009 the total production of ***dead burned*** and ***calcined dolomite*** has varied between around 51 and 94 to 50,800 tpy, showing a declining tendency (Tab. 2).

Tab. 2. Dead-burned dolomite statistics in Poland — CN 2518 20

'000 t

Year	2009	2010	2011	2012	2013
Production	84.4	93.5	84.6	67.3	50.8
Imports	0.9	1.9	4.8	7.0	4.5
Exports	0.2	0.3	0.4	6.6	7.9
Consumption[a]	85.1	95.1	89.0	67.7	47.4

Source: ***The Central Statistical Office (GUS)***

The production of ***dolomite flour for the ceramic and glass-making industries***, as well as of ***dolomite flour for paints, plastics, and rubber industry***, has been based on the purest rocks (***dolomitic marble***) mined at **Ołdrzychowice** and **Rędziny** (the Lower Silesia). The **Rędziny** mine, operated by **Jelenia Góra Mineral Mines**, has provided 190,000–220,000 tpy of ***dolomitic marble***. In the nearby **Pisarzowice** processing plant, as well as in another **Jarnołtówek** plant, the company has produced 100,000–150,000 tpy of ***dolomite flour*** (***grade 1***, ***1S***, ***2***), as well as significant amounts of ***Ca-Mg carbonate fertilizers***. The output of ***dolomitic marble*** from the **Ołdrzychowice-Romanowo** deposit (extracted by **Omya Warszawa**, former **Kambud** of **Ołdrzychowice**) in recent years has risen significantly to almost 600,000 tpy. The plant has delivered the highest quality ***grits***, as well as small amounts of ***dolomite flour of 2*** and ***2S grade***. In the **Jasice** processing plant near Ożarów (Świętokrzyskie voivodeship), the same company has manufactured ***dolomite flour of 1*** and ***1S grade***. The remaining part of ***dolomite grits*** has been sold for the production of ***terrazzo***, as well as to other processors, producing dolomite flour for the glass, ceramic, and chemical industries. ***Dolomitic marble*** from the nearby **Nowy Waliszów C** deposit has been irregularly extracted by **Omya**, being mainly used for the production of ***dolomite flour***. The total production of ***dolomite flours*** in Poland has amounted to over 400,000 tpy in recent years. The majority of them has been used in the glass industry (coarse grades), while minor part as filler in the other industries (very fine grades).

Dolomites for road building and ***construction*** have been extracted from over 20 deposits, located only in the Silesia-Cracow and Świętokrzyskie Mountains regions. Their total output has achieved a level of 11-13 Mtpy, only in 2011 exceeding 15 Mt (Tab. 1). The share of ***fertilizers*** in the production of these mines usually amounted to 10–20%, whereas ***aggregates*** accounted for 80–90%. Currently, the ***dolomite aggregates*** and ***fertilizers*** manufacturers in the **Silesia-Cracow** region have been: **Tribag** of **Siewierz**, the **Dolomit Dąbrowa Górnicza**, the **Road Materials Quarries** of **Rudawa** near Cracow (**Lafarge Group**), **Promag** of **Żelisławice**, **Dolomit** of **Libiąż**, **PRInż**

Surowce of **Katowice**, **Kopalnia Imielin** of **Imielin,** the **Mineral and Light Aggregates Production Plant** of **Katowice**, as well as the above mentioned **Mining Dolomite Works** (**GZD**) in **Siewierz**, and the **Żelatowa Dolomite Mining and Roasting Plant** in **Chrzanów** (the total output of 5-6 Mtpy of dolomite aggregates). Moreover, ***dolomite aggregates*** have been produced on the basis of ***ore-bearing dolomite*** from ***Zn-Pb ores*** deposits in the **Silesia-Cracow** region, where ***washed dolomite*** has bee obtained as a by-product of ore processing. Such aggregates have been currently manufactured only by **Boloil** of **Bukowno** near Olkusz on the basis of dolomite waste rock from the **Bolesław Mining and Smelting Plant** (0.5–0.7 Mtpy).

In the Świętokrzyskie Mountains, ***dolomite aggregates*** and ***Ca-Mg fertilizers*** have been delivered by four larger producers: the **Dolomite Quarries** of **Sandomierz**, **Lafarge Kruszywa** of **Warsaw**, the **Minerals Mines** of **Kielce**, and **Kamieniołomy Świętokrzyskie** of **Kielce**, and a few smaller mines (total amount 4-6 Mtpy of dolomite aggregates).

Trade

Both the production volume and product assortments of ***dolomite commodities*** satisfy the domestic demand, except for ***top quality flours***: coarse grades for glass-making and ceramics, as well as fine grades used as fillers for the production of plastics, paints, etc. These grades have been imported mainly from Slovakia and Estonia (cheap grades), as well as from Norway, the Czech Republic, Sweden, Germany and others (higher quality grades). A deficit of such flours on the domestic market resulted in a sharp increase in imports to 140,000 t in 2009, with strong drop to lesss than 100,000 t in 2011 and some recovery in the next two years (Tab. 3). The exportation of dolomite flours has been also reported, but it has not exceeded 40,000 tpy (Tab. 1). They have been sold mostly to Ukraine and Belarus.

Tab. 3. Polish imports of dolomite flour, by country — CN 2518 10

‘000 t

Year	2009	2010	2011	2012	2013
Imports	**140.0**	**133.2**	**98.2**	**132.7**	**117.0**
Czech Republic	13.1	10.0	3.6	-	-
Estonia	16.7	4.2	3.0	-	-
Germany	2.9	1.5	0.5	0.3	0.3
Norway	5.4	5.5	4.6	9.7	9.0
Slovakia	97.8	109.6	86.0	121.7	106.5
Sweden	3.7	1.9	0.0	0.0	0.0
Others	0.4	0.5	0.5	1.0	1.2

Source: ***The Central Statistical Office (GUS)***

Other dolomite products, mainly ***dead burned dolomite***, have been both imported and exported. In recent years they have risen to a few thousand tpy (Tab. 2).

In 2009-2011 the ***dolomite*** trade balances were negative, ranging from -11 to -3 million PLN/y. Recently, trade balances have turned positive due to lower imports of cheaper dolomite flour grades, as well as higher exports of more expensive dolomite flour grades and dead-burned dolomite (Tab. 4). The average unit values of ***dolomite***

flour imports declined from around 52 USD/t in 2009 to with to ca. 30 USD/t in 2012 with some recovery to 35 USD/t in 2013 (Tab. 5), while ***dolomite flour*** exports unit values rose to almost 100 USD/t. Unit values of the production of ***dead burned and calcined dolomite*** after reduction to ca. 90 USD/t rose to 110-135 USD/t (Tab. 5).

Tab. 4. Value of dolomite trade in Poland — CN 2518

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	12,429	14,395	12,225	17,519	20,225
Imports	23,440	19,649	15,306	16,119	14,854
Balance	**-11,011**	**-5,254**	**-3,081**	**+1,400**	**+5,371**

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Average unit values of production and trade of dolomite commodities in Poland

Year	2009	2010	2011	2012	2013
Dolomite rock CN 2518 10					
Average production values					
— PLN/t	57.1	82.3	84.7	94.7	84.0
— USD/t	18.4	27.3	29.1	29.0	26.6
Dolomite flour CN 2518 10					
Average imports values					
— PLN/t	161.3	147.5	131.5	100.4	109.8
— USD/t	51.8	48.9	45.2	30.7	34.8
Dead-burned and calcined dolomite CN 2518 20					
Average production values					
— PLN/t	271.6	279.2	340.0[e]	363.6	420.0[e]
— USD/t	87.3	92.6	116.7[e]	111.2	135.0[e]

Source: ***The Central Statistical Office (GUS)***

Consumption

One of the basic consumers of dolomite has been the steelmaking industry, utilizing ***raw dolomite*** as a ***fluxing agent*** for blast furnace, open-hearth furnace, and converter operations. ***Dolomite*** from the **Siewierz** and **Żelatowa** mines has been mainly used for this purpose. Consumption of this sector in the last years varied between 500 and 1,000 ktpy, with maximum level reported in the years 2007-2008. The second large consumer is the refractory industry. Its importance has been continuously decreasing, to below 150,000 tpy in 2009-2012, and probably only ca. 100,000 t in 2013. Raw dolomite of DK, DM1, and DM2 grades have been used for the manufacture of ***dead burned*** (***sintered***) ***dolomite*** grades for this industry, being applied for ***dolomitic refractory***

mixes, ***refractory dolomite bricks***, ***magnesite-dolomite bricks***, ***dolomite-tar bricks***.

The glass-making and ceramic industries have consumed over 400,000 tpy of ***high purity dolomite flours*** with low contents of coloring oxides, particularly Fe_2O_3 and TiO_2 (max. 0.05–0.40% Fe_2O_3, depending on the grade). These have been destined for the production of float glass, as a 10–20% batch additive. In the ceramic industry, they have been applied as fluxing agents in glazes, porcelain, and faience mixes. Both the glass-making and ceramic industries have utilized ***dolomite flours*** of ***grades 1***, ***1S***, ***2*** and ***2S***, obtained currently from **Ołdrzychowice-Romanowo**, and **Rędziny** dolomitic marble deposits. However, some applications require ***extra pure dolomite flour*** (<0.05% Fe_2O_3), which need to be imported. ***Fine dolomite flours*** have been used as ***fillers*** for paints, emulsions, surface layers, plastics, etc., as well as ***agglomeration preventing agent*** for fertilizers (e.g. ammonium nitrate).

An important application of dolomite has been the production of ***Ca-Mg fertilizers*** that improve the pH balance of soils. However, as the subsidies to their purchase were abandoned in May 2004, the production has been significantly reduced. Other important dolomite product is ***feed grade dolomite*** for animals. ***Dolomite food supplements*** for humans (to compensate ***magnesium*** deficiency) are of marginal importance.

A considerable portion of dolomite has been applied for the production of a wide range of ***crushed aggregates***, used for road and railway building purposes, primarily in the close vicinity of quarries, i.e. in the Upper Silesia and the Cracow region, and in the Świętokrzyskie Mountains. ***Dolomite grits*** from dolomitic marble have been also utilised in the construction industry for ***terazzo flooring*** and ***plates***.

The estimated structure of dolomite consumption in Poland in 2013 was as follows: ***aggregates*** and ***fertilizers*** — 91%, ***flux for steelworks*** — 5%, ***glass*** and ***ceramics*** — 3%, ***refractories*** — <1%.

Principal companies involved in dolomite assortment production in Poland as of December 2013

- Górnicze Zakłady Dolomitowe S.A. w Siewierzu (Mining Dolomite Works Joint Stock Co. of Siewierz), ul. Bacholińska 11, 42–470 Siewierz, tel. +48 32 6744300, fax +48 32 6744305, www.gzd.com.pl — *raw dolomite for metallurgy and refractories, aggregates, fertilizers.*
- Kopalnia i Prażalnia Dolomitu Żelatowa S.A. w Chrzanowie (Żelatowa Dolomite Mining and Roasting Plant Joint Stock Co. of Chrzanów), 32–500 Chrzanów, ul. Borowcowa 125, tel. +48 32 6234275, fax +48 32 6234278, www.zelatowa.com.pl — *raw dolomite for metallurgy and refractories, aggregates, fertilizers*.
- ArcelorMittal Refractories Sp. z o.o. w Krakowie (ArcelorMittal Refractories Ltd. of Cracow), ul. Ujastek 1, 30–969 Kraków, tel. +48 12 6804800, fax +48 12 6802908, www.pmo-komex.pl — *dead burned dolomite*.
- Zakłady Wapiennicze Lhoist S.A., Wydział Produkcyjny Sabinów w Częstochowie (ZW Lhoist Joint Stock Co., Sabinów Production Unit of Częstochowa), ul. Żyzna 15, 42–200 Częstochowa, tel. +48 34 3699171, fax +48 34 3699167, www.lhoist.pl — *dead burned dolomite, calcined dolomite (dolomite lime)*.
- Chemokor Sp. z o.o. w Dąbrowie Górniczej (Chemokor Ltd. of Dąbrowa Górnicza), ul. Myśliwska 9, 41–303 Dąbrowa Górnicza, tel. +48 32 2601646, fax +48 32

2602002, www.chemokor.com.pl — *dead burned dolomite, calcined dolomite (dolomite lime)*.

- Jeleniogórskie Kopalnie Surowców Mineralnych w Szklarskiej Porębie (Jelenia Góra Minerals Mines of Szklarska Poręba), ul. B. Czecha 2, 58–580 Szklarska Poręba, tel. +48 75 7172001, fax +48 75 7172515, www.jksm.pl — *dolomite flour, Ca-Mg fertilizers*.
- Omya Sp. z o.o. w Warszawie (Omya Ltd. of Warszawa), ul. Krucza 16/22, 00–526 Warszawa, tel./fax +48 22 5258900, www.omya.pl — *dolomite flour, dolomite grits*.
- Przedsiębiorstwo Produkcyjno-Usługowo-Handlowe Dolomit S.A. w Dąbrowie Górniczej (Dolomit Production, Services and Trade Enterprise Joint Stock Co. of Dąbrowa Górnicza), ul. Dolomitowa 6, 42–520 Dąbrowa Górnicza, tel. +48 32 2623010, fax +48 32 2623013, www.dolomit.com.pl — *aggregates, Ca-Mg fertilizers, raw dolomite for metallurgy*.
- Kopalnie Odkrywkowe Surowców Drogowych w Rudawie S.A. (Road Materials Quarries Joint Stock Co. of Rudawa), ul. Legionów Polskich 105, 32–064 Rudawa, tel./fax +48 12 2838751, www.kosd-rudawa.pl — *aggregates, Ca-Mg fertilizers*.
- Przedsiębiorstwo Wielobranżowe Promag Sp z o.o. (Promag Multipurpose Enterprise Ltd.), ul. Podleśna, Żelisławice, 42–470 Siewierz, tel./fax +48 32 6741830, www.promagpw.pl — *aggregates, Ca-Mg fertilizers, raw dolomite for metallurgy and refractories*.
- Tribag Sp. z o.o. w Siewierzu (Tribag Ltd. of Siewierz), ul. Przemysłowa 2, 42–470 Siewierz, tel. +48 32 2676056, fax +48 32 2676057, www.tribag.pl — *aggregates, Ca-Mg fertilizers*.
- Przedsiębiorstwo Produkcyjno-Usługowe Dolomit Sp. z o.o. w Krakowie, Kopalnia Dolomitu w Libiążu (Dolomit Production and Services Enterprise Ltd. of Kraków, Dolomite Quarry of Libiąż), ul. Kamienna 9, 32–590 Libiąż, tel./fax +48 32 6277273, www.dolomitlibiaz.pl — *aggregates, Ca-Mg fertilizers, dimension dolomite, dolomite pitcher, raw dolomite for metallurgy.*
- Boloil S.A. w Bukownie (Boloil Joint Stock Co. of Bukowno), ul. Kolejowa 37, 32–332 Bukowno, tel.+48 32 2955708, fax +48 32 2955745, www.boloil.com.pl — *aggregates.*
- Lafarge Kruszywa i Beton Sp. z o.o., Kopalnia Dolomitu w Radkowicach (Lafarge Kruszywa and Beton Ltd., Dolomite Mine in Radkowice), 26–026 Morawica, tel./fax +48 41 3117571, www.lafarge-kruszywa.pl — *aggregates, Ca-Mg fertilizers*.
- Kopalnie Dolomitu S.A. w Sandomierzu (Dolomite Quarries Joint Stock Co. of Sandomierz), ul. Błonie 8, 27–600 Sandomierz, tel./fax +48 15 8323036, www.kopalnie-dolomitu.pl — *aggregates, Ca-Mg fertilizers*.
- Kieleckie Kopalnie Surowców Mineralnych S.A. w Kielcach (Minerals Mines of Kielce Joint Stock Co.), ul. Ściegiennego 5, 25–033 Kielce, tel. +48 41 3612711, fax +48 41 3613249, www.kksm.com.pl — *aggregates, Ca-Mg fertilizers*.
- Kamieniołomy Świętokrzyskie Sp. z o.o. w Sandomierzu (Kamieniołomy Świętokrzyskie Ltd. of Sandomierz), ul. Błonie 8, 27–600 Sandomierz, tel. +48 15 8611662, fax +48 15 8320662, www.kruszywa-mineralne.pl — *aggregates, Ca-Mg fertilizers*.

FELDSPAR

Overview

The **feldspars** are the commonest of the rock forming minerals in the earth's crust (up to 60% of the igneous rocks mineral composition). There are two series: the **alkali feldspars** which have compositions between $KAlSi_3O_8$ (***orthoclase/microcline***) and $NaAlSi_3O_8$ (***albite***), and the **plagioclase feldspars** which lie between $NaAlSi_3O_8$ (***albite***) and $Ca_2Al_2Si_2O_8$ (***anorthite***). Pure ***feldspar rocks***, such as ***K-feldspar*** (which is distinguished from other feldspars by its high potash content) are very rare. As a source of alkalis are also utilized ***quartz-feldspar rocks*** that occur much more frequently. The most important varieties of these rocks are leucogranite, leucoporphyry, aplite, and nepheline syenite.

Feldspar raw materials consist of feldspar, along with feldspar-quartz and quartz-feldspar mixtures containing over 8% K_2O+Na_2O. They are used mainly in the ceramics and glass-making industries, and in the manufacturing of paints, plastics, and rubber.

Sources

At the end of 2013 domestic resource base consisted of 10 deposits of ***feldspar-quartz*** and ***quartz-feldspar rock*** located in the Lower Silesia region and in the vicinity of Cracow. Their total resources amounted to around 137.5 Mt. There were two deposits of feldspar-quartz rock operated, i.e. the **Pagórki Wschodnie** and **Stary Łom**, both near Sobótka (***leucogranite***). An important source for feldspar recovery were also Lower Silesian deposits of granitoids, e.g. **Pagórki Zachodnie**, **Strzeblów I**, **Graniczna**, **Rogoźnica II**, **Gniewków**, **Kośmin**, and **Czernica** among others.

Production

The production of ***feldspar-quartz*** raw materials in Poland, which achieved around 540,000 t in 2011, after a 10% reduction in 2012, improved in 2013 exceeding 510,000 t (Tab. 1). It was a result of variability in demand from principal end-users, i.e. ceramic tile producers. The largest domestic producer of feldspar-quartz raw materials, supplying 380,000-450,000 tpy (over 80% of the total domestic production) is the **Strzeblowskie Mineral Mines** (**SKSM**) of **Sobótka**, with the production capacities approaching 500,000 tpy. The company extracted ***feldspar-quartz rock*** from the following deposits: **Pagórki Wschodnie**, **Pagórki Zachodnie**, **Strzeblów I** (since 2007), and **Stary Łom** (since 2011). The raw material has been processed into ***feldspar-quartz grits*** (98-99% of sales) and ***powders***, which were basically utilized in the ceramic and glass-making industries.

Tab. 1. Feldspar minerals statistics in Poland — CN 2529 10, 2529 30

'000 t

Year	2009	2010	2011	2012	2013
Mining output[1]	445.5	513.7	550.0[e]	376.5	690.6
Production	478.0	485.1	538.8	487.2	513.0
including feldspar-quartz from granite processing	*69.3*	*72.3*	*83.3*	*61.7*	*60.3*
Imports[2]	276.7	324.1	412.4	364.3	374.5
Exports[2]	9.2	8.4	10.5	8.6	9.1
Consumption[a]	745.5	800.8	940.7	841.9	878.4

[1] the output of the Pagórki Wschodnie, Pagórki Zachodnie, Karpniki (until 2010), Strzeblów I (since 2007), and Stary Łom (since 2011) deposits

[2] feldspar and nepheline syenite

Source: ***The Central Statistical Office (GUS), producers' data***

Until 2010 another producer of feldspar raw materials was **Pol-Skal** of **Cracow** operating **Karpniki** deposit. Its output achieved 100,000 t in 2008, but in 2009-2010 the company's sales of ceramic grades of ***feldspar-quartz grits*** (0–8, 1-8, 0-2 mm) were reduced from maximum level of 100,000 tons in 2008 to 65,000 and 30,000 t in 2009-2010, respectively. In the mid-2010 the Pol-Skal indefinitely suspended mining activity due to the opposition of local community.

Since the mid-1990s, fine-grained fractions generated in course of the production of crushed aggregates at the Lower Silesian granite quarries have been utilized as a source of feldspar-quartz raw materials in the ceramic industry. Despite high content of Fe_2O_3, these cheap alkali-rich products have been utilized in the manufacturing of glazed stoneware and clinker tiles. The largest supplier of these materials (22,000-34,000 tpy in recent years) have been the **Wrocławskie Mineral Mines – WKSM** (since 2010 **Eurovia Kruszywa**). The company has offered basically ***granite sand*** 0–2 mm which has been successfully utilized in the ceramic industry for the production of gres porcellanato tiles and biscuit, as well as for the manufacturing of clinker tiles and red ceramics goods. Fine-grained material (usually 0–5 mm size) has been also sold to the ceramic industry by other producers of crushed aggregates and building stones in the Lower Silesia, e.g.: **Gniewków Mine**, **Rogoźnica II Granite Mine**, **Kośmin Syenite (Granodioryte) Mine**, and **Czernica Granite Mine**. Total domestic consumption of these feldspar-quartz by-products in the ceramic industry (which is not recorded in the official statistics) has been estimated at 60,000-80,000 tpy.

Relatively small amounts (5,000-10,000 tpy) of ***feldspar powders*** have been also offered by the **Jeleniogórskie Mineral Mines** of **Szklarska Poręba.** These products are appropriated basically for the glass-making industry.

Trade

The importation of feldspar commodities to Poland reached its top level of 412,000 t in 2011. That was the result of record deliveries of feldspar from Turkey and nepheline syenite from Norway (Tab. 2). In subsequent two years it remained at the level of 360,000-370,000 tpy, which was higher than in 2009-2010. There were imported

feldspar grit and ***powder*** of the highest quality for the porcelain industry, ***feldspar concentrate*** for high-purity glass production, and ***nepheline syenite*** for the glass and sanitaryware industries. The share of nepheline syenite in total deliveries ranged from 22 to 24% in the last couple of years. Large amounts of feldspar of relatively lower quality were also brought for the ceramic tiles industry (ca. 60% of the total) to supplement domestic supplies, which were insufficient to keep pace with expansion of this sector's demand, especially in respect to production of ***gres porcellanato*** tiles (with 40-50% of feldspar in the ceramic body composition). The principal deliveries of ***tile grades*** (usually sodium feldspars) has come from the Czech Republic and Turkey, and – until 2011 – from Norway. In 2013 from the Czech Republic originated around 36% of the total importation (mainly from **Lasselsberger**'s **Halamky** deposit, and **KMK Granit — Krasno** deposit), from Turkey (basically ***sodium feldspar*** of ceramic grade made by **Kaltun**, **Esan Eczacibasi**, **Cine Akmaden**, **Kalemaden**, and **Ermad**) – 37%, while from Norway — 24% (only ***nefeline syenite*** manufactured at **Stjernoy** island by **Sibelco Nordic**). Until 2011 there were also ***feldspar flotation concentrates*** imported from Norway, but in June 2011 the only facility in the global scale that separated potassic and sodic feldspar from pegmatite via flotation - **Lillesand** plant was closed. The reason were expensive processing costs and falling demand, notably in traditional cathode ray tube TV sets market. Regular deliveries of smaller quantities of feldspar commodities came also from France (**Imerys**) and Germany (**AKW Amberger Kaolinwerke/Quarzwerke Group**).

Tab. 2. Polish imports of feldspar commodities, by country

'000 t

Year	2009	2010	2011	2012	2013
Imports, total	**276.7**	**324.1**	**412.4**	**364.3**	**374.5**
Feldspar CN 2529 10	**194.3**	**244.9**	**316.0**	**285.0**	**283.9**
Czech Republic	93.7	90.0	120.5	136.2	136.4
Finland	0.4	1.0	1.8	1.5	1.6
France	9.5	6.3	6.2	6.2	0.3
Germany	2.4	4.5	3.1	3.5	4.8
Italy	6.5	3.9	0.3	–	0.1
Norway	10.6	13.8	8.8	0.0	0.0
Spain	–	–	1.5	4.4	2.2
Sweden	0.1	0.2	0.2	0.1	0.8
Turkey	71.1	125.0	173.5	133.0	137.7
Others	–	0.2	0.1	0.3	–
Nepheline syenite CN 2529 30	**82.4**	**79.2**	**96.4**	**79.3**	**90.6**
Norway	82.3	79.2	96.1	79.2	90.6
Others	0.1	0.0	0.3	0.1	0.0

Source: ***The Central Statistical Office (GUS)***

A small exportation of ***feldspar raw materials*** from Poland was also recorded, which ranged from 8,000 to 10,000 tpy in recent years (Tab. 1). The most regular recipients of these sales has been Ukraine, Belarus, and Hungary. Small amounts were also sold sporadically to the Czech Republic, Slovakia and other neighbouring countries. In 2013 almost 87% (in 2012 - 84%) of the exportation were made up by nepheline syenite, sold (re-exported) in large portion to Ukraine (probably to the **Cersanit's** foreign sanitaryware division in Kiev) and the Czech Republic.

The combined trade balance of feldspar commodities was always negative. In 2009-2010 it ranged from 64 to 67 million PLN/y, deepening to 95 million PLN in 2011 and 84-89 million PLN/y in the last two years, respectively, as a result of increased importation (Tab. 3).

Tab. 3. Value of feldspar commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Feldspar CN 2529 10					
Exports	928	1,609	1,753	887	778
Imports	35,462	41,220	61,992	56,629	55,719
Balance	**-34,534**	**-39,611**	**-60,239**	**-55,742**	**-54,941**
Nepheline syenite CN 2529 30					
Exports	4,648	4,500	6,192	6,454	7,085
Imports	33,958	31,663	40,961	34,290	41,057
Balance	**-29,310**	**-27,163**	**-34,769**	**-27,836**	**-33,972**

Source: ***The Central Statistical Office (GUS)***

The unit values of ***feldspar*** importation to Poland varied between 55 and 66 USD/t, i.e. 168 and 199 PLN/t (Tab. 4). The unit cost of deliveries from two principal suppliers, i.e. the Czech Republic and Turkey, were much lower as compared to the unit values of importation from other countries. In 2013 the value of the Czech's feldspar amounted to 56 USD/t, i.e. 177 PLN/t, while in the case of Turkish raw materials it was 64 USD/t, i.e. 200 PLN/t. The unit cost of Norwegian ***nepheline syenite*** importation were much higher, i.e. 131-143 USD/t, influencing the overall financial results of trade in feldspar commodities. The 2013 prices of feldspar-quartz grades sold by domestic producer **Strzeblów Mineral Mines** were incomparably lower, i.e. in the range of 40–110 PLN/t for ***grits*** and of 206-328 PLN/t for ***feldspar-quartz powder***.

Consumption

Consumption trends in the domestic market for ***feldspar***, ***feldspar-quartz*** and ***nepheline syenite*** are largerly defined by demand from primary end-users of ceramics and glass, i.e. the construction industry. In the ceramics, the alkalis in feldspar (basically potassium and sodium oxides) act as a flux, lowering the melting temperature of a mixture. In the glassmaking, alumina from feldspar prevent the glass crystallization, improves product hardness, durability, and resistance to chemical corrosion.

Tab. 4. The unit value of feldspar imports to Poland

Year	2009	2010	2011	2012	2013
Feldspar CN 2529 10					
PLN/t	182	168	196	199	196
USD/t	58	55	66	61	62
Nepheline syenite CN 2529 30					
PLN/t	412	400	425	433	453
USD/t	136	131	143	132	143

Source: ***The Central Statistical Office (GUS)***

The world economic recession of 2008-2009 resulted in noticeable declines in housing starts and commercial construction projects in Poland. This led to a slump in the consumption of feldspar in tile (especially of gres porcellanato type with 40-50% of feldspar in the ceramic batch) and porcelain pottery units used in sanitaryware, as well as to drop in demand for automotive and residential flat glass. After critical year 2009 the feldspar market recovered, increasing to 940,000 t in 2011 (Tab. 1). This was partly a result of the introduction of antidumping duties for the importation of tiles from China to the EU in 2011 (acc. to EC regulation N° 258/2011 from 26-32% imposed on suppliers listed in the regulation, up to 73% for other than those mentioned in that document), and better performance of the construction industry (new commercial buildings start-ups connected with organization of Euro 2012 football cup in Poland, increased repairs and renovation). The year 2012 brought a slowdown in the development of the construction sector, which led to contraction in demand for feldspar to 840,000 t. Last year it improved slightly (by nearly 5%), growing to around 880,000 t.

The tile sector has been the largest ***feldspar*** consumer, accounting for over 80% (by tonnage) of the total domestic demand. In recent couple of years Poland has become the fourth tile producer in Europe - after Italy, Turkey, and Spain. Large-scale investments in new production facilities and technologies in that branch resulted in the expansion of its total capacities to 120-140 Mm^2py (including over 60 Mm^2py of gres porcellanato), 70% of which fell on two giants: **Cersanit** (**Rovese Group**) and **Ceramika Paradyż**. The remaining 20% of the total feldspar consumption has gone into the manufacture of the following products: glass, including glass containers and glass fiber — 10%, sanitaryware — 5%, tableware and electrical porcelain, semi-vitreous China-ware, faience — ca. 3%, chemicals, enamels, abrasives, refractories, etc. — ca. 2%.

Companies involved in feldspar commodities production in Poland as of December 2013

- Strzeblowskie Kopalnie Surowców Mineralnych Sp. z o.o. w Sobótce (Strzeblów Mineral Mines of Sobótka), ul. Torowa 1, 55–051 Sobótka, tel. +48 71 3904211, fax +48 71 3904224, www.sksm.pl — *ceramic and glass grade feldspar-quartz grits and powders.*

- Jeleniogórskie Kopalnie Surowców Mineralnych S.A. (Jelenia Góra Mineral Mines), ul. Bronka Czecha 2, 58–580 Szklarska Poręba, tel. +48 75 7172001, fax +48 75 7172515, www.jksm.pl — *glass grade feldspar powders.*
- Eurovia Kruszywa S.A. (Eurovia Aggregates), ul. Powstańców Śląskich 5, 53–332 Wrocław, tel. +48 71 3351002, tel./fax +48 71 3351061, www.eurovia.pl — *quartz-feldspar sand and powder.*

FERROALLOYS

Overview

Ferroalloys are defined as iron alloys that contain one or more alloy metals. They are made in smelters from ores and concentrates and in specialized electrometallurgical plants affiliated with mines, e.g. nickel alloys made of siliceous and latheritic ores, known as ***nickel matte*** and ***ferronickel*** (Ni yields of 93–95% from the ore). ***Specular pig iron*** (***Spiegeleisen***) rich in manganese, ***carbon ferromanganese*** containing 6–8% C, and ***ferrosilicon*** containing 10–15% Si are melted in iron blast furnaces. Most alloys are produced by electrothermal methods in electric furnaces. These include: ***ferroaluminum***; low-, medium-, and high-carbon ***ferrochromium***, containing 60% Cr (minimum 55% Cr); ***ferromanganese*** in several grades; ***ferromolybdenum***, with 50–60% Mo; ***ferronickel***; ***ferroniobium***, and ***ferrotantalum***; ***ferrophosphorus***; ***ferrosilicon*** in various grades, depending on the Si content (from 20 to 92% Si); ***ferrosilicoaluminum*** in several grades, containing 25–60% Si and 10–50% Al; ***ferrosilicochromium***; ***ferrosilicomanganese***; ***ferrosilicotitanium***; ***ferrosilicocalcium***; ***ferrosilicotungsten***; ***ferrotungsten***; ***ferrozirconium***, containing 18–55% Zr; and ***nitrided ferroalloys***, which contain purposefully introduced nitrogen.

Ferroalloys are used to produce alloyed steel, cast iron, and cast steel, as well as other alloys. They serve to introduce alloy additives into fused steel or cast iron, and also act as modifiers, and as deoxidizing and de-nitriding agents. They are used for technical reasons (easier fusing with the base metal) and also for economic reasons: the cost of obtaining a metal additive in the form of a ferroalloy, e.g. ferrotungsten, is considerably lower than the cost of pure metal production.

Sources

Imported ores and concentrates are the main sources for the production of ferroalloys in Poland (see: **CHROMIUM**; **MANGANESE**). The exceptions are ***ferrosilicon*** and ***ferrosilicomanganese***, where silicon originates partly from the **Bukowa Góra** ***quartzite*** deposit, and in past also from the **Stanisław** ***quartz*** deposit.

Production

High grades of ferroalloys, such as ***ferrosilicomanganese***, ***ferrosilicon*** (mainly 75%), and in 2013 also ***ferrosilicochromium*** (high-carbon), have been produced at the **Łaziska Smelter** in electric furnaces (Tab. 1). Following weakened condition of the domestic steelmaking industry, as well as financial difficulties of the Łaziska Smelter, in 2009 the output was reduced to only 14,000 t. However, in 2010–2013 as a result of growing demand from the steelmaking industry, the production improved substantially, reaching 84,900 t. Moreover, from 2012 **Łaziska Smelter** is an enterprise in systemic bankruptcy, and in the years of 2012–2013 performed manufacturing services for **RE Alloys** in Łaziska Górne. Ferrosilicon remained its main product, while the production of ferrosilicomanganese has been significantly reduced. In 2013 there was started the production of high-carbon ***ferrosilicochromium*** from imported high-carbon ***ferrochromium***. In 2013 its output reached 10,100 t (Tab. 1).

Tab. 1. Ferroalloys statistics in Poland

'000 t

Year	2009	2010	2011	2012	2013
Ferroalloys, total					
Production	**15.7**	**54.3**	**74.2**	**79.3[r]**	**85.7**
Imports	**133.6**	**128.4**	**146.0**	**128.0**	**187.4**
Exports	**38.7**	**77.4**	**86.5**	**83.2**	**143.4**
Consumption[a]	**110.6**	**105.3**	**133.7**	**124.1[r]**	**129.7**
Ferroalloys from blast furnace					
Production	1.7	0.8	0.8	0.8	0.8
• *ferromanganese* **CN 7202 11**	*1.7*	*0.8*	*0.8*	*0.8*	*0.8*
Imports	27.3	25.5	33.0	25.2	38.0
Exports	1.5	1.8	0.8	1.2	11.4
Consumption[a]	27.5	24.5	33.0	24.8	27.4
Ferroalloys from electric furnace					
Production	14.0	53.5	73.4	78.5[r]	84.9
• *ferrosilicomanganese* **CN 7202 30**	*0.0*	*0.1*	*0.4*	*0.1[r]*	*0.1*
• *ferrosilicon* **CN 7202 21–29**	*9.7*	*53.2*	*72.7*	*78.1[r]*	*73.6*
ferrosilicochromium **CN 7202 50**	–	–	–	–	*10.1*
• *other* **CN 7202x**	*4.2*	*0.2*	*0.3*	*0.3*	*1.1*
Imports	106.3	102.9	113.0	102.8	149.4
Exports	37.2	75.6	85.7	82.0	132.0
Consumption[a]	83.1	80.8	100.7	99.3[r]	102.3

Source: ***The Central Statistical Office (GUS)***

Stalmag in **Ruda Śląska** has been the sole producer of ***blast furnace ferromanganese*** (high carbon ferromanganese) in Poland. In 2009-2010, due to the slowdown in the Polish steelmaking industry and economic problems of the above mentioned producer, the production declined to only 762 t in 2010. The output remained almost unchanged in subsequent three years (Tab. 1), in spite of growing demand from the steelmaking industry. The domestic FeMn production volume in the last five years has been significantly lower in comparison to 2004 when it amounted to almost 47,000 t.

Trade

The domestic demand for ***ferroalloys***, especially those not produced in Poland, has been satisfied by imports. In the years 2009–2013 it came mainly from Ukraine, Norway, Slovakia, Russia, Germany, and Kazakhstan. In recent years the importation of ***ferromanganese*** from blast furnace has been dominated by deliveries from Norway, the Republic of South Africa and Germany, while the role of France – the former large supplier – has been reduced (Tab. 2). In the years 2009–2013 imports of FeMn from blast furnace ranged from 25 to 38 ktpy, while imports of ferroalloys from electric furnace were ca. three times higher in recent years. The highest importation was recorded in 2013 and the lowest - appeared in 2010 and 2012 (Tab. 2).

Tab. 2. Polish imports of ferroalloys, by country

'000 t

Year	2009	2010	2011	2012	2013
Ferroalloys from blast furnace	**27.3**	**25.5**	**33.0**	**25.2**	**38.0**
Ferromanganese CN 7202 11	**27.3**	**25.5**	**33.0**	**25.2**	**38.0**
Austria	0.4	–	–	–	–
Belgium	–	–	–	0.1	0.0
Brazil	–	–	–	1.2	–
China	0.0	–	0.0	0.0	0.0
Czech Republic	1.1	0.4	0.3	0.0	0.6
France	0.3	0.2	0.0	1.8	7.9
Germany	0.8	2.1	0.9	0.8	0.1
India	0.4	0.2	0.0	0.3	0.2
Netherlands	0.3	0.9	0.3	0.1	0.1
Norway	15.1	13.6	17.7	11.4	18.8
Russia	0.2	0.5	0.8	0.9	0
Slovakia	1.7	1.7	0.2	0.0	0.2
South Africa, Republic of	3.2	2.4	6.8	5.1	9.4
Spain	0.1	0.0	0.1	–	–
Ukraine	3.3	3.3	5.6	3.1	0.5
Others	0.4	0.2	0.3	0.3	0.2
Ferroalloys from electric furnace	**106.3**	**102.9**	**113.0**	**102.8**	**149.4**
Ferromanganese CN 7202 19	**3.6**	**5.8**	**11.1**	**5.8**	**26.4**
Brazil	0.0	–	–	–	–
China	0.1	0.0	–	0.0	0.1
Czech Republic	–	–	–	–	0.3
France	0.0	–	0	0.0	0.2
Germany	0.1	0.4	0.3	0.4	0.2
India	–	–	–	–	0.0

Norway	3.1	5.2	1.7	3.9	21.1
Slovakia	–	–	–	0.1	4.1
South Africa, Republic of	0.0	0.0	8.7	1.0	0.1
Sweden	0.2	–	–	0.0	0.0
Turkey	0.0	0.1	0.2	0.0	0.1
Ukraine	0.0	0.0	0.1	0.1	–
Others	0.1	0.1	0.1	0.2	0.2
Ferrosilicon CN 7202 21–29	**15.9**	**21.9**	**18.7**	**15.5**	**22.9**
Argentina	–	–	0.4	0.5	0.4
Belgium	0.2	0.1	0.1	–	–
Brazil	0.5	1.8	0.5	0.3	0.5
Bulgaria	0.3	0.1	0.0	0.0	0.0
China	0.3	0.1	0.1	0.0	0.1
Czech Republic	2.0	2.1	1.6	0.9	0.4
France	0.1	0.1	0.2	0.4	0.5
Germany	2.2	3.7	3.8	3.4	3.5
Iceland	0.4	0.4	0.2	–	2.9
India	1.1	1.1	1.0	0.7	0.1
Italy	0.1	0.1	0.2	0.4	0.4
Luxembourg	1.5	0.3	0.4	1.5	0.8
Macedonia	0.2	0.2	0.1	0.7	0.6
Netherlands	0.5	0.4	0.6	0.0	0.4
Norway	1.4	2.3	2.7	3.2	5.5
Russia	0.9	0.4	0.3	–	0.0
Slovakia	1.4	3.0	2.0	1.8	2.9
Slovenia	0.1	0.1	0.1	0.4	0.4
Spain	0.1	–	–	–	0.0
South Africa, Republic of	0.0	–	0.0	–	1.1
Ukraine	2.2	5.3	3.9	1.1	1.8
United Kingdom	0.1	0.2	0.1	–	0.0
USA	–	–	–	0.0	0.2
Others	0.3	0.1	0.4	0.1	0.3
Ferrosilicomanganese CN 7202 30	**73.0**	**56.8**	**65.5**	**60.6**	**71.3**
Bahrain	–	0.1	–	–	0.1
Brazil	–	–	–	0.5	0.0
China	0.8	0.3	0.0	–	–
Czech Republic	2.6	2.4	0.1	1.1	1.5
France	0.4	0.0	–	0.0	0.0
Germany	1.4	1.6	0.0	–	0.0
India	0.8	0.1	0.2	0.1	1.3

Italy	–	–	–	0.1	0.0
Kazakhstan	0.1	2.5	2.4	2.2	1.3
Netherlands	0.1	0.8	0.6	0.6	0.0
Norway	17.4	14.6	15.6	17.6	27.6
Saudi Arabia	0.1	1.1	0.5	0.0	0.0
Slovakia	5.5	1.1	0.1	7.6	3.9
South Africa, Republic of	1.0	1.1	9.3	2.0	0.8
Ukraine	42.1	30.5	36.2	28.4	32.3
United Kingdom	0.0	0.1	0.2	0.0	2.0
Others	0.7	0.5	0.2	0.4	0.4
Ferrochromium CN 7202 41–49	**5.7**	**7.9**	**7.7**	**9.4**	**19.3**
Albania	–	–	–	–	0.6
Brazil	0.0	–	0.3	0.3	0.2
China	0.2	0.3	0.1	0.1	0.0
Czech Republic	0.5	1.0	1.3	0.9	0.9
Germany	0.1	0.1	0.1	2.0	4.3
India	0.7	0.5	1.8	0.5	0.2
Kazakhstan	0.5	0.9	1.4	1.3	0.4
Luxembourg	0.0	0.0	–	–	–
Netherlands	0.1	0.1	0.2	0.2	0.0
Russia	1.7	2.6	1.7	3.4	5.2
Slovakia	0.1	0.4	0.1	0.0	–
South Africa, Republic of	1.7	0.6	0.2	0.3	0.9
Sweden	0.0	0.0	0.0	0.0	0.8
Switzerland	0.0	–	–	0.1	–
Turkey	0.1	0.4	0.1	0.1	4.7
United Kingdom	0.0	–	0.1	0.1	0.7
Zimbabwe	–	0.6	0.0	–	–
Others	0.0	0.3	0.2	0.1	0.4
Ferrosilicochromium CN 7202 50	**0.1**	**0.5**	**0.0**	**0.1**	–
Ferronickel CN 7202 60	**0.0**	**0.0**	**0.0**	**0.2**	**0.1**
Ferromolybdenum CN 7202 70	**0.7**	**0.6**	**0.4**	**1.0**	**1.3**
Ferrotungsten and ferrosilicotungsten CN 7202 80	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Ferrotitanium and ferrosilicotitanium CN 7202 91	**0.1**	**0.2**	**0.2**	**0.3**	**0.3**

Ferrovanadium CN 7202 92	**0.3**	**0.4**	**0.2**	**0.5**	**0.6**
Ferroniobium CN 7202 93	**0.2**	**0.4**	**0.2**	**0.4**	**0.3**
Ferrophosphorus CN 7202 99 10	**0.6**	**0.9**	**1.2**	**1.0**	**0.9**
Ferrosilicomagnesium CN 7202 99 30	**2.6**	**3.4**	**1.9**	**1.7**	**1.3**
Other ferroalloys CN 7202 99 80	**3.3**	**4.1**	**5.9**	**6.3**	**4.7**

Source: ***The Central Statistical Office (GUS)***

In recent years exports of ferroalloys have been very unstable, reflecting economic condition of the domestic steelmaking industry. As usual, ***ferrosilicon***, ***ferrosilicomanganese***, and ***ferromanganese*** from blast furnace have had the main share in exports volume, and the main recipients have been Germany and other European Union countries (Tab. 3).

Tab. 3. Polish exports of ferroalloys, by country

'000 t

Year	2009	2010	2011	2012	2013
Ferroalloys from blast furnace	**1.5**	**1.8**	**0.8**	**1.2**	**11.4**
Ferromanganese CN 7202 11	**1.5**	**1.8**	**0.8**	**1.2**	**11.4**
Czech Republic	0.6	0.7	0.3	0.6	6.4
Germany	–	0.6	0.1	0.1	0.9
Romania	–	–	–	0.1	0.5
Slovakia	0.7	0.2	0.1	0.0	2.6
Slovenia	0.1	0.1	–	–	0
Ukraine	–	–	0.2	0.2	0.5
Others	0.1	0.2	0.1	0.1	0.5
Ferroalloys from electric furnace	**37.2**	**75.6**	**85.7**	**82.0**	**132.0**
Ferromanganese CN 7202 19	**0.9**	**0.8**	**0.8**	**0.8**	**14.7**
Czech Republic	0.0	0.0	–	0.0	6.4
Bulgaria	0.0	0.0	0.1	0.1	–
Hungary	0.4	0.4	0.4	0.4	0.9
Indonesia	0.2	0.3	0.2	0.2	0
Italy	0.1	–	–	–	–
Romania	0.0	–	0.0	–	1.7
Russia	0.1	0.1	0.1	–	0
Slovakia	–	–	–	–	5.2
Others	0.0	0.0	0.0	0.1	0.5

Ferrosilicon CN 7202 21–29	**16.2**	**63.4**	**76.0**	**72.1**	**82.5**
Austria	0.9	3.1	4.1	6.4	10.3
Belarus	0.0	0.0	0.1	0.1	0.1
Belgium	–	9.3	18.9	1.4	3.2
Bulgaria	0.0	0.0	0.0	0.0	0.1
Croatia	–	–	–	–	0.2
Czech Republic	5.1	11.1	17.1	16.8	11.6
Finland	1.5	0.8	1.2	0.2	0.2
France	–	1.2	0.1	0.8	2.2
Germany	4.2	25.0	22.5	26.8	38.6
Greece	–	–	–	0.3	–
Hungary	0.1	0.4	0.6	1.5	0.3
Indonesia	0.0	0.1	0.0	0.1	0.1
Italy	0.8	1.9	1.6	8.1	6.8
Montenegro	–	–	–	0.1	0.2
Netherlands	0.0	1.3	0.0	–	0.2
Romania	0.2	1.4	0.7	1.1	0.3
Russia	0.1	0.2	0.1	–	0.1
Slovakia	0.9	1.8	1.8	2.2	2.0
Slovenia	0.9	2.5	3.1	2.9	2.5
Spain	–	–	0.7	0.2	–
Sweden	1.4	2.9	3.1	2.2	2.6
United Kingdom	–	0.1	0.0	0.4	0.4
Others	0.1	0.3	0.3	0.5	0.5
Ferrosilicomanganese CN 7202 30	**18.3**	**7.4**	**1.7**	**3.7**	**18.1**
Belgium	–	0.2	–	–	–
Croatia	–	–	–	0.0	0.7
Czech Republic	6.7	2.8	0.5	1.7	11.7
France	1.4	–	–	–	–
Germany	8.3	2.3	0.6	1.6	3.6
Hungary	0.1	0.1	0.0	0.1	0.3
Luxembourg	0.3	1.2	–	–	–
Netherlands	0.1	0.1	–	–	–
Romania	0.0	–	0.2	0.0	1.6
Slovakia	1.1	0.4	0.0	–	–
Slovenia	0.2	0.2	0.3	0.1	–
Others	0.1	0.1	0.1	0.1	0.2
Ferrochromium CN 7202 41–49	**0.4**	**0.7**	**0.3**	**0.5**	**0.7**
Austria	–	–	–	–	0.1

Bosnia and Herzegovina	0.1	0.0	0.0	–	–
Czech Republic	0.1	0.0	0.0	0.0	0.0
Hungary	–	0.0	–	0.0	0.0
Lithuania	–	0.0	–	–	0.1
Netherlands	–	–	–	–	0.0
Slovakia	0.1	0.4	0.0	0.0	0.0
Romania	0.0	0.1	0.0	0.1	0.2
Ukraine	0.0	0.2	0.1	0.4	0.2
Others	0.1	0.0	0.1	0.0	0.0
Other ferroalloys[1]	**1.4**	**3.3**	**6.9**	**4.9**	**16.0**

[1] in 2009, ***FeNi***, ***FeMo***, ***FeTi*** and ***FeSiTi***, ***FeV***, ***FeNb***, ***FeP***, ***FeSiMg***, and others,
in 2010, ***FeSiCr***, ***FeNi, FeMo***, ***FeW*** and ***FeSiW***, ***FeTi*** and ***FeSiTi***, ***FeV***, ***FeNb***, ***FeP***, ***FeSiMg*** and others,
in 2011, ***FeMo***, ***FeW*** and ***FeSiW***, ***FeTi*** and ***FeSiTi***, ***FeV***, ***FeNb***, ***FeP***, ***FeSiMg***, and others,
in 2012, ***FeNi, FeMo***, ***FeW*** and ***FeSiW***, ***FeTi*** and ***FeSiTi***, ***FeV***, ***FeNb***, ***FeP***, ***FeSiMg***, and others,
in 2013, ***FeSiCr***, ***FeNi, FeMo***, ***FeW*** and ***FeSiW***, ***FeTi*** and ***FeSiTi***, ***FeV***, ***FeNb***, ***FeP***, ***FeSiMg***, and others,

Source: ***The Central Statistical Office (GUS)***

The trade balance in ***ferroalloys***, except for 2011 and 2013, was traditionally negative and in 2009 amounted to the record 477 million PLN, while in the years 2010–2012 due to significant increase in exportation, the negative value of ferroalloys trade improved. In 2011 and 2013 they turned positive and amounted to almost 12 and 5.5 million PLN/y, respectively (Tabs. 1, 4).

Tab. 4. Value of ferroalloys trade in Poland — CN 7202

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	177,218	513,125	725,721	631,587	885,682
Imports	564,549	683,640	713,821	681,244	880,171
Balance	**-477,331**	**-170,515**	**+11,900**	**-49,657**	**+5,511**

Source: ***The Central Statistical Office (GUS)***

Consumption

Ferroalloys produced in Poland, as well as those imported, have been almost entirely consumed in the domestic steelmaking industry. The demand is expected to rise significantly, because of the anticipated increase in the alloyed steel production in Poland.

Companies involved in ferroalloys production in Poland, as of December 2013

- Huta Łaziska S.A. w Łaziskach Górnych (Łaziska Smelter Joint Stock Co. of Łaziska Górne), ul. Cieszyńska 23, 43–170 Łaziska Górne, tel. +48 32 2241500, fax +48 32 2241523, www.hlsili.pl — *ferrosilicon and ferrosilicomanganese from electric furnace.*
- STALMAG Sp. z o.o. w Rudzie Śląskiej (STALMAG Ltd. of Ruda Śląska) ul. Hutnicza 2, 41–709 Ruda Śląska, tel. +48 32 7712801, fax +48 32 7712800, www.stalmag.pl — *ferromanganese from blast furnace.*

FLINT

Overview

Flints are silica concretion balls of spherical or oval shape, sometimes occurring as banks (up to 30 cm thick), usually among carbonate rocks of the Jurassic or Cretaceous ages. Due to their high resistance to erosion, they remain in coarse-grained deposits. The main constituents are minerals containing SiO_2: ***chalcedony***, ***autogenous quartz***, rarely ***opal***, with admixtures of carbonates, iron hydroxides, pyrite, etc. Flint stones of commercial significance contain over 96% SiO_2. Well-rounded flint stone balls, called **"shots,"** are used as **millstones** in rolling mills. Flint stone is also comminuted and classified to obtain **flint abrasives** utilised in the production of abrasive cloth and papers, known under the English name **flint**. **Striped flint stone** is commonly used to make some jewellery and stone fancy products.

Sources

Flint stone was one of the first rock types used by Man for the production of tools, beginning in the Paleolithic period. In the Neolithic age, flint stone was extracted in the vicinity of Tomaszów Mazowiecki, Inowłódz, Radom, Iłża, and Kraśnik, and on the largest scale - in **Krzemionki Opatowskie** underground mine in the vicinity of **Ostrowiec Świętokrzyski**, dated 3,500–1,600 BC, currently being a tourist attraction (the **Krzemionki Opatowskie Museum**).

The most important raw materials are ***flint stone balls*** occurring in Cretaceous limestone (e.g. **Karsy**, **Mielnik**, and **Kornica**), ***bank type flint*** near **Inowłódz**, and the so-called ***"horn flint,"*** e.g. **Leszczawa Górna**, **Krzeszowice**, and **Radom**. There are deposits in **Bocheniec** and **Tokarnia** (***striped flint stone***) with total resources of 28 kt (as of 31 December 2013).

Production

Currently, the ***flint stone*** deposits in Poland have not been extracted. However, some amounts of ***flint stone*** (a dozen tpy or so) have been irregularly recovered in the **Bełchatów Lignite Mine**. They have been used as millstones in the mills of some processing plants.

Collectors pick up ***striped flints*** in the **Świętokrzyskie Mountains** (a few hundred kilograms per year), recently mainly from **Śródborze** limestone quarry near Ożarów. Despite the press release that since May 2011 ***striped flints*** had been legally extracted from limestone deposit in Śródborze (with flint content ca. 0.1%, and the average weight of lumps of about 20 kilograms), the mining output has not begun.

Trade

Flint millstones have been mainly imported, but exact data are not available. Some amounts of ***flint abrasives*** have been also imported by small manufacturers of abrasive paper. Currently, the **Franspol** company of Warszawa has been the largest importer — ca. 1,000 tpy of the ***flint pebbles*** (grain size from 1 to 15 cm) and ***granulated flints*** (0.5–12mm) from France. ***Granulated flints***, useful as fillers, have been also offered by **Mercury Ltd.** of Żary.

Striped flints from Ożarów area have been exported to Germany and Austria for the production of jewellery.

Consumption

Flint millstones are used mainly as grinding media and mill-linings in mills for the comminution of ceramic materials, cosmetics and drugs, in order to avoid contamination with colouring metal oxides, particularly Fe_2O_3 and TiO_2. The ***granulates flints*** are used as fillers for paints and plasters production. There is no information on the consumption of ***flint abrasives*** in Poland.

The ***striped flint stone*** that collectors pick up is used to make fancy goods, e.g. ashtrays. For over 30 years, striped flint stone from Ożarów area in the Świętokrzyskie Mountains has been used for the production of jewellery. Recently, it has started to be very attractive jewellery stone, being introduced e.g. in the jewellery collection of the **W. Kruk** company.

FLUORITE

Overview

The most commonly used forms of **fluorine** (**F**) are **fluorite CaF_2** (**fluorspar**) and **hydrofluoric acid**, as well as its derivatives (fluorides, fluosilicates, etc.). In practice, the only primary raw material is **fluorite**, which occurs in various types of individual deposits, or as an accompanying mineral in deposits of ***barite***, ***Zn-Pb***, ***Pb***, and ***Ag ores***. To a limited extent, some fluorine compounds (e.g. **fluosilic acid**, **sodium fluosilicate**) are recovered in course of ***phosphate*** and ***apatite*** processing. **Synthetic cryolite** is also produced by recycling in aluminum smelters.

Sources

There are no ***fluorite*** deposits of economic significance in Poland. The resources of ***fluorite*** were recognized in the deeper parts of the **Stanisławów** ***barite*** deposit. They have been evaluated at 542 kt (as of 31 December 2013).

Production

There is no domestic production of ***fluorite***. Small amounts of ***synthetic cryolite***, ca. 1,000–2,000 tpy, have been produced in course of processing of ***phosphates*** into ***phosphoric acid*** at **Siarkopol Tarnobrzeg Chemical Plants Ltd.** of **Tarnobrzeg**. Some ***fluorine compounds*** have been also produced by domestic chemical plants.

Trade

The demand for ***fluorite*** has been entirely covered by imports, which in the years 2011–2012 exceeded 11,000 tpy (Tab. 1). It has been bought mainly in Mexico (mostly ***metallurgical grade***, some amounts of ***ceramic grade***), Germany (mainly ***chemical grade***), and the Czech Republic (***chemical*** and ***ceramic grade***). In 2013 imports decreased by almost 30% to 8,100 t. Imports from Mexico was reduced, while deliveries from other suppliers increased, e.g. the Czech Republic, Spain and Pakistan. Until 2012 the share of ***chemical grade fluorite*** in the total imports was ca. 31%, while in 2013 it rose to ca. 54%. The main suppliers were Germany and the Czech Republic, the smaller ones - Mexico and China. Many fluorine compounds have been also imported, e.g. ***aluminum fluoride***, ***synthetic cryolite***, and ***hydrofluoric acid***. Due to liquidation of ***primary aluminum*** production at the **Konin Aluminum Smelter** of Konin (see: **ALUMINUM**) imports of ***aluminum fluoride*** decreased by over 2,000 tpy since 2009. Simultaneously, small amounts of ***synthetic cryolite*** were exported (Tab. 2).

Tab. 1. Polish imports of fluorite, by country — CN 2529 21,22

'000 t

Year	2009	2010	2011	2012	2013
Imports = Consumption[a]	**9.5**	**9.2**	**11.2**	**11.4**	**8.1**
• ***metallurgical and ceramic grade***	***5.8***	***6.3***	***7.8***	***7.9***	***3.7***
• ***chemical grade***	***3.7***	***2.9***	***3.4***	***3.5***	***4.4***
Czech Republic	0.3	0.8	0.4	0.6	1.2
Germany	4.2	3.4	3.5	4.3	4.2
Mexico	4.1	4.7	6.6	6.1	1.7
Pakistan	–	–	–	0.1	0.3
Spain	–	–	–	0.1	0.3
United Kingdom	0.9	0.2	0.5	0.0	0.3
Others	0.0	0.1	0.2	0.3[r]	0.4

Source: ***The Central Statistical Office (GUS)***

Tab. 2. The trade of fluorine commodities in Poland

t

Year	2009	2010	2011	2012	2013
Hydrofluoric acid CN 2811 11					
Imports	555	682	826	534	659
Exports	26	6	1	20	8
Aluminum fluoride CN 2826 12					
Imports	182	234	313	331	432
Exports	10	22	32	45	48
Synthetic cryolite CN 2826 30					
Imports	758	1,368	1,397	1,524	1,571
Exports	175	300	208	115	70

Source: ***The Central Statistical Office (GUS)***

The trade balances of ***fluorite*** and ***fluorine commodities*** have been constantly negative (Tab. 3), while their values correlated with imports volumes and unit values of imported commodities (Tab. 2 and 4).

Tab. 3. Value of fluorine commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Fluorite CN 2529 21,22					
Imports = **Balance**	**-8,723**	**-8,109**	**-10,660**	**-12,445**	**-11,479**

Hydrofluoric acid CN 2811 11					
Exports	40	51	11	132	60
Imports	2,358	3,564	4,009	2,746	2,962
Balance	**-2,318**	**-3,513**	**-3,998**	**-2,614**	**-2,902**
Aluminum fluoride CN 2826 12					
Exports	52	90	158	220	251
Imports	669	669	1,021	1,079	1,407
Balance	**-617**	**-579**	**-863**	**-859**	**-1,156**
Synthetic cryolite CN 2826 30					
Exports	589	969	704	514	314
Imports	2,411	2,911	3,272	3,822	3,182
Balance	**-1,822**	**-1,942**	**-2,568**	**-3,308**	**-2,868**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Average unit values of fluorine commodities trade in Poland

Year	2009	2010	2011	2012	2013
Fluorite CN 2529 21,22					
Imports unit values					
— PLN/t	919.1	877.1	950.9	1,088.3	1,425.9
— USD/t	296.2	291.8	324.4	332.5	453.8
Hydrofluoric acid CN 2811 11					
Imports unit values					
— PLN/t	4,246.5	5,225.4	4,855.4	5,141.5	4,495.3
— USD/t	1,371.8	1,742.5	1,642.6	1,576.0	1,433.1
Aluminum fluoride CN 2826 12					
Imports unit values					
— PLN/t	3,680.5	2,863.5	3,266.9	3,256.4	3,255.4
— USD/t	1,185.3	967.0	1,094.6	1,003.3	1,030.1
Synthetic cryolite CN 2826 30					
Exports unit values					
— PLN/t	3,370.8	3,235.9	3,384.2	4,452.2	4,494.5
— USD/t	1,091.7	1,058.3	1,173.5	1,361.6	1,427.4
Imports unit values					
— PLN/t	3,181.2	2,128.5	2,341.6	2,508.6	2,025.1
— USD/t	1,039.7	706.0	798.2	765.7	643.9

Source: ***The Central Statistical Office (GUS)***

Consumption

The main consumers of ***fluorspar*** and ***fluorine compounds*** in Poland have been: the steel-making, chemical, and glass-making industries, and glaze manufacturers. Until early 2009, also the **Konin Aluminum Smelter** was their important consumer. The detailed consumption structure of fluorite consumption in Poland is unknown.

If domestic sources of fluorine were more fully utilized, imports would be considerably reduced. After a closure of electrolysis unit in the **Konin Aluminum Smelter**, imported phosphates and apatites processed into phosphoric acid has remained the only possible source for recovery of ***fluorine compounds***.

Companies involved in fluorine compounds production in Poland as of December 2013

- Zakłady Chemiczne Siarkopol Tarnobrzeg Sp. z o.o. w Tarnobrzegu (Siarkopol Tarnobrzeg Chemical Plants Ltd. of Tarnobrzeg), ul. Zakładowa 50, 39–402 Tarnobrzeg 4, tel. +48 15 8555710, fax. +48 15 8229797, +48 15 8227208, www.zchsiarkopol.pl — *synthetic cryolite*.

GALLIUM

Overview

Over 90% of **gallium** (**Ga**) is recovered as **primary gallium** during the complex electrolysis of so-called ***red slime*** — waste material from ***bauxite*** processing into ***alumina***. The remainder is obtained by the chemical method from ***zinc dust*** from smelters.

Gallium has been in wider use since the end of the 1950s, when digital watches and calculators were developed and popularized (**gallium arsenide GaAs** is used in LEDs). The growth of the gallium market is directly related to the extent of utilization of its arsenide, a substitute for silica in the semi-conductors and integrated circuits used in wireless and satellite communication.

Sources

The potentially available reserves of ***gallium*** in the as-yet-unmined **Silesia-Cracow *Zn-Pb ore*** deposits were estimated at 120 t Ga (as of 31 December 2008). In the years of 2009–2013 these reserves were not reported in the Polish Mineral Resources Datafile.

Production

Gallium is not presently recovered in Poland.

Trade

The entire demand for ***gallium*** has been satisfied by imports, mainly in ***gallium-bearing*** electronic products. In the years 2009–2013 imports of ***gallium*** in unprocessed form (**CN 8112 92 89**) fluctuated between 25–35 kgpy, except for 2012 when it reached 61 kg (Tab. 1). The main suppliers were Slovakia, the US, Germany, France and Sweden. Similarly, in the years 2009–2011 and in 2013 exports (re-exports) were at the level of 4–8 kg, and the sole purchaser was Belarus (in 2009-2011), and Russia (in 2013). In 2012 there were no re-exports of gallium from Poland (Tab. 1).

Tab. 1. Gallium statistics in Poland — CN 8112 92 89

kg

Year	2009	2010	2011	2012	2013
Imports	25	35	34	61	31
Exports	8	4	7	–	5
Consumption[a]	17	31	27	61	26

Source: ***The Central Statistical Office (GUS)***

Moreover, there were recorded imports of ***gallium***, ***indium*** and ***vanadium products*** (**CN 8112 99 70**) to Poland. In 2009 the deliveries amounted to 115 kg, with Japan and the US as the main suppliers. In 2010 they decreased to 86 kg and main imports sources were Japan, the US, Russia, and Germany. In 2011 imports soared up to 2,115 kg, with Germany and China as the main deliverers, while in 2012 they dropped to 1,847 kg, and the main supplier was Germany, but in 2013 increased up to 3,066 kg with Germany as the main supplier again. Exports of ***gallium***, ***indium*** and ***vanadium products*** in 2009 amounted to 526 kg, with Japan as the main recipient, in 2010 they dropped to only 6 kg, the majority of which went to the USA. In the years 2011–2012 they soared even more than imports, to 2,475 kg, with Belgium and Germany as the main recipients, while in 2012 the sales reached a record of 4,786 kg and were directed to China, Laos and Germany. Moreover, in 2012 the unit value of exports was five times lower than imports, but in 2011 both unit values were comparable. In 2013 exports amounted to only 1 kg and was directed to the USA.

Consumption

There are no reliable data on the structure of ***gallium*** consumption in Poland available.

GARNET

Overview

Garnets occur in magmatic and metamorphic rocks, and form concentrations in deposits of ***beach*** and ***alluvial sand***, ***glass sand***, ***foundry sand***, and ***natural aggregates***, from which they are separated. **Concentrates of garnets** (mainly of ***almandine*** and ***andradite***) are produced in various grain sizes; they are characterized by high hardness and density, and are resistant to chemical and physical erosion.

For centuries **garnets** were used as ***gemstones*** (see: **GEMS**). Since the mid-nineteenth century, they have been mainly applied in the tools and abrasives industries. The demand from these industries is continuously growing.

Sources

There are no deposits of ***garnets*** in Poland. Nevertheless, their occurrences have been found in many regions, e.g. in ***mica schists*** with ***garnets*** near **Gierczyn** in the **Izerskie Foothills**, containing 20–40% of ***almandine*** and ***andradite*** with grain sizes from 3 to 5 mm, locally even to 10 mm. The heavy fractions of **Słupsk Bank** ***aggregates*** contain fine grains of garnets, as do some ***beach sands*** (in the vicinity of Hel, Władysławowo, Łeba, and Darłowo). Garnets also occur in heavy fractions separated from ***glass sand*** and ***molding sands***. These may serve as sources for ***fine-grained garnets***, which are much less valuable.

Production

Due to the lack of deposits, there is no production of ***garnets*** in Poland. They are also not recovered from heavy fractions obtained during processing of other minerals.

Trade

Domestic demand has been covered exclusively by imports of both garnet grains (used as abrasive blasting medium and water-jet medium) and garnet abrasive tools. Over the analyzed period, the importation of ***garnets*** considerably increased, from ca. 4,000 in 2009 to above 10,000 tpy in 2013. They were reported together with ***corundum*** and ***emery*** in one CN item (see: **CORUNDUM AND EMERY**). The supplies has come from India and have been utilized e.g. by **JetSystem** and **Garnet Polska** from Elbląg. The growth of these deliveries has been connected with substitution of silica sand in some blast cleaning applications. In May 2004, according to EU regulations, due to health risk a ban for quartz sand use for blast cleaning was introduced in Poland. The unit values of imported garnets have ranged from 219 to 250 USD/t. Some amounts of ***garnets*** have been re-exported to Russia. These re-exports rose from 850 t in 2009 to 1,739 t in 2011, with the reduction to ca. 1,100 t in the years 2012–2013. The prices of the exported garnet has shown a generally decreasing tendency; they dropped from 336 USD/t in 2009 to 157 USD t in 2012, with slight improvement to 190 USD/t in 2013.

Consumption

Poland, together with Russia and the Czech Republic, is one of the European fastest growing markets for ***industrial garnets***. The increasing domestic consumption relates primarily to abrasive grains utilized in ***waterjet cutting technology*** of wide variety of materials. The important importer of garnet for this application is the **JetSystem** from Elbląd, consuming ***almandine*** in various grain sizes. Other relevant application of this mineral is ***sandblasting*** of steel constructions (blast cleaning), and the production of ***abrasive tools***. Small amounts of garnets are utilized as a ***filtration medium***.

GAS, NATURAL

Overview

Natural gas is the most important gaseous fuel in the world economy. It consists mainly of ***methane*** CH_4, accompanied by higher gaseous and liquid hydrocarbon compounds (***ethane***, ***propane***, ***butane***) and other gas components, especially ***carbon monoxide*** and ***carbon dioxide***, ***hydrogen sulfide***, ***nitrogen***, ***hydrogen***, ***helium***, and ***argon***. **Dry natural gas** is obtained from individual deposits, whereas **wet natural gas** — rich in higher liquid hydrocarbons — comes from ***gas/petroleum*** deposits, as well as from ***condensate*** deposits. **Methane gas**, similar to natural gas, occurs in ***hard coal*** deposits. Among the natural gas substitutes used in many countries for commercial and public utility purposes are **coke-oven gas**, obtained in coking plants, and the **town gas** produced in municipal gas works.

Before it is delivered to the users, **raw natural gas** must be treated to remove small particles of solid minerals, hydrocarbons other than methane, and excess nitrogen and helium; it must also be desulfurized (see: **NITROGEN**; **HELIUM**; **SULFUR**) and dried. ***Helium***, ***sulfur***, ***butane*** and ***propane***, ***liquid nitrogen***, and ***liquid***, easily evaporating ***gasoline*** are obtained as co-products. Gas is delivered by systems of pipelines connecting suppliers and consumers. **Liquefied natural gas** is also transported by ship, in special gas tankers, or by road in tank trucks, and then re-gasified.

Natural gas is a valuable and eco-friendly fuel directly consumed in many branches of industry and in households, and also used for the production of electrical power and many chemicals, as well as for fueling automobile engines.

Sources

In Poland ***natural gas*** terrestrial deposits occur in the **Polish Lowland** (71.2% of resources), in the **Carpathian Foredeep** (27.8%), and in the **Carpathian Mountains** (1.0%). The gas from the Lowland deposits is generally of poor quality (from under 20% to 85% methane), has high nitrogen and sulfur contents, and requires purification before utilization. Some of the deposits contain ***helium*** (see: **HELIUM**). Gas from the Carpathian Mountains and the Carpathian Foredeep contains much more methane (70–99%). The recoverable terrestrial resources of natural gas amounted to 127.0 Bm^3, with 57.1 Bm^3 of economic reserves occurring in 283 deposits (as of 31 December 2013). At the present extraction volume, these reserves will be sufficient for the next 23 years.

On the **Baltic Sea Shelf**, up till now two crude oil and natural gas deposits **B3** and **B8** have been recognized (see: **OIL, CRUDE**), as well as two natural gas and condensate deposits **B4** and **B6**. Natural gas from the Baltic Sea Shelf commonly contains 70–95%

of methane. The recoverable and economic reserves of natural gas amounted to 5.0 Bm^3 (as of 31 December 2013).

At the end of 2009, some international oil companies announced their interest in potential deposits of ***shale gas*** and ***tight gas*** in Poland. Up to the end of 2013, the Ministry of the Environment granted 96 prospecting licences for unconventional gas. In 2012 Polish Geological Institute reported estimated resources of ***shale gas*** in Lower Paleozoic shales in Bałtyk-Podlasie-Lublin Basin at max. ca. 1,920 Bm^3, but most probably between 346 and 768 Bm^3. Moreover, prognostic resources of natural gas in conventional deposits were estimated at ca. 1,727 Bm^3 (as of 31 December 2009).

The ***methane*** resources associated with ***hard coal*** deposits complement the total natural gas resources. Currently, the recoverable resources of very high quality methane gas in deposits of the **Upper Silesia Coal Basin** amounted to 85.4 Bm^3, including 6.9 Bm^3 of economic reserves, occurring in 53 deposits (as of 31 December 2013), while the perspective recoverable resources there were evaluated at approx. 107 Bm^3 (as of 31 December 2009).

In 1998 ***nitrogen gas*** deposits were recognized separately in the Polish Lowland. They contain from 91.0% to 97.6% of ***nitrogen*** and from 1.6% to 5.2% of ***methane***. Two deposits were evaluated: **Cychry** and **Sulęcin**. Their recoverable resources amounted to 14.8 Bm^3, and economic reserves - to 0.95 Bm^3 (as of 31 December 2013). Only Cychry deposit has been mined (the production of natural gas), while Sulęcin deposit is planned to be extracted to obtain liquid nitrogen.

Production

In the years 2009–2013 the mining production of ***natural gas*** ranged from 5,560 to 5,990 Mm^3py, including 1,630–1,680 Mm^3py of high-methane gas, 3,510–3,970 Mm^3py of nitrified gas from oil and gas deposits, and 298–393 Mm^3py of coal-bed methane (Tab. 1). Traditionally, over 99.5% of the production has come from terrestrial deposits. In 2013, commercial extraction and use of natural gas accompanying crude oil in B3 deposit (in the Polish part of Baltic Sea shelf), amounted to 20.9 Mm^3. At the end of 2008, the largest domestic producer the **Polish Oil and Gas Company** (**POGC**) announced new POGC Strategy until 2015. It assumes gradual increase of domestic natural gas output to ca. 4.5 Bm^3py (on high-methane basis). In 2013, this output amounted to ca. 4.5 Bm^3, including ca. 4.4 Bm^3 from POGC (on high-methane basis). There are also some possibilities for growth of the off-shore production of natural gas from the Baltic Sea Shelf deposits.

Nitrified natural gas has been extracted from nitrogen-rich deposits of the Polish Lowlands, the largest of which are **Brońsko**, **Kościan S**, **BMB**, **Żuchlów**, and **Radlin**. Gas has been extracted by the **POGC — Zielona Góra Unit**. In 2013, ca. 52% of raw nitrified gas output was directed to the **POGC — Odolanów Unit** (formerly Natural Gas Denitriding Plant “KRIO” in Odolanów) and new denitriding plant in **Grodzisk Wielkopolski** (part of the **POGC — Zielona Góra Unit**) for ***nitrogen*** removal. As a result, 1.4 Mm^3 of high-methane gas was obtained there (Tab. 1).

High-methane gas from oil and gas deposits comes mainly from the Carpathian Foredeep (dominated by the **Przemyśl** and **Zalesie** deposits), and marginally from the Carpathian Mountains and the Baltic Sea Shelf. In 2013, ca. 3% of its mining output was

Tab. 1. Natural gas and others fuel gas statistics in Poland

million m³

Year	2009	2010	2011	2012	2013
High-methane natural gas CN 2711 21					
Production	2,047	2,010	2,025	2,016	1,976
• *gas from oil and gas deposits*	*1,669*[e]	*1,634*	*1,632*	*1,631*	*1,678*
• *coal-bed methane*	*378*[e]	*376*	*393*	*385*	*298*
Imports	9,436	10,328	11,177	11,611	11,818
Exports	39	44	28	3	89
Stocks change	-308	-330	689	269	314
Consumption	11,752	12,624	12,486	13,355	13,391
• *gas from denitrification plants*	1,018	1,386	1,484	1,464	1,364
Consumption, total	12,770	14,010	13,970	14,819	14,755
Nitrified natural gas					
Production[1]	3,511	3,753	3,896	3,972[r]	3,907
Stocks change	9	50	105	38	23
Consumption	3,502	3,703	3,791	3,934[r]	3,883
• *gas from blending plants*	67	67	61	53	59
Consumption, total	3,569	3,770	3,852	3,987[r]	3,943
Coke-oven gas CN 2705					
Production = Consumption[a]	3,076	4,239	4,055	3,878	4,089

[1] from oil and gas deposits

Source: ***The Central Statistical Office (GUS)***

directed to blending plants, where 59 Mm³ of ***nitrified natural gas*** was obtained (Tab. 1). Gas has been extracted from the Carpathian Foredeep and Carpathian Mountains deposits by the **POGC — Sanok Unit**, while from the Baltic Sea Shelf deposit - by the **LOTOS Petrobaltic** (**LOTOS Capital Group**).

The recovery of ***methane*** from ***hard coal*** deposits has been conducted from 22 deposits in the Upper Silesia Coal Basin. Their total production (recovery) amounted to ca. 300 Mm³ in 2013 (Tab. 1). Exploration and extraction activities initiated by several Polish and foreign enterprises, which could improve coal-bed methane recovery, have been practically abandoned in recent years due to technical and commercial problems.

Trade[1]

In the years 2010 – 2013, imports of ***natural gas*** to Poland increased by 25%. Imports satisfied ca. 80% of the Polish demand for high-methane gas in 2013. Share of deliveries from Russia and Middle Asia (since 2010 also from Azerbaijan) decreased from ca. 90% to ca. 77% (Tab. 2).

[1] Data on geographic structure and value of natural gas trade in Poland collected by the **Central Statistical Office** has been kept secret.

Tab. 2. Polish imports of natural gas, by country — CN 2711 21

million m³

Year	2009	2010	2011	2012	2013
Imports	**9,436**	**10,328**	**11,177**	**11,611**	**11,818**
Czech Republic	0	0	0	556	553
Germany	1,028	1,077	1,628	1,794	2,150
Russia, The Middle Asia countries, Azerbaijan[1,2]	8,402	9,245	9,549	9,261	9,115
Ukraine	5	6	–	–	–

[1] including ***Yamal contract*** [2] Uzbekistan, Turkmenistan, since 2010 - also from Azerbaijan

Source: ***Ministry of the Economy, The Central Statistical Office (GUS), POGC***

Gas delivered on the basis of long-term Yamal contract, signed with Russia in 1996 and valid until 2022 (on the basis of *take-or-pay* rule, without possibilities of re-exports in the case of lower domestic consumption, but with possibility of reception in the next years) has remained the main source of natural gas in Poland. In 2009, there were significant disturbances in natural gas supplies from Russia to Poland. Due to conflict between Russia and Ukraine, gas deliveries from Middle Asia carried out by RosUkrEnergo AG company were blocked in Ukraine. As a result, new short-term contracts were signed with Russian Gazprom. There were talks on renegotiation of long-term Yamal contract, finished in October 2010. Re-exports of Yamal gas started to be possible. Increase in gas deliveries has been also assumed: in 2010 – 9.03 Bm^3, in 2011 – 9.78 Bm^3, in 2012-2022 – 10.25 Bm^{3}py, in the total - 131.56 Bm^3 (2010-2022). Some amounts of natural gas from European countries have been delivered through pipelines passing Germany and the Czech Republic (new connection in Cieszyn area) on the basis of smaller contracts. In December 2007 **POGC** decided on location and construction of LNG terminal in **Świnoujście** of initial capacity of ca. 2.5 Bm^{3}py. In 2009, POGC signed long-term contract for LNG deliveries from Qatar - 1 million tpy of LNG (1.4 Bm^{3}py) in the years 2014-2033.

The trade balance in ***natural gas*** has been consistently negative. Trade deficit has been supposedly rising, according to growth of world gas prices, but exact data are not available due to the so-called statistical secret. Probably trade deficit has recently ranged from 15 to 25 billion PLN/y.

Consumption, distribution, and storage

In the years 2010–2013 the consumption of ***high-methane gas*** increased by ca. 16%, to ca. 14.8 billion m^3, while consumption of ***nitrified gas*** increased by 10.5%, to 3.9 billion m^3 (Tab. 3). Over that period the total domestic ***natural gas*** consumption increased by 14.4%. The domestic structure of natural gas consumption in 2013 was dominated by the industry (63.8%), with 21.8% share of households. Agriculture, transportation and construction consumed together 3.3% of natural gas, while other users (trade, services, etc.) — 10.8%. In 2013, share of natural gas in the Poland's consumption of primary energy increased to ca. 14%, whereas in the world this percentage was ca. 23% and is still increasing.

Tab. 3. Structure of natural gas consumption in Poland — CN 2711 21

million m^3

Year	2009	2010	2011	2012	2013
High-methane gas					
Consumption, total	**12,770**	**14,010**	**13,970**	**14,819**	**14,755**
• direct consumption in households	3,510	3,926	3,590	3,704	3,765
• other direct consumption	7,556	8,301	8,694	9,030^r	9,191
• energy transformation	1,446	1,453	1,582	1,799^r	1,746
• balance losses and differences	258	330	104	286	53
Nitrified gas					
Consumption, total	**3,569**	**3,770**	**3,852**	**3,987^r**	**3,943**
• direct consumption in households	354	303	259	292	309
• other direct consumption	1,101	818	824	838^r	904
• energy transformation	2,121	2,730	2,874	2,856	2,726
• balance losses and differences	-7	-81	-105	1	3

Source: ***The Central Statistical Office (GUS)***

The main consumer of natural gas has been the industry. The main users have been manufacturers of nitrogen fertilizers, steel works, glass works and other metal processing industries, plants of building ceramics, as well as food and drinks producers — all of them consume natural gas as a fuel directly in the production process (62.7%), while in power and heating plants, natural gas denitrification and blending plants, refineries, gas is utilized in energy transformation processes (37.3%).

The second group of consumers consists of individuals using natural gas for household and home heating purposes. In 2013, household consumption increased again (Tab. 3).

Currently, direct consumption accounts for 75.8% of the total volume of gas used. The rest is transformed into other energy carriers, and covers various losses and differences in the balance (Tab. 3). In November 2009, the Polish government accepted "Energy Policy of Poland until 2030", which assumed that demand for natural gas should reach 14.1 billion m^{3}py in 2010 (calculated as high-methane gas), 15.4 billion m^{3}py in 2015, 17.1 billion m^{3}py in 2020, 19.0 billion m^{3}py in 2025, and 20.2 billion m^{3}py in 2030. Taking into account domestic mining output of natural gas (ca. 4.3 billion m^3 in 2009, calculated as high-methane gas) and POGC assumptions, it is expected that domestic natural gas production in the years 2010-2015 will amount to 4.3–4.8 billion m^{3}py (if ***shale gas*** production will not be commenced), while the rest of demand will be met by imports.

Other types of gas are also used as fuel in Poland. These include primarily ***coke-oven gas*** (calorific value of approx. 4,500 kcal/m^3), a by-product of the coking of coal (Tab. 1). ***Coke-oven gas*** still plays an important role in the Lower and Upper Silesia, but since 1996 it has been utilized locally, in plants located close to cokeries.

Seasonal variations in the demand for gas (approx. 20 Mm^3 per day in summer versus 48 Mm^3 per day in winter) results in buffering storage of gas during spring and summer. **POGC** controls six storages in exhausted natural gas deposits: **Wierzchowice** — being currently enlarged, **Husów**, **Strachocina**, **Swarzów**, **Brzeźnica**, **Daszewo** and **Bonikowo** (since 2010, storage of nitrified gas); as well as cavern storage at the **Mogilno II** ***salt*** deposit. At the end of 2013 their total capacity amounted to ca. 2.5 Bm^3, but works for their enlargement are still going on. In 2007, **DPV SERVICE** (subsidiary of EMFESZ NG Polska) started to construct commercial storage facility in the exhausted natural gas deposit — **Antonin**, with planned capacity ca. 200 Mm^3. Moreover, POGC has been constructed the new **Kosakowo** storage facility (cavern storage at the salt deposit), with planned capacity ca. 250 Mm^3.

Companies involved in the production of natural gas in Poland, as of December 2013

- Polskie Górnictwo Naftowe i Gazownictwo S.A. (Polish Oil and Gas Company Joint Stock Co.) — ul. Krucza 6/14, 00–537 Warszawa, tel. +48 22 5835000, fax +48 22 6918273; www.pgnig.pl — *natural gas.*
- LOTOS Petrobaltic S.A. (LOTOS Petrobaltic Joint Stock Co.) — ul. Stary Dwór 9, 80–958 Gdańsk, tel. +48 58 3013061–5, fax +48 58 3014311, www.lotos.pl — *natural gas.*
- FX Energy Poland Sp. z o.o. (FX Energy Poland Ltd.) — ul. Chałubińskiego 8, 00-613 Warszawa, tel. +48 22 8300074, fax +48 22 6306632; www.fxenergy.pl — *natural gas.*
- ZOK Sp. z o.o. (ZOK Ltd.) — ul. Boczna 24, 44335 Jastrzębie Zdrój, tel. +48 32 4760602, fax +48 32 4760601; www.zok.pl — *natural gas.*
- DPV Service Sp. z o.o. (DPV Service Ltd.) — Al. Ujazdowskie 41, 00-540 Warszawa, tel. +48 22 3195720, fax +48 22 3195721; www.dpvservice.pl — *natural gas.*

GASES, COMMERCIAL

Overview

Commercial gases are natural gases (air and its constituents) and synthetic gases used for commercial purposes. They are produced by the commercial gas industry, which is also involved in producing **medical gases**, **reference standard gases**, etc. The most important commercial gases are produced from atmospheric air, primarily **nitrogen** (see: **NITROGEN**), **oxygen**, **argon**, **neon**, **krypton**, **xenon** and **ammonia** NH_3 - a nitrogen derivative. Other gases, e.g. **acetylene**, **carbon dioxide**, **helium** (see: **HELIUM**), and **hydrogen**, are obtained from sources other than air. One of the most important commercial gases is **chlorine**, a principal raw material in the chemical industry.

Sources

The majority of ***commercial gases*** are obtained from ***atmospheric air***. The exceptions are: ***chlorine***, produced by the electrolysis of ***sodium chloride*** water solution; ***carbon dioxide*** CO_2, coming from gas purification process in ammonia plants, and ***elementary hydrogen*** obtained by the reaction of methane and water steam under high pressure (the first stage of ammonia synthesis). The recovery of ***helium*** from atmospheric air is insignificant, as compared to its production from natural gas (see: **HELIUM**).

Production

Natural and ***synthetic commercial gases*** are produced in Poland for many branches of the industry, including medicine and the aircraft industry, at more than twenty commercial gas plants. All of them have changed their ownership structure through privatization, and now they are subsidiaries of large international commercial gases companies: **Air Products**, **Linde Gaz Polska**, and **Messer Polska**. The domestic commercial gases plants together supply approx. 30% of the demand, mainly for ***oxygen***, ***argon***, ***carbon dioxide***, ***acetylene***, and ***nitrogen***. Other large producers of commercial gases are steel works (***commercial oxygen*** for steel-making purposes) and large chemical plants (***carbon dioxide*** in **Puławy** and **Tarnów**, ***chlorine*** in **Włocławek**, and **Brzeg**). Some amounts of ***carbon dioxide*** have been supplied by health resorts.

Information on the domestic market for commercial gases is incomplete. ***Oxygen*** in compressed and a liquid form is the main product in terms of production volume. The level of its production has varied between 1.9 and 2.3 Mtpy in recent years, depending on demand of steel works (Tab. 1). The most common grade is ***technical grade oxygen*** (over 95% O), manufactured and utilised by steel works. Higher grades of ***technical grade oxygen***, as well as ***medical*** and ***aircraft*** (fuel component) grades, are produced by commercial gas plants.

Tab. 1. Commercial gases statistics in Poland

'000 t

Year		2009	2010	2011	2012	2013
Gases recovered from the air						
Oxygen CN 2804 40						
Production		1,939.0	1,978.6	2,263.7	2,340.2	2,228.4
Imports		30.7	15.8	6.1	6.0	6.9
Exports		13.7	29.1	50.5	73.6	57.5
Consumption[a]		1,956.0	1,965.3	2,219.3	2,272.6	2,177.8
Argon CN 2804 21						
Production	[Mm^3]	15.8	29.9	186.9	44.0	41.0
Imports		21.8	18.7	18.1	17.2	19.6
Exports		1.0	2.7	4.8	7.8	8.3
Gases recovered from other sources						
Chlorine CN 2801 10						
Production		333.2	279.0	282.5	298.6	268.0
Imports		2.4	33.0	18.3	16.1	8.7
Exports		12.0	14.7	13.7	12.9	14.8
Consumption[a]		323.6	297.3	287.1	301.8	261.9
Carbon dioxide CN 2811 21						
Production		458.6	568.0	464.8	609.8	598.9
Imports		8.3	0.7	3.8	2.1	3.9
Exports		33.8	39.1	34.1	33.0	33.0
Consumption[a]		433.1	529.6	434.5	578.9	569.8
Hydrogen CN 2804 10						
Production	[Mm^3]	1,111.1	1,181.4	1,189.3	1,220.9	1,223.6
Imports		0.1	0.2	0.2	0.2	0.2
Exports		0.0	0.0	0.2	0.1	0.1

Source: ***The Central Statistical Office (GUS)***

Among the noble gases obtained from the air the most important is ***argon***. Domestic commercial gas plants supply ***pure liquid argon*** (99.9998% Ar), ***commercial liquid argon*** (99.995% Ar), ***pure gaseous argon*** (99.995% Ar), ***compressed argon for welding*** (99.98% Ar), and mixtures of ***argon*** with nitrogen, oxygen, and carbonic acid (***Coxogen***), ***carbon dioxide***, ***oxygen***, ***silicon hydride***, ***methane***, and ***neon***. Production data on ***argon*** previously varied between 15 and 30 Mm^3py, with sharp increase to ca. 187 Mm^3 in 2011 and decline to 41 Mm^3 in 2012 (Tab. 1). Besides ***argon***, also ***krypton***, ***xenon***, and a mixture of both (used to fill light bulbs, for example) are produced, but in much smaller amounts, along with ***neon***, ***helium***, and a mixture of both.

Chlorine is produced at the chemical plants in **Włocławek**, and **Brzeg**. The production has varied between 0.27 and 0.33 Mtpy, including up to 50% of chlorine in gaseous form (Tab. 1).

The domestic production of ***carbon dioxide*** has recently risen to the level of ca. 0.6 Mtpy (Tab. 1). Recently, most of the carbon dioxide has been supplied by the **Puławy** and **Tarnów** nitrogen plants. Some health resorts have delivered some quantities of liquid CO_2 (e.g. Duszniki a few hundred tons per year).

The domestic production of ***elementary hydrogen*** has oscillated between 1,110 and 1,220 Mm^3py (Tab. 1). The majority of the hydrogen has been produced by nitrogen plants, as well as by caustic soda manufacturers and in commercial gas plants, delivering gaseous hydrogen.

Trade

The most important items in the trade of commercial gases in Poland for many years have been high grades of imported ***oxygen***. Their exports have risen to over 50,000 tpy, while imports have dropped to only 6,000-7,000 tpy (Tab. 1).

Exports of ***argon*** have been usually below 10,000 tpy in recent years, while their imports have approached 20,000 tpy (Tab. 1). The level of ***other noble gases*** (***excluding argon*** and ***helium***) trade currently has not exceeded 100 tpy.

Chlorine has been a subject of very variable turnover, typically a few thousand tpy of imports (in 2010 it rose incidentally to 33,000 t) and 12,000–15,000 tpy in exports in recent years (Tab. 1).

Carbon dioxide is traded in a form of compressed gas, liquid gas, and the so-called ***dry ice*** (***solidified carbon dioxide***, ***carbon dioxide snow***). In recent years, imports have been less than 10,000 tpy, while exports — coming from the **Puławy Nitrogen Plant** — have risen to 30,000-40,000 tpy (Tab. 1). ***Hydrogen*** turnover has been marginal.

The only group of commercial gases having traditionally positive trade balance has been ***chlorine*** (6–10 million PLN/y), except for the years 2010-2012. The ***oxygen*** and ***argon*** trade balances have been generally negative, though since 2010 oxygen trade balance has started to be distinctly positive, similarly as in the case of ***carbon dioxide*** (Tab. 2).

The average unit values of trade of commercial gases have varied widely. The highest values have been reported in the case of noble gases, e.g. ***argon***, while the lowest ones — for ***oxygen*** (Tab. 3).

Consumption

It is difficult to assess the consumption level in Poland, due to the lack of complete data on the production. ***Oxygen*** is used mainly in steelworks to intensify blast furnace process. It is also an important raw material in the organic chemical industry. Smaller amounts of oxygen are utilised as rocket fuel, in medicine, etc.

Argon is used mainly as an inert gas in welding and other processes. It is also used for glow-discharge tubes. ***Neon*** is applied for glow-discharge tubes, lamps, and starters.

Chlorine is utilized for the production of ***hydrogen chloride***, ***hydrochloric acid***, ***plastics*** (e.g. PVC), and other chemical compounds, as well as in the pulp and paper industry, for the chlorination of potable water, etc.

Tab. 2. Value of commercial gases trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Oxygen CN 2804 40					
Exports	4,880	10,960	17,862	24,566	20,445
Imports	11,099	4,996	2,465	2,471	2,868
Balance	**-6,219**	**+5,964**	**+15,397**	**+22,095**	**+17,577**
Argon CN 2804 21					
Exports	1,175	2,684	5,225	8,836	9,763
Imports	21,815	14,706	14,682	14,713	16,782
Balance	**-20,640**	**-12,022**	**-9,457**	**-5,877**	**-7,019**
Chlorine CN 2801 10					
Exports	8,692	11,037	9,813	9,491	10,479
Imports	1,331	25,195	14,245	12,760	4,436
Balance	**+7,361**	**-14,158**	**-4,432**	**-3,269**	**+6,043**
Carbon dioxide CN 2811 21					
Exports	12,064	14,759	11,446	10,530	9,180
Imports	6,540	2,680	2,802	3,989	4,492
Balance	**+5,524**	**+12,079**	**+8,644**	**+6,541**	**+4,688**

Source: ***The Central Statistical Office (GUS)***

The compressed and liquid forms of ***carbon dioxide*** are used mainly in the food industry, for the production of carbonated beverages, and in medicine. ***Dry ice*** is used mainly as a cooling agent.

Elementary hydrogen is used in the fat industry for hydrogenating fats and oils, in metallurgy with high-melting-point metals, e.g. platinum, cobalt, tungsten, germanium (the temperature of hydrogen/oxygen flame is 2,700°C), in the synthesis of petrol, alcohols, etc.

The principal companies involved in commercial gases production in Poland as of December 2013

- Anwil S.A. we Włocławku (Anwil Joint Stock Co. of Włocławek), ul. Toruńska 222, 87–805 Włocławek, tel. +48 54 2363091, fax +48 24 3677634, www.anwil.pl — *chlorine (liquid).*
- PCC Rokita S.A. w Brzegu Dolnym (PCC Rokita Joint Stock Co. of Brzeg Dolny), ul. Sienkiewicza 4, 56–120 Brzeg Dolny, tel. +48 71 7942000, fax +48 71 7942197, www.pcc.rokita.pl — *chlorine (liquid and gaseous).*
- Grupa Azoty S.A. (Grupa Azoty Joint Stock Co.), ul. Kwiatkowskiego 8, 33–101 Tarnów, tel. +48 14 6330781, fax +48 14 6330718, www.grupaazoty.com — *carbon dioxide (liquid).*

Tab. 3. Average unit values of commercial gases trade in Poland

Year	2009	2010	2011	2012	2013
Oxygen **CN 2804 40**					
Exports unit values					
— PLN/t	355.0	376.2	353.7	333.9	355.6
— USD/t	120.0	124.8	119.6	102.2	113.1
Imports unit values					
— PLN/t	361.6	316.6	406.8	413.8	417.6
— USD/t	116.4	107.1	139.0	126.5	132.4
Argon **CN 2804 21**					
Exports unit values					
— PLN/t	1,207.0	997.7	1,090.4	1,126.2	1,176.7
— USD/t	373.6	332.6	371.9	344.5	374.9
Imports unit values					
— PLN/t	1,000.7	785.1	811.8	855.0	856.9
— USD/t	320.0	261.2	277.2	261.5	272.8
Chlorine **CN 2801 10**					
Exports unit values					
— PLN/t	725.1	753.2	714.7	734.0	706.4
— USD/t	235.7	250.1	241.1	223.9	225.1
Imports unit values					
— PLN/t	546.0	764.2	779.0	792.5	510.8
— USD/t	179.9	253.8	268.1	243.0	162.6
Carbon dioxide **CN 2811 21**					
Exports unit values					
— PLN/t	356.8	377.9	335.8	318.7	278.1
— USD/t	114.8	120.5	116.2	96.9	88.1
Imports unit values					
— PLN/t	790.9	3,618.8	732.7	1,864.5	1,138.3
— USD/t	254.3	1,189.9	257.5	565.1	361.2

Source: ***The Central Statistical Office (GUS)***

- Grupa Azoty Zakłady Azotowe Puławy S.A. w Puławach (Grupa Azoty Puławy Nitrogen Plants Joint Stock Co. of Puławy), Al. Tysiąclecia Państwa Polskiego 13, 24–110 Puławy, tel. +48 81 5652833, fax +48 81 5652856, www.zapulawy.pl — *carbon dioxide (liquid, solidified).*
- Air Products Sp. z o.o. w Warszawie (Air Products Ltd. of Warsaw), ul. Pory 59, 02–757 Warszawa, tel. +48 22 4403200, fax +48 22 4403205, www.airproducts.com.pl — *oxygen, argon, noble gases, carbon dioxide, hydrogen.*

- Linde Gaz Polska Sp. z o.o. w Krakowie (Linde Gaz Polska Ltd. of Cracow), al. Jana Pawła II 41a, 31–864 Kraków, tel. +48 12 6439200, fax +48 12 6439300, www.linde-gaz.pl — *oxygen, argon, noble gases, carbon dioxide, hydrogen.*
- Messer Polska Sp. z o.o. w Chorzowie (Messer Polska Ltd. of Chorzów), ul. Maciejkowicka 30, 41–503 Chorzów, tel. +48 32 7726000, fax +48 32 7726115, www.messer.pl — *oxygen, hydrogen, argon, noble gases, carbon dioxide, hydrogen*.
- Nitrogen and ammonia producers — see: **NITROGEN**. Other helium producers — see: **HELIUM**.

GEMS

Overview

Gems are minerals, more seldom rocks, which in their natural form or ground and polished are suitable for direct use in jewellery. The German classification standard **RAL560A5** divides gems into ***precious stones***, ***decorative jewellery***, ***decorative***, ***reconstructed*** and ***synthetic stones***, ***doublets*** and ***triplets***, ***natural pearls***, ***precious corals***, and ***amber***, as well as ***counterfeits*** and ***imitations***.

Precious stones are characterized by their considerable hardness, beautiful colours, bright glance, excellent transparency, high refractory index, and resistance to chemicals, e.g. ***diamonds***, ***rubies***, ***sapphires*** (varieties of corundum) and ***emeralds*** (varieties of beryllium). The most precious is **diamond**, one of eight allotropic forms of ***elemental carbon***. Diamond is the hardest mineral, colourless or slightly coloured (the most precious is blue shaded). It is characterized by strong sheen and high index of refraction. Two classes of **natural diamonds** are distinguished: ***jewellery*** and ***industrial***. ***Jewellery diamonds*** are ideally transparent, with no cracks, inclusions, or defects, and are therefore suitable for precise grinding into ***brilliants***. ***Industrial diamonds*** are used in the grinding industry in the form of powders and micro-powders; in the tool-making industry, medicine, optics and electronics.

As the substitutes of diamond can be used synthetic abrasives of similar hardness, e.g. **boron nitride — BN** (of the same structure but distinct from diamond in terms of resistance to oxidation) and **boron suboxide B_2O** - manufactured in Poland.

Decorative stones include those minerals, which due to their beautiful colours or play of colours are used in jewellery, e.g. ***opal***, ***topaz***, and ***turquoise***. **Decorative stones** — e.g. ***quartz***, ***chalcedony***, ***jade***, ***gagate*** — are various rocks, sometimes minerals and solid organic substances, characterized by permanent decorative properties, and often occurring in nature in considerable amounts. It is assessed that among 2,700 minerals, approximately 100 can be qualified to this category. **Amber** is a solid substance of organic origin, occurring in the form of petrified resins of ancient conifers.

Synthetic stones are crystals or amorphous solids obtained by synthesis. Their chemical and physical properties are similar to those of natural stones, e.g. ***corundum***, which may have the colour of ***ruby***, ***emerald***, or ***quartz***. **Synthetic diamonds** have been produced since 1955. Presently, the world production capacity has exceeded the supply of natural diamonds over threefold.

Sources

In Poland, the most familiar and common ***gem*** is ***amber***, which for centuries has been collected along the Baltic seaside. Total economic resources of four recognized

amber deposits amounted to 1,118 t (as of 31 December 2013). Three of them, including recently recognized **Przeróbka–SL** deposit (with resources of 17 t), as well as **Możdżanowo** (containing ca. 10 t of amber at a depth of 11 m), and **Wiślinka I** deposits (with 2.7 t of amber at a depth of 6 m) occur in the Baltic seaside. Moreover, there are some uneconomic accumulations of amber documented primarily in large **Chłapowo** deposit (resources of approx. 640 t), located near Władysławowo at a depth of 95–130 m. The exploration for amber in the marine areas has been unsuccessful so far.

On the other hand, some occurrences of amber have been recognized near Lublin, in the Carpathian Foredeep. The total resources in this area are estimated at 6,900 t, but presently only **Górka Lubartowska** deposit near Parczewo has been recognised. The resources of the deposit are estimated at 1,088 t. Amber occurs at a depth below 20-30 m and its average content in the deposit is about 377 g/m^2. Moreover, small occurrences of amber have been found in the Pleistocene sediments in Tuchola, Konin and Bełchatów areas as well as in the Tertiary sediments of Lower Silesia.

There are no deposits of ***precious stones*** including ***natural diamond***, while there were recognized 41 kinds of ***decorative jewellery*** and ***stones***, which can be utilized in jewellery and gold decoration manufacturing.

Quartz, one of the most common minerals, forms veins of ***milky*** and ***white quartz*** in **Taczalin**, the resources of which amount to 500,000 t. The ***rock crystal*** from **Jegłowa**, characterized by exceptional clarity, is also an excellent jewellery material. Its resources are considerable, particularly in the deeper part of the deposit. ***White*** and ***yellowish quartz*** also occurs there. ***Morion*** (opaque) and ***smoky quartz*** (transparent) can be found in the old granite quarry at **Czernica**. ***Amethyst*** in various shades of violet, even purple, occurs in the vicinity of **Szklarska Poręba** and **Nowy Świętów**.

The most significant member of the ***chalcedony*** group is ***chrysoprase***: green or bluish, glassy, transparent, or matte, which occurs in **Marta** – an old mine of ***nickel ore*** in **Szklary**, and in the **Wiry** ***magnesite*** mine in **Wiry**. ***Agate***, with its characteristic colour band structure, occurs in the vicinity of **Płóczki Górne** and **Nowy Kościół**. Due to their small sizes, numerous cracks, and low transparency, these agates are of limited value. ***Jasper***, red-grey or (rarely) green, forms concentrations in **Świerki** near Nowa Ruda and in **Niedźwiedzia Góra** near Krzeszowice.

The only precious variety of ***opal*** recognized in Poland is ***hialite***. It may be found in the serpentine quarry in **Nasławice**. However, the quality of the mineral is very changeable, and its resources have not been determined. As for ***tourmaline*** minerals, there are noteworthy concentrations of ***scorile*** occurring in the **Izera Foothills**, approaching in size to 10 cm. These minerals are utilised for the production of stone fancy goods. On the other hand, ***tourmalines*** from the **Sowie Mountains**, particularly those of 30–40 cm diameter, are highly prized by collectors.

Nephrite, known as ***Polish decorative stone*** (due to its excellent properties for sculpturing and decoration), has been extracted in a very small scale. The occurrence of ***nephrite*** in **Jordanów** near Sobótka is ranked second in Europe in respect to its quality.

Flint stone, containing ***opal*** or ***chalcedony***, and characterized by its colourful bands, is attractive for jewellery and decorative purposes. Its concentrations are known in the **Cracow-Częstochowa Jurassic Range**, along the northeast edge of the **Świętokrzyskie Mountains**, in the **Lublin Upland**, and in other parts of Poland. They are used in various branches of industry and in jewellery. ***Petrified tree-stems***, formed primarily from ***chalcedony*** or ***fine-grained quartz***, are characterized by compact texture, considerable hardness, and mechanical strength. They occur in the vicinity of **Krzeszowice** near Cracow, in the region of Kielce, and near Wałbrzych. However, the main concentrations occur in **Siedliska** near Bełżec.

Gagate (jet coal) is characterized by pitch-black colour and shade. The only concentrations are the so-called ***zagajskie seams*** near **Odrowąż**.

Production

For all practical purposes, only ***amber*** is collected in Poland, mainly along the Baltic Sea coast in the Gdańsk region. Moreover, the extraction of amber has been carried out illegally on a small scale in this area (Sobieszewo Island, Stogów and Wiślinka region), by hydraulic boreholes method. The structure of gathered assortments has been dominated by small agglomerates — 1–10 g and coarser — 10–40 g. Since 2008, data about amber production and trade have not been available. It is estimated that the total amount of amber collected on the beaches and illegally mined in Poland has not exceeded 5–6 tpy (in 2000 it was ca. 20 t). Moreover, during the exploration of deposits in the marine areas some amounts of amber have been obtained.

The prices of ***amber*** in Poland have been increasing in recent years. The price of the ***amber*** sold by private collectors varied depending on the weight of amber, e.g.: for 2,5–5 g — 960 PLN/kg; 5–10 g — 2,200 PLN/kg; 10–20 g — 3,900 PLN/kg; 20–50 g — 5,900 PLN/kg.

Data on the domestis output of ***gems***, other than amber, are not available. Among the ***synthetic gemstones — artificial ruby***, ***zircon***, and ***corundum monocrystal*** were produced in Poland by the **Cemkor Ltd.** in Skawina until early 2000s. Until 1998 **Diamsil Ltd.** in **Osieczany** near Cracow manufactured ***synthetic diamonds*** — total production capacity was 1.2 million carats per year. In the face of increasing competition, mainly from Russian and Ukrainian suppliers, the operation was halted in 1999.

Trade

There is no official information on the imports of ***amber***. However, it is estimated that these deliveries varied between 40 and 65 tpy in the years 2009–2013. The main supplier of ***amber*** to Poland was Russia, primarily Primorskaja mine (Sambia Peninsula) with production up to 340 tpy in recent years. Second important supplier remained Ukraine, where after closing the Pugacz mine in 2011 amber has been obtained only illegally. The foreign recipients of Polish jewellery with amber (ca. 40% of production exported) have been the EU countries, the US, Canada, China, and Russia. The trade balances in amber and amber products have been estimated at ca. 800 million PLN/y.

The imports of ***rough precious*** and ***decorative stones*** (excluding diamonds) decreased from 50–60 tpy in 2009–2010 to 23-24 tpy in the years 2011–2012, with recovery to ca. 38 t in 2013. It was exceeding exports (Tab. 1). Deliveries came primarily from China, Congo, Brazil, and the South Africa, while the main recipients of ***precious*** and ***decorative stones*** re-exported from Poland were China, Hong Kong, Switzerland, Ukraine, and the US. Despite quite high imports, the value of exports was considerably higher than value of imports in the years 2009–2011. In the last two years trade balances of precious and decorative stones were negative (Tab. 2).

Tab. 1. Precious and synthetic stones trade in Poland

t

Year	2009	2010	2011	2012	2013
Precious and decorative stones CN 7103					
Exports	8.8	7.9	5.1	3.4	1.6
Imports	56.5	49.4	23.8	22.7	38.2
Consumption[a]	47.7	41.5	18.7	19.3	36.6
Synthetic stones CN 7104					
Exports	2.0	6.3	7.7	7.5	6.4
Imports	53.4	61.2	42.3	22.0	25.1
Consumption[a]	51.4	54.9	34.6	14.5	18.7

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Value of precious and synthetic stones trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Precious and decorative stones CN 7103					
Exports	47,834	11,433	10,109	5,941	7,002
Imports	9,971	10,307	5,479	7,562	8,011
Balance	**+37,863**	**+1,126**	**+4,630**	**-1,621**	**-1,009**
Synthetic stones CN 7104					
Exports	1,364	11,195	13,151	7,483	5,829
Imports	13,135	14,149	12,442	11,445	12,339
Balance	**-11,771**	**-2,954**	**-709**	**-3,962**	**-6,510**

Source: ***The Central Statistical Office (GUS)***

Imports of ***synthetic stones*** increased from 51.3 t in 2009 to 61.2 t in 2010, but afterwards it dropped to 22-25 tpy. The exports rose from 2.0 t in 2009 to ca. 7 tpy (Tab. 1). The trade balance in ***synthetic stones*** has always been negative. The deficit was reduced from ca. -12 million PLN in 2009 to ca. -0.7 million PLN in 2011, while in the following years it deepened, to ca. -6.5 million PLN in 2013 (Tab. 2). In the years 2009–2013 the unit values of ***synthetic stones*** imports to Poland ranged from 76 to 159 USD/t and they were considerably higher than the unit values of ***precious*** and ***decorative stones*** imports (Tab. 3).

Domestic demand for ***diamonds*** has been satisfied by imports (Tabs. 4, 5, 6). Deliveries of ***natural non-industrial diamonds*** have come mainly from India, Belgium and the US - in 2013 (Tab. 4). In 2013 the main supplier of ***natural industrial diamond*** was Germany (Tab. 5). The majority of ***synthetic diamonds*** has been imported from China, Belgium, Ireland, Japan, Germany, Ukraine, the US, the UK, and Russia (Tab. 6). In spite of incidental exports of ***diamonds*** reported in recent years, the trade balance has

Tab. 3. The unit value of gems imports to Poland

Year	2009	2010	2011	2012	2013
Precious and decorative stones CN 7103					
PLN/kg	176	208	230	333	210
USD/kg	56	69	79	102	66
Synthetic stones CN 7104					
PLN/kg	246	231	294	521	492
USD/kg	76	77	101	159	157

Source: ***The Central Statistical Office (GUS)***

been negative (Tab. 7). The unit values of diamond imports to Poland depended on the volume of imports (Tab. 8).

Tab. 4. Polish imports of natural non-industrial diamonds, by country — CN 7102 31–39

kg

Year	2009	2010	2011	2012	2013
Imports	**5**	**11**	**5**	**5**	**14**
Belgium	1	2	0	0	2
Germany	0	0	0	0	0
India	0	1	0	0	6
Italy	–	5	0	0	0
Netherlands	0	0	0	3	0
USA	0	0	0	0	2
Thailand	0	1	3	1	0
Others	4	2	2	1	4

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Polish imports of natural industrial diamonds, by country — CN 7102 21–29

kg

Year	2009	2010	2011	2012	2013
Imports	**161**	**160**	**9**	**2**	**28**
Austria	128	11	–	–	–
China	4	–	2	–	–
Germany	2	53	3	1	28
Netherlands	0	1	0	–	0
South Africa, Republic of	2	0	0	0	0
United Kingdom	25	80	3	1	–
Others	0	15	1	0	0

Source: ***The Central Statistical Office (GUS)***

Tab. 6. Synthetic diamonds statistics in Poland — CN 7105 10

kg

Year	2009	2010	2011	2012	2013
Imports	**52,428**	**396**	**42,519**	**649**	**709**
Belgium	18	3	4	62	52
China	52,263	249	42,292	317	410
France	2	–	1	–	0
Germany	11	17	41	39	14
Ireland	38	2	7	49	38
Italy	–	5	14	46	15
Japan	10	40	34	41	63
Russia	16	14	21	7	3
Switzerland	0	3	1	0	9
Ukraine	12	–	–	23	31
United Kingdom	27	20	8	8	24
USA	30	41	54	9	5
Others	1	2	42	48	45
Exports	**102**	**10**	**12**	**7**	**0**
Consumption[a]	**52,326**	**386**	**42,507**	**642**	**709**

Source: ***The Central Statistical Office (GUS)***

Tab. 7. Value of diamonds trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Natural non-industrial diamonds CN 7102 31–39					
Exports	695	366	302	879	830
Imports	12,396	9,979	17,839	14,423	15,283
Balance	**-11,701**	**-9,613**	**-17,537**	**-13,544**	**-14,993**
Natural industrial diamonds CN 7102 21–29					
Exports	43	234	432	142	237
Imports	1,400	3,429	1,809	1,710	3,159
Balance	**-1,357**	**-3,195**	**-1,377**	**-1,568**	**-2,932**
Synthetic diamonds CN 7105 10					
Exports	65	43	21	94	8
Imports	933	849	1,283	1,963	1,918
Balance	**-868**	**-806**	**-1,262**	**-1,869**	**-1,910**

Source: ***The Central Statistical Office (GUS)***

Tab. 8. Unit values of diamond imports to Poland

Year	2009	2010	2011	2012	2013
Natural non-industrial diamond CN 7102 31–39					
PLN/kg	2,479,298	907,217	3,567,778	2,884,697	4,865,900
USD/kg	785,791	298,958	1,220,701	886,178	1,091,635
Natural industrial diamond CN 7102 21–29					
PLN/kg	8,695	21,430	586,261	855,065	112,837
USD/kg	2,887	7,061	200,955	259,894	35,944
Synthetic diamonds CN 7105 10					
PLN/kg	18	2,144	30	3,025	2,705
USD/kg	6	700	10	924	859

Source: ***The Central Statistical Office (GUS)***

Consumption

Amber is used in artistic craftwork, which is expected to develop in the near future. The official data on the consumption are not available, however it is estimated that 60–70 tpy of amber was utilized in Poland in the years 2009–2013. The overwhelming majority of plants has started production of silver jewellery, in which amber constitutes only 8–15% by weight, despite its visual dominance. It is a result of its much lower density in comparison to silver. ***Decorative stones*** are also consumed in large amounts, e.g. ***flint***, which is used both in various industries and in jewellery (see: **FLINT**).

The ***corundum*** monocrystals (***leucosapphires***) were used for the production of elements for analytical scales, surgical blade, nozzles, and other goods.

Demand for ***synthetic*** and ***natural industrial diamonds*** has been very changeable. Apparent consumption of ***synthetic diamonds*** has varied between 0.4 and 52.3 tpy. Consumption of ***natural industrial diamonds*** ranged from kilograms to hundreds of kilograms per year. Because of high unit values of ***natural non-industrial diamonds*** their consumption did not exceed a hundred kilograms per year (Tab. 8). Both ***synthetic*** and ***industrial diamonds*** are used in production of abrasive diamond paste and diamond suspensions. ***Synthetic diamonds*** are used also in the production of surgical and abrasive tools, in the food making industry (nozzles) and in laboratory devices manufacturing.

GERMANIUM

Overview

Germanium (**Ge**) is obtained as a by-product from the roasting of ***zinc sulfide concentrates***, and also in course of ***zinc*** smelting, mainly as **germanium tetrachloride** (**$GeCl_4$**), being the raw material for the production of **germanium dioxide GeO_2** and **germanium metal**. To a lesser extent it is produced in ***lead*** and ***copper ore*** smelting operations. The sources of considerable amounts of germanium are secondary materials (***electronic scrap*** and ***optoelectronic waste***), as well as the US strategic reserves. The ***fly ash*** produced by the combustion of thermal coal is a rich potential source of germanium.

Germanium appeared in the commercial metals market in 1948, after germanium transistors began to be manufactured. Now, due to competition from cheaper silicon, germanium is used mainly for IR night vision systems and fiber optics.

Sources

Trace amounts of ***germanium*** occur in ***Zn-Pb ore*** deposits in the **Silesia-Cracow** region. The resources amounted to 40 t of Ge (as of 31 December 2008). In the years of 2009–2013 these reserves were not reported in the Polish Mineral Resources Datafile.

Production

Germanium is not recovered at Polish ***lead*** and ***zinc*** smelters.

Trade

Domestic demand has been satisfied by imports of small amounts of ***germanium commodities*** (raw germanium, germanium scrap, waste, and powders) — up to 32 kgpy, and of ***germanium oxides*** -nin the range 15–77 tpy (Tab. 1). They have come mainly from China, France, the UK, the Netherlands, Germany, as well as from Canada, Japan and the US. In the last five years variable imports of ***germanium products*** were reported.

The trade balances of all ***germanium commodities*** and ***products*** have been consistently negative, mainly due to increase in importation of ***germanium oxides*** (Tab. 2). In recent years the unit values of germanium oxides imports to Poland has reflected the changes of producer prices, but in comparison to them were surprisingly low (Tab. 3).

Consumption

The structure of ***germanium*** and ***germanium compounds*** consumption in Poland is difficult to ascertain. ***Germanium oxide*** is probably used mainly in IR systems, fiber optics, and electronics.

Tab. 1. Germanium statistics in Poland

kg

Year	2009	2010	2011	2012	2013
Germanium[1] commodities CN 8112 92 95					
Imports = Consumption[a]	15	4	22	32	3
Germanium products CN 8112 99 20					
Imports = Consumption[a]	130	12	44	26	56
Germanium oxides [t] CN 2825 60					
Imports	23	15	77	60	55
Exports	20	–	0	3	4
Consumption[a]	3	15	77	57	51

[1] raw germanium, germanium scrap, waste, and powders

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Value of germanium trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Germanium[1] commodities CN 8112 92 95					
Exports	–	–	–	–	–
Imports	28	3	115	332	44
Balance	**-28**	**-3**	**-115**	**-332**	**-44**
Germanium products CN 8112 99 20					
Exports	–	–	–	–	–
Imports	118	108	121	75	135
Balance	**-118**	**-108**	**-121**	**-75**	**-135**
Germanium oxides CN 2825 60					
Exports	270	–	329	852	638
Imports	1,037	745	1,956	2,424	2,006
Balance	**-767**	**-745**	**-1,627**	**-1,572**	**-1,368**

[1] raw germanium, germanium scrap, waste, and powders

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit values of germanium oxides imports to Poland — CN 2825 60

Year	2009	2010	2011	2012	2013
PLN/t	45,087	49,903	25,312	40,383	36,231
USD/t	14,427	16,527	8,562	12,323	11,515

Source: ***The Central Statistical Office (GUS)***

GOLD

Overview

Gold (**Au**) is known and used since ancient times. It was used in jewellery and as instrument of payment (golden coins). In the last centuries, governments and banks collected gold reserves, and after introduction of banknotes in the 19th century, convertibility of banknotes into gold was established (gold standard). Gold standard was removed after the Second World War, in the US in 1970 at the latest. Government reserves of gold are continuously reduced in many countries, what sometimes influence negatively on the world market of gold. Jewellery is still the main consumer of gold, but industrial applications are dynamically developing. In electronics, telecommunications, aviation and astronautics, gold is used in pure form or in the form of alloys with silver, copper, platinum and zinc.

The majority of world **gold** supply comes from mine production (60 – 65%), while 21 – 30% comes from scraps, and 8 – 16% from government and central banks sales together with private person's disinvestment. About 80 – 85% of gold mine production origin from its primary deposits, while 15 – 20% is recovered as a by-product of silver and base metals ore treatment.

Sources

Gold occurs in Poland almost entirely in the Lower Silesia, but economic concentrations have marginal importance. There are four basic forms of gold occurrence: ***gold-bearing alluvias*** in the **Kaczawa** river valley (**Złotoryja** and **Legnica** area) and the **Bóbr** river valley (**Bolesławiec** area), ***gold-bearing veins*** in the **Kaczawa Mountains** (**Stara Góra**, **Czarnów**, etc.), ***arsenopyrite ore*** in **Złoty Stok**, impurities of ***gold*** in ***copper ore*** deposits of the **Fore-Sudetic Monocline**.

In the **Złoty Stok** deposit of ***arsenopyrite ores***, which was abandoned in 1960, the average gold content in the ore is about 2.8 ppm, with total remaining gold resources being estimated at ca. 1,500 kg. Prospecting license was issued there to **KGHM Polska Miedź**, but prospecting was finished without success. Moreover, in 2014 seven gold prospecting licenses in Kaczawa Mountains (Lower Silesian) were granted to **Amarante Investment** of Kraków.

So, impurities of ***gold*** in ***copper ore*** deposits of the **Fore-Sudetic Monocline** are currently the only recoverable primary source of gold in Poland. It is concentrated mainly in copper-bearing shale, with content ranged from 0.01 to 0.3 ppm, but locally it approaches over 1,000 ppm (0.1%). Gold forms its own minerals and is present as a natural alloy with silver and other metals (e.g. ***bornite***). Its resources in the **Fore-Sudetic Monocline** deposits are estimated at ca. 50 t.

Production

KGHM Polska Miedź is currently the only domestic ***primary gold*** producer. The ***copper ore*** extracted from deposits in the **Fore-Sudetic Monocline** contains an average of less than 0.1 g/t of Au, while copper concentrates under 1 g/t. In the **Precious Metals Plant** at the **Głogów Smelter** of the **KGHM Polska Miedź**, gold is recovered after silver electrolysis of anode slimes in two-stadial process of leaching and precipitation. The so-called ***"gold sand"*** is obtained, which is then melted and cast into ***gold ingots*** (99.99 – 99.995% Au). Gold yield in this process amounts to 99.8%. The annual production depends on gold content in extracted ores and processed concentrates (also imported ones, see: **COPPER**). In recent years, it varied between 700 – 1,070 kgpy (Tab. 1).

Tab. 1. Gold[1] statistics in Poland — CN 7108 11–12

kg Au

Year	2009	2010	2011	2012	2013
Production[2]	814	776	704	916	1066
Imports	352	342	714	178	196
Exports	103	199	2,288	9,689	3,714
Consumption[a]	1,063	919	-870	-8,595	-2,452

[1] together with gold powder [2] primary gold production in the **KGHM Polska Miedź**.

Source: ***The Central Statistical Office (GUS), producer's data***

Trade

Gold trade mainly in bar, powder and coin form, as well as in the form of semiproducts (rods, wires, foils, etc.), is very variable. It is partly influenced by "unofficial trade" of these forms of gold (smuggling). However, this aspect is much more important in case of golden jewellery.

Raw gold exports from Poland according to official data amounted commonly to 100 - 200 kgpy in 2009-2010 and significantly increased since 2011 (Tab. 2). Belgium, France, Germany, and numerous other European countries were the main buyers of Polish gold in 2013 (Tab. 2). However, since 2011 extraordinary gold exports have been reported, mainly to Italy, reaching even almost 10 t in 2012. This maybe related to some sales of gold stocks by central bank, but it is not confirmed. In recent years some ***gold semiproducts*** were also exported.

Official ***raw gold*** imports to Poland are also variable from 170 kgpy to 350 kgpy in the years 2009-2013 (Tab. 3). It comes mainly from Austria and Germany (tab. 3). Commonly, 300 - 800 kgpy of ***gold semiproducts*** were also imported.

Until 2005, the trade balance in ***raw gold*** has had a positive value in general, but since 2005 it changed entirely and trade balance was negative, down to 26.9 million PLN in 2008, with improvement in 2009. In 2010, it started to be positive again, while in 2012 it achieved record value of 1,666 million PLN and decreased to 467 million PLN in 2013 (Tab. 4). The average unit values of ***raw gold*** trade are very variable (Tab. 5), being a result of a fact that trade of gold alloys is sometimes also reported under this CN item (e.g. gold alloys, high-purity gold).

Tab. 2. Polish exports of gold[1], by country — CN 7108 11–12

kg Au

Year	2009	2010	2011	2012	2013
Exports	**103**	**199**	**2,288**	**9,689**	**3,714**
Austria	–	53	–	120	2
Belgium	–	–	–	17	1,440
Czech Republic	16	39	23	29	112
France	–	–	–	–	966
Germany	83	96	473	600	902
Italy	3	1	1,773	8,922	244
Lithuania	–	–	7	–	–
Slovakia	–	–	6	–	–
Turkey	1	10	3	1	48
Others	–	1	3	–	–

[1] together with gold powder

Source: ***The Central Statistical Office*** *(GUS)*

Tab. 3. Polish imports of gold[1], by country — CN 7108 11–12

kg Au

Year	2009	2010	2011	2012	2013
Imports	**352**	**342**	**714**	**178**	**196**
Australia	–	–	6	–	–
Austria	–	63	129	36	104
Canada	–	–	5	–	–
China	–	–	8	0	0
Czech Republic	9	5	3	2	2
Ghana	–	1	–	10	–
Germany	207	204	435	44	87
Hungary	42	24	16	4	1
Italy	5	4	1	0	0
Latvia	5	3	6	0	0
Lithuania	8	10	8	5	–
Slovakia	67	12	–	14	–
Sweden	2	–	1	0	–
United Kingdom	–	–	87	63	1
USA	1	9	2	0	0
Others	6	7	7	0	1

[1] together with gold powder

Source: ***The Central Statistical Office*** *(GUS)*

Tab. 4. Value of gold[1] trade in Poland — CN 7108 11–12

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	10,834	23,011	364,443	1,690,632	476,290
Imports	22,991	19,634	55,562	24,403	29,397
Balance	**-12,157**	**+3,377**	**+308,881**	**+1,666,229**	**+446,893**

[1] together with gold powder

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Average unit values of raw gold[1] trade in Poland — CN 7108 11–12

Year	2009	2010	2011	2012	2013
Exports unit values					
PLN/kg	105,189	115,635	159,284	174,490	128,242
USD/kg	31,927	38,623	52,013	53,296	40,915
Imports unit values					
PLN/kg	65,315	57,408	77,818	137,096	149,988
USD/kg	20,167	19,172	27,289	42,776	48,234

[1] together with gold powder

Source: ***The Central Statistical Office (GUS)***

Consumption

Gold produced by the **KGHM Polska Miedź**, as well as imported to Poland in the form of raw gold and gold semiproducts, find primarily industrial applications (electronics, precise instruments, special alloys, photography, etc.). It is also used by the **State Mint** of **Warsaw** (under 100 kgpy), as well as in golden and gold-plated jewellery. It is also collected in bars as a treasury. Total consumption of gold from official sources (domestic production, official trade) is estimated at 900 – 1,800 kgpy. Level of real consumption of gold is very difficult to establish due to a lack of data on gold scrap recovery and stocks changes in Poland. It is also a result of large dispersion of gold use in jewellery. Recovery of scrap of jewellery gold alloys (583, 750 and 875 fineness) by jewelers may achieve a level of even 10 – 20 tpy. Use of gold in industry (mainly electronics) and for coinage may amount to 300 – 600 kgpy.

Companies involved in gold recovery in Poland, as of December 2013

- KGHM Polska Miedź S.A. w Lubinie (KGHM Polska Miedź Joint Stock Co. of Lubin), ul. Marii Skłodowskiej-Curie 48, 59-301 Lubin, tel. +48 76 8478200, fax +48 76 8478500, www.kghm.pl - *refined gold*.

GRAPHITE

Overview

Graphite is one of two polymer varieties of ***elementary carbon*** (the other being ***diamond***). The basic varieties of the mineral are ***large crystalline***, ***flake crystalline***, and the so-called ***"amorphous" graphite***. It is a good thermal and electrical conductor, resistant to chemicals and high temperatures, and thus particularly suitable for the manufacture of refractory materials, as well as for foundry work, brake friction linings, and greases.

Natural graphite is often replaced by **synthetic graphite**, obtained by the ***graphitization*** of ***petroleum coke*** and other petroleum and coal derivatives. Synthetic graphite is mainly used for the production of electrodes and anodes, in foundry work, and for the production of graphite crucibles. However, such substitution of natural graphite by synthetic one is not always used due to high cost of production of appropriate synthetic variety.

Sources

There are no ***graphite*** deposits in Poland, nor any prospects for their discovery.

Production

There is no ***natural graphite*** production in Poland. However, production of its synthetic substitutes — ***refined coal products***, ***graphitized products***, and ***synthetic graphite*** — is carried out primarily by the **SGL Carbon Polska**, in two large plants in **Nowy Sącz** and **Racibórz**. Plant in Racibórz specializes in ***graphite linings*** for blast furnace, electric arc furnace and Al electrolyzers, as well as in ***graphite cathode blocks***, while plant in Nowy Sącz — in the production of ***graphite electrodes***. Recently, both plants were refurbished, and further investments have been planned. The company is planning to build two production lines in Nowy Sącz plant. First of them, where the ***slabs of the exfoliated graphite*** for air-conditioning systems will be manufactured, will be completed by end of the 2016. Second line, where the graphite will be processed into ***anode materials*** for lithium-ion batteries, will be opened by the end of 2017.

The total production of ***synthetic graphite***, together with ***colloidal graphite*** and ***similar products***, decreased significantly from 52,600 t in 2009 to 23,800 t in 2013 (Tab. 1). The total production of ***coal and graphite electrodes*** and ***similar products for electrical use*** varied between 40,000 and 50,000 tpy in the years 2009-2013, depending on demand of the steelmaking industry.

Tab. 1. Synthetic graphite and related products[1] statistics in Poland — CN 3801

'000 t

Year	2009	2010	2011	2012	2013
Production[1]	52.6	39.6	48.6	33.2	23.8
Imports	29.3	36.0	48.4	37.3	15.4
Exports	25.6	28.2	34.5	27.7	5.1
Consumption[a]	56.3	47.4	62.5	42.8	34.1

[1] together with colloidal graphite, graphite blocks etc.

Source: ***The Central Statistical Office (GUS)***

Trade

The demand for ***natural graphite*** is satisfied entirely by imports which ranged between 2,800 and 10,300 tpy in the last years (Tab. 2). The main suppliers were China, Germany and Ukraine (**Zavalievsky Graphite Complex**). Moreover, considerable amounts of graphite have been imported from Brazil in 2013. Growth of ***"amorphous" graphite*** purchases from France were observed in the years 2011–2012. Deliveries from specific suppliers are variable, depending on the price/quality ratio (Tab. 3).

Tab. 2. Natural graphite statistics in Poland — CN 2504

t

Year	2009	2010	2011	2012	2013
Imports	2,875	7,208	10,359	6,817	7,338
Exports	66	232	589	111	796
Consumption[a]	2,809	6,976	9,770	6,706	6,542

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Imports of natural graphite to Poland, by country — CN 2504

t

Year	2009	2010	2011	2012	2013
Imports	**2,875**	**7,208**	**10,359**	**6,817**	**7,338**
Austria	12	–	12	1	19
Brazil	22	–	0	–	1,270
China	2,376	4,016	6,815	3,508	3,878
Czech Republic	72	87	139	77	97
France	4	65	130	130	20
Germany	260	1,390	910	1,113	834
Ukraine	20	1,420	1,997	1,583	730
United Kingdom	59	80	164	152	199
Others	50	150	192	253	291

Source: ***The Central Statistical Office (GUS)***

Synthetic graphite and ***related products*** has been traditionally exported in the amounts of 25,000–35,000 tpy, with decrease to ca. 5,000 t in 2013 (Tab. 1). Substantial imports of these commodities are also recorded, mainly of grades and types which are not manufactured in Polish plants. Volume of the imports were higher than exports, generally maintained at the level of 30,000–50,000 tpy, except of a substantial decline to ca. 15,000 t in 2013 (Tab. 1). The sales data for ***coal and graphite electrodes*** and similar products for electrical use (**CN 8545**) have been not available since 2005. However, reported decrease of the trade value[1] in the years 2009–2013 could have been the indication of possible drop of quantity of the sales.

The trade balance in ***natural graphite*** has consistently been negative. Deficit varied between 7 and 35 million PLN/y in the years 2009–2013, depending mainly on imports volume (Tab. 4). On the contrary the trade balance of ***synthetic graphite*** and ***related products*** has been at that time positive. However, it strongly fluctuated between 23 million PLN in 2011 and 82 million PLN in 2013 (Tab. 4). Great surplus was reported in case of trade of coal and graphite electrodes and similar products for electrical use, however, it significantly dropped, from 384 million PLN in 2009 to 169 million PLN in 2013.

Tab. 4. Value of natural and synthetic graphite trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Natural graphite CN 2504					
Exports	449	232	3,260	5,980	4,410
Imports	8,062	17,959	38,138	26,325	28,449
Balance	**-7,613**	**-17,727**	**-34,878**	**-20,345**	**-24,039**
Synthetic graphite and related products CN 3801					
Exports	140,848	146,281	198, 247	222,805	151,148
Imports	115,369	102,014	174, 949	147,118	69,050
Balance	**+25,479**	**+44,267**	**+23,298**	**+75,687**	**+82,098**

Source: ***The Central Statistical Office (GUS)***

Unit values of ***natural graphite*** imports to Poland amounted to 820–1,880 USD/t in the last years (Tab. 5). Unit values of different grades of graphite ranged from 60-80 USD/t (***graphite*** from Ukraine), 800–1,700 USD/t (***graphite*** from China), 1000–2500 USD/t (***graphite*** from the Czech Republic), to 600–4,000 USD/t (***graphite*** from the other suppliers).

Consumption

There are no exact data available on the structure of ***natural graphite*** consumption in Poland. However, it is estimated that demand for ***flake graphite*** in the refractories

[1] According to the ***Yearbook of foreign trade statistics*** value of exports of coal and graphite electrodes considerably decreased from 539 million PLN in 2009 to 336 million PLN in 2013, while imports value slightly increased from 155 million PLN in 2009 to 167 million PLN in 2013.

Tab. 5. Unit values of natural graphite imports to Poland

Year	2009	2010	2011	2012	2013
PLN/t	2,804.2	2,491.5	3,681.6	6,125.5	3,877.0
USD/t	915.0	821.1	1,240.4	1,879.3	1,242.2

Source: ***The Central Statistical Office (GUS)***

industry (***magnesia-carbon*** and ***alumina-carbon refractories***), rose to above 6,000 tpy in recent years, with the exception of 2009, when it did not exceed ca. 2,000 t. The major domestic consumers in that sector have been ArcellorMittal Refractories of Cracow, Ropczyce Magnesite Plant, Vesuvius Skawina Refractories, and PCO Żarów. The smaller amounts of the imported graphite are used for ***brake friction linings*** and ***lubricant*** (***"amorphous"*** grade), ***seal*** and recently also in electrolytic machining (e.g. parts of machines made from hardened steel). A potential growth of demand for graphite might constitute commencement of the refractory concretes production for lining of the blast furnace trough that will replace molded products.

Domestic, as well as imported ***synthetic graphite*** and ***related products***, are used for production of electrodes, linings for blast furnace, electric arc furnace, and Al electrolyzers, cathode blocks, crucibles, in foundries, etc. ***"Amorphous" natural graphite***, but especially ***synthetic graphite*** (also ***granulated graphite*** produced by **Pegas Co.** from Olkusz on the basis of ***synthetic graphite***) are used in cast iron carburizing and cast steel carbon restoration.

Principal companies involved in synthetic graphite production in Poland as of December 2013

- SGL Carbon Polska S.A. (SGL Carbon Polska Joint Stock Co.), ul. Piastowska 29, 47–400 Racibórz, tel. +48 32 4154501, fax +48 32 4595520, www.sglcarbon.com — *graphite linings, graphite cathode blocks, graphite electrodes.*

GYPSUM AND ANHYDRITE

Overview

Gypsum (**$CaSO_4 \cdot 2H_2O$**) is a widely known construction binding mineral. It forms individual evaporate-type deposits, which are very common all over the world. It is also obtained as a by-product of certain chemical processes, e.g. desulfurization of off-gases in power plants (**synthetic gypsum**), or in course of processing phosphorus minerals into fertilizers (**phospho-gypsum**). Raw gypsum is an important cement additive. After partial dehydration of raw gypsum to **calcined gypsum $CaSO_4 \cdot 0.5H_2O$**, it is utilized for the commercial production of ***gypsum binders***, as well as ***gypsum prefabricated construction materials***, such as ***hollow bricks***, ***gypsum plasterboard***, ***dry plasters***.

Anhydrite (**$CaSO_4$**) is also a common mineral, but of much less economic significance. It is now used mainly for the production of cement (as an additive) and self-levelling floor layers, though in the past it was also used for the production of sulphuric acid.

Sources

Gypsum forms primarily Miocene evaporate-type deposits, occurring along the north edge of the **Carpathian Foredeep**. The resources of these shallow deposits are estimated at billions of tons, including eight deposits recognized in the Nida river valley, with 177.6 Mt (as of 31 December 2013). Only two of them are currently mined, i.e. **Leszcze** and **Borków-Chwałowice** deposits. Gypsum is also recognized in the roof part of several ***anhydrite*** deposits in the Lower Silesia. ***Alabaster*** (the decorative variety of gypsum) was occasionally extracted from the **Łopuszka Wielka** deposit near Przeworsk. The total resources of gypsum were 181.7 Mt, including 59.7 Mt in developed deposits (as of 31 December 2013). The prognostic resources are many times larger.

Deposits of ***anhydrite*** accompanying ***copper ore*** in the Lower Silesia form outcrops along the edge of the **North Sudetic Syncline**. Near the surface anhydrite is usually transformed into anhydrite-gypsum rock or gypsum rock. Four anhydrite deposits have been recognized there: three in Niwnice near Lwówek Śląski (**Nowy Ląd**, **Nowy Ląd-Pole Radłówka**, and **Nawojów Śląski**) and one in Iwiny near Bolesławiec (**Lubichów**). Their total resources were 71.8 Mt, including 69.7 Mt in three operated deposits: **Nowy Ląd**, **Nowy Ląd-Pole Radłówka**, and **Lubichów** (as of 31 December 2013). The large deposits of anhydrite available from the headings of the **Lubin-Głogów Copper District** have not been recognized.

A huge secondary source of gypsum is ***phospho-gypsum***, a waste material stored at the **Police**, **Gdańsk** and **Wizów** chemical plants. It has been derived from the production of fertilizers made of ***phosphates*** and ***apatites*** (these plants deliver ca. 2 Mtpy of phosphogypsum). There is also enormous potential for ***secondary gypsum*** (***synthetic gypsum***) production in the process of removing ***sulphur*** from ***off-gases*** in coal-fired power plants. However, only a part of power plants constructed desulphurisation installations with the use of wet lime method and synthetic gypsum as a product. Up till now, such installations were commissioned at the **Bełchatów**, **Pątnów**, **Opole**, **Jaworzno III**, **Konin**, **Połaniec**, **Łaziska**, **Dolna Odra**, **Kozienice**, **Ostrołęka**, **Rybnik,** and **Siekierki** power plants.

Production

Gypsum rock mines were traditional and — till 2000 — main sources of gypsum raw materials in Poland. The leading Polish producer of ***gypsum rock*** is the **Dolina Nidy Gypsum Plant** of Leszcze, which delivered usually ca. 414,000–600,000 tpy from the **Leszcze** deposit. Around 80% of its production has been consumed internally for the production of ***gypsum binders*** and ***plasters*** (on site), as well as of ***gypsum plasterboards*** (in separate plant). The remaining 20% of production (mainly 0–30 mm fraction) has been sold to cement plants and abroad. **Dolina Nidy Gypsum Plant** has been run by the consortium of Polish company **Atlas Łódź** and French company **Lafarge**. Currently, **Atlas** has operated the ***gypsum binders***, ***plasters***, and ***blocks*** production unit through its subsidiary **- Nowa Dolina Nidy**, whereas **Lafarge -** through its subsidiary **Lafarge Gips Polska**, which in October 2012 changed name to **SINIAT**, has managed ***gypsum plasterboard*** production[1].

Rigips Saint-Gobain Rigips-Stawiany Plant of Szarbków is the second domestic producer of ***gypsum rock***. Its production from the **Borków-Chwałowice** deposit has recently varied between 414 and 532 ktpy. Until 1999, the plant produced only gypsum rock, which was sold mainly to cement plants. However, after a new gypsum plasterboard plant commissioning (see: **Consumption**), close to the mine site in 1999, the sales of gypsum rock from this plant were sharply reduced.

Smaller amounts of ***gypsum rock*** — less than 35,000 tpy — have been supplied by the **Nowy Ląd Gypsum and Anhydrite Mine** of Niwnice, which has extracted the **Nowy Ląd** deposit. However, ***white gypsum*** of the best quality, has been entirely processed on site. Due to expected exhaustion of gypsum reserves in the **Nowy Ląd** deposit, in 2005 the company started to extract satellite deposit — **Nowy Ląd-Radłówka**, the raw material of which is white gypsum of the highest quality. It has been processed in whole at the site into the different grades of white gypsum binders and special gypsum (i.e. dental, surgical, etc.).

The total production of ***gypsum rock*** in Poland in 2009 amounted to 1.1 Mt, but in subsequent years, due to economic slowdown in the domestic construction industry, as well as the increasing share of synthetic gypsum in Polish gypsum market, it decreased to only 0.95 Mt in 2013 (Tab. 1).

The domestic production of ***anhydrite***, in the recent five years has ranged between 133 and 167 ktpy (Tab. 1). Both mines — **Niwnice** in Niwnice and **Lubichów** in Iwiny — have been recently operated by one company: **Nowy Ląd Gypsum and Anhydrite Mine** of Niwnice. This company is owned by the leading domestic producer of construction dry

[1] It manages **SINIAT**, while its products have a brand name **Nida**.

Tab. 1. Gypsum and anhydrite statistics in Poland — CN 2520 10

'000 t

Year	2009	2010	2011	2012	2013
Production	3,353.1	3,567.9	3,730.7[r]	3,799.7[r]	3,852.1
— gypsum rock	*1,124.9*	*1,012.2*	*1,067.3*	*1,077.6*	*951,8*
— anhydrite	*151.9*	*167.1*	*158.3*	*150.3*	*132.8*
— synthetic gypsum	*2,076.3*	*2,388.6*	*2,505.1*[r]	*2,571.8*[r]	*2,767.5*
Imports	158.0	129.3	131.5	123.2	19.5
Exports	0.2	0.3	49.2	44.7	44.8
Consumption[a]	3,510.9	3,696.9	3,813.0[r]	3,878.2[r]	3,826.8

Source: ***The Central Statistical Office (GUS)***

mixes and binders: **Atlas** of Łódź. To date, **Niwnice** plant has supplied 40,000–60,000 tpy of ***anhydrite lumps*** (<100 mm), while the rest of the output has been processed into ***anhydrite powder*** (<0.1 mm). The **Lubichów** plant has produced entirely ***anhydrite powder***. However, after modernization of Niwnice plant (construction of modern gypsum binders mixing plant, anhydrite milling plant, and modern gypsum calciner), anhydrite lumps deliveries were reduced. It resulted from the new strategy of the owner — to develop a wide range of products under the trade name ***Gipsar*** such as ***anhydrite binders***, ***gypsum binders***, ***gypsum-anhydrite binders***, and ***white gypsum coats*** and ***self-levelling floors***.

Synthetic gypsum, obtained from flue gas desulphurisation in power plants, is a very important substitute for gypsum rock, with similar applications. Its production in Poland began in 1994 with the commissioning of the first installation at the **Bełchatów** power plant. Currently, such installations have operated in ten power plants: **Bełchatów** (since 1994, the capacity of 1,800,000 tpy), **Jaworzno III** (since 1996, ca. 240,000 tpy), **Opole** (since 1997, ca. 190,000 tpy), **Konin** (since 1997, ca. 70,000 tpy), **Połaniec** (since 1999, ca. 180,000 tpy), **Łaziska** (since 2000, ca. 140,000 tpy), **Dolna Odra** (since 2000, ca. 100,000 tpy), **Kozienice** (since 2001, ca. 240,000 tpy), **Ostrołęka** (since 2008, ca. 80,000 tpy), **Rybnik** (since 2008, ca. 100,000 tpy), **Pątnów I** and **II**, (since 2008, ca. 540,000 tpy), and **Siekierki** (since 2011, ca. 80,000 tpy). As a consequence, the production of synthetic gypsum rose from about 30,000 t in 1994 to 1,140,000 t in 2000, and up to a record of 2,767,000 t in 2013 (Tab. 1).

The total domestic production of ***gypsum*** and ***anhydrite*** increased from 3.3 Mt in 2009 to 3.8 Mt in 2013 (Tab. 1). A share of natural gypsum and anhydrite in the total supply decreased from 100% in 1993 to only 28.2% in 2013.

Trade

Exports of ***gypsum*** in the years 2009–2010 almost died out (Tab. 1). This was mainly ***gypsum rock***. In 2011 exports increased to 49,200 t, while in next two years stabilized at a level of around 45 ktpy. The ***synthetic gypsum*** has been the most important exported gypsum commodity. The traditional recipients of gypsum rock were the Czech Republic, Hungary, Germany, and Russia, while synthetic gypsum was sold to Germany.

For many years gypsum was usually imported in quantities from 4 to 8 ktpy. The majority of these deliveries was high quality ***white gypsum*** from Germany. However, due to the deficit of gypsum for gypsum plasterboard and cement production on the domestic market, in the years of 2009–2012 imports of ***gypsum*** to Poland exceeded 120,000 tpy, with sharp reduction to 19,500 t in 2013 (Tab. 1). It was mainly synthetic gypsum from flue gas desulphurisation installations in Germany, and in 2009 - also synthetic gypsum from the Czech Republic (Tab. 2).

Tab. 2. Polish imports of gypsum, by country — CN 2520 10

'000 t

Year	2009	2010	2011	2012	2013
Imports	**158.0**	**129.3**	**131.5**	**123.2**	**19.5**
Czech Republic	0.7	–	–	–	–
France	–	3.2	4.3	2.1	2.4
Germany	157.2	126.1	126.3	120.9	17.0
Ukraine	–	0.0	–	–	0.0
Others	0.1	0.0	0.9	0.2	0.1

Source: ***The Central Statistical Office (GUS)***

Anhydrite has not been probably traded in recent years.

The ***gypsum*** trade balances have been very unstable, due to varying volume of exports and imports, as well as high unit values of the best quality gypsum assortments that have been imported (Tab. 3). However, since 2006 it has been staying negative.

Tab. 3. Value of gypsum trade in Poland — CN 2520 10

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	71	212	227	294	740
Imports	9,026	11,857	12,430	11,695	5,243
Balance	**-8,955**	**-11,645**	**-12,203**	**-11,401**	**-4,503**

Source: ***The Central Statistical Office (GUS)***

Average unit values of the ***gypsum rock*** production sold in Poland in 2009 amounted to 32.4 PLN/t, i.e. 10.4 USD/t (Tab. 4). In 2010 there was recorded a significant increase of the unit value of sales - by 27% in PLN/t and 30% in USD/t (Tab. 4). In the years 2011–2012 the value of production sold slightly increased, by 4% in PLN/t to 42.8 PLN/t, but in USD/t, after a slight increase in 2011, in 2012 it decreased by 6% to 13.1 USD/t. In 2013 the value increased significantly, by 17% in PLN/t and by 21% in USD/t (Tab. 4)

Average unit values of ***gypsum rock*** exports in 2009 amounted to 344 PLN/t, while in 2010 they rose by almost 200% (Tab. 4), probably due to increased share of high quality white gypsum. Large amounts of synthetic gypsum exported in the years 2011–2012 to Germany were worth only 1 PLN/t in 2011 and 1.5 PLN/t in 2012, resulting in sharp decrease in the average unit value of exports, which amounted to only 4.6 and 6.6 PLN/t, respectively. In 2013 Germany was again the main recipient of Polish synthetic gypsum exports, the unit value of which increased to 4 PLN/t so the total unit value of gypsum rock exportation from Poland reached 16.5 PLN/t, i.e. 5.2 USD/t (Tab. 4).

Average unit values of ***gypsum rock*** importation showed an increasing tendency in the years 2009–2013. Moreover, in 2009–2010 they were ten times lower than the unit values of exports. It was correlated with increased share of cheap synthetic gypsum in the total imports. In 2013 foreign deliveries were six times lower, the share of cheap synthetic gypsum diminished too, so the unit value of gypsum rock imports increased significantly up to almost 269 PLN/ t, i.e. 85.6 USD/t (Tab. 4).

Tab. 4. Average unit values of gypsum production and trade in Poland — CN 2520 10

Year	2009	2010	2011	2012	2013
Production average unit values					
PLN/t	32.4	41.1	41.3	42.8	50.3
USD/t	10.4	13.5	13.9	13.1	15.8
Exports average unit values					
PLN/t	344.0	681.2	4.6	6.6	16.5
USD/t	107.0	227.3	1.6	2.0	5.2
Imports average unit values					
PLN/t	57.1	83.0	94.5	95.0	268.7
USD/t	18.5	27.4	32.2	29.1	85.6

Source: ***The Central Statistical Office (GUS)***

Consumption

Gypsum and ***anhydrite*** are the basic raw materials for the production of numerous construction materials. Calcined gypsum is used in the majority of applications, while raw gypsum or anhydrite - in the cement industry. The main gypsum and anhydrite applications are: the production of cement (as a few percent additives), binders and plasters, plasterboards, wall elements and other construction products (gypsum), self-levelling floor layers (anhydrite).

Cement plants have been the main consumers of gypsum and anhydrite for years. In 2009–2013 gypsum and anhydrite consumption in cement plants fluctuated between 700 and 900 ktpy due to variable level of the production of cement. These facts coupled with rising demand in other applications resulted in the declining share of this sector in total gypsum raw materials consumption — from over 60% in the beginning of the 1990s to 18–21% in recent years. Cement plants have utilised ***natural gypsum rock***, ***anhydrite lump***, and — in recent years — also ***synthetic gypsum*** from power plants (**Bełchatów**, **Konin**, **Połaniec**, **Łaziska**). The share of ***synthetic gypsum*** in the consumption of cement industry has achieved ca. 60% recently. These materials are added as corrective constituents of ***Portland cement*** (4–6% of a batch for its production), and — in minor quantities — for the production of ***anhydrite cement*** and other high quality cement grades. It is probable that in coming years gypsum raw materials consumption in this sector will decrease, if ashes from fluidised bed combustion will start to be used in significant quantities. They can be used simultaneously as pozzolanic admixture and as material for setting time regulation (instead of gypsum raw materials).

The most typical use of gypsum is the production of ***gypsum binders*** and ***mortars***. In the years of 2009-2011 it was continuously increasing, jointly by 23%, and amounted to the record volume of 1,625,900 t, but in the period 2012–2013 it decreased by almost 29%, down to 1,263,700 t, and was lower than recorded in 2009 (Tab. 5). **Dolina Nidy** has been the main producer, but more than 20 other domestic and international companies have been also active on the market (e.g. **Knauf**, **Henkel**, **Siniat**, **BPB**, **Kreisel**, **Arel–Gips**, **Alpol Gips**, **Megaron**, **Franspol**). In addition to natural gypsum rock, traditionally used in Poland for the production of gypsum binders, synthetic gypsum has been also introduced for this purpose (e.g. by **Knauf-Jaworzno III** in Jaworzno, **Arel-Gips** in Bełchatów, **Megaron** in Szczecin, **Piotrowice III** in Rybnik, **Franspol** in Konin and Połaniec, **Atlas** in Konin, **Kreisel** in Bełchatów and recently in Ostrołęka). A part of produced gypsum binders has been used for the production of ***gypsum plasterboards*** and ***stuccowork***, which have been supplied by more than 20 domestic companies. In spite of the sharp increase in the production of gypsum binders in Poland, there has been a noticeable deficit on the domestic market, especially of ***white gypsum binders***, though **Nowy Ląd Gypsum and Anhydrite Mine Ltd.** of **Niwnice** has developed their production (under the trade name of ***Gipsar***). Such a deficit has resulted in growth of imports until 2008, when it amounted to the record volume of 215,500 t, but in the following years – due to the production development – the importation has been reduced to the level of ca. 40-50 ktpy (Tab. 5).

Tab. 5. Gypsum binders statistics in Poland — CN 2520 20

‘000 t

Year	2009	2010	2011	2012	2013
Production	1,317.4	1,346.8	1,625.9	1,509.6	1,263.7
Exports	40.3	30.0	50.8	60.8	67.8
Imports	82.6	53.6	46.3	39.3	42.8
Consumption[a]	1,359.7	1,370.4	1,621.4	1,488.1	1,238.7

Source: ***The Central Statistical Office (GUS)***

Until 1997, gypsum was used for the production of ***gypsum plasterboards*** in only one plant: **Nida-Gips Ltd.** of **Gacki** (subsidiary of **Dolina Nidy Gypsum Plant**), delivering up to ca. 10 Mm^2 of plasterboard per year. In the years 1997–1998 **Knauf** of Germany opened a plant with total capacity of 24 Mm^2py near the **Bełchatów** power plant. In 1998, the **Norgips** of Norway constructed another plant based on synthetic gypsum near the **Opole** power plant (capacity 40–50 Mm^2py), which currently is operated by **Knauf Bełchatów Ltd.** Yet another plant, based on gypsum rock from **Stawiany** mine in **Szarbków**, with a capacity of 26 Mm^2py, was commissioned by **Rigips Polska Stawiany**, a subsidiary of **British Plaster Board** in 1999, currently **Rigips Saint-Gobain Rigips-Stawiany Plant**. The last new plant was commenced in 2002 by **SINIAT** in **Leszcze**, former **Lafarge Nida Gips Ltd.** in **Gacki** (capacity of 45 Mm^2py). Although ***gypsum plasterboard*** production in Poland has grown very dynamically in recent years — from less than 10 Mm^2py to the record of 138.5 Mm^2 in 2008. In the period 2009–2013 due to domestic market condition worsening, the production decreased to less than 109 Mm^2/y, what — together with restricted imports volume — was correlated with the domestic consumption (Tab. 6). Since 1999 Poland has started to be a very significant supplier of these products to Eastern and Central Europe markets. As a result of the growing plasterboards production in Poland its share in the total consumption of gypsum raw materials increased from only 4% in the beginning of the 1990s to ca. 40% in 2008, but in period 2009–2013 it decreased to ca. 30%. Future development of the production will depend — however — on the condition of domestic construction sector, as well as on possibilities of plasterboard exportation.

Tab. 6. Statistics of gypsum plasterboards and relative gypsum products in Poland — CN 6809

million m²

Year	2009	2010	2011	2012	2013
Production[e]	117.5	116.7	112.8	108.7	108.9
Exports	47.0[e]	39.0[e]	40.4[e]	41,1[e]	40.8[e]
[‘000 t]	*437.7*	*363.7*	*377.0*	*383.7*	*380.8*
Imports	3.2[e]	3.5[e]	3.9[e]	3.5[e]	3.3[e]
[‘000 t]	*30.1*	*32.5*	*36.8*	*33.2*	*31.2*
Consumption[a,e]	73.7	81.2	76.3	71.1	71.4

Source: ***The Central Statistical Office (GUS)***

Despite since 1999 Poland has been a net exporter of ***gypsum binders*** and ***plasterboards***, in the years 2009–2010 their trade balances were negative. In subsequent three years they turned positive, mainly due to reduced imports and increased foreign sales (Tab. 7 and 6).

Tab. 7. Value of gypsum binders and plasterboards trade in Poland

‘000 PLN

Year	2009	2010	2011	2012	2013
Gypsum binders CN 2520 20					
Exports	29,038	18,721	29,016	35,212	37,782
Imports	36,854	25,984	26,433	24,668	23,443
Balance	**-7,816**	**-7,263**	**+2,853**	**+10,544**	**+14,339**
Gypsum plasterboards CN 6809					
Exports	240,934	178,006	204,179	211,910	213,867
Imports	26,518	29,945	33,788	36,721	33,737
Balance	**+214,416**	**+148,061**	**+170,391**	**+175,189**	**+180,130**

Source: ***The Central Statistical Office (GUS)***

Other uses of gypsum have been of minor importance. The **Nowy Ląd Gypsum and Anhydrite Mine Ltd**. of Niwnice has bee virtually the only Polish producer of ***specialized grades of gypsum***: ***ceramic***, ***plaster of Paris***, ***dental***, and ***surgical gypsum***. **Dolina Nidy Gypsum Plant** is the main producer of ***gypsum wall elements*** and ***gypsum***

stuccowork, but there have been also more than 20 domestic producers of such products (e.g. **VG-Orth** in Jaworzno, **Baumit** in Bełchatów).

The main areas of ***anhydrite*** application in Poland include ***self-levelling floor layers***, and ***anhydrite binders*** in the form of ***anhydrite powder***. Other uses of anhydrite powder, such as the production of furniture glue, PVC floor tiles, or fire dams in underground coal mines, have been of marginal importance. The development of the construction industry creates a perspective for further increase in demand for anhydrite powder, both in the area of ***self-levelling floor layers*** and ***anhydrite binders***. Growth of the production of ***Gipsar white anhydrite binder*** in **Nowy Ląd** has been a good example.

The structure of ***gypsum*** and ***anhydrite*** consumption has changed significantly in recent years. It is estimated that in 2013 ca. 18% of the total tonnage was used in the cement industry as a ***cement additive*** (ca. 48% in 1995), ca. 30% for ***gypsum plasterboard*** production (only ca. 9% in 1995), ca. 33% for ***binding materials*** (ca. 38% in 1995), and ca. 9% for other uses (ca. 6% in 1995), including increased utilisation of raw gypsum as a component of subsoil in cultivation of mushrooms in recent years. The increasing supplies of ***synthetic gypsum*** from flue gas desulphurisation at power plants on domestic market have led to oversupply. In 2013 the surplus amounting to ca. 0.4 Mt was stored at some power plants waste dumps.

Companies involved in gypsum and anhydrite production in Poland, as of December 2013

- Dolina Nidy Sp. z o.o. w Leszczach (Dolina Nidy Ltd. of Leszcze), Leszcze 15, 28–400 Pińczów, tel. +48 41 3578100, fax +48 41 3578700, www.dolinanidy.com.pl — *gypsum rock, gypsum products*.
- Rigips Saint-Gobain Fabryka Rigips-Stawiany w Szarbkowie (Rigips Saint-Gobain Rigips-Stawiany Plant of Szarbków), 28–400 Pińczów, +48 41 3569208, fax +48 41 3569298, www.rigips.com.pl — *gypsum rock, gypsum plasterboards*
- SINIAT, Zakład Produkcyjny Płyt Gipsowo-Kartonowych w Leszczach (SINIAT, The Gypsum Plasterboard Factory of Leszcze), Leszcze 15, 28–400 Pińczów, tel. +48 41 3578200, fax +48 41 3578161, www.siniat.pl — *gypsum plasterboards*.
- Kopalnia Gipsu i Anhydrytu Nowy Ląd Sp. z o.o. w Niwnicach (Nowy Ląd Gypsum and Anhydrite Mine Ltd. of Niwnice), 59–600 Lwówek Śląski, tel. +48 75 7824356, fax +48 75 7823557, www.nowylad.com.pl — *specialized gypsum grades, anhydrite lumps, anhydrite powder, gypsum and anhydrite binders*.
- PGE GiEK S.A. Oddział Elektrownia Bełchatów w Rogowcu (PGE GiEK Joint Stock Co. Division of Bełchatów Power Plant of Rogowiec), 97–406 Bełchatów 5, Rogowiec, +48 44 6325132, fax +48 44 7352211, www.elbelchatow.pgegiek.pl — *synthetic gypsum*.
- PGE GiEK S.A. Oddział Elektrownia Opole w Brzeziu (PGE GiEK Joint Stock Co. Division of Opole Power Plant of Brzezie), 46–021 Brzezie k. Opola, tel. +48 77 4235050, fax +48 77 4235012, www.elopole.pgegiek.pl — *synthetic gypsum*.
- Tauron Wytwarzanie S.A. Oddział Jaworzno III w Jaworznie (Tauron Wytwarzanie Joint Stock Co. Division of Jaworzno III in Jaworzno), ul. Promienna 51, 43–603 Jaworzno, tel. +48 32 6155071, fax +48 32 7153088, www.pl.ej3.pkesa.com — *synthetic gypsum*.

- Tauron Wytwarzanie S.A. Oddział Łaziska w Łaziskach Górnych (Tauron Wytwarzanie Joint Stock Co. Division of Łaziska in Łaziska Górne), ul. Wyzwolenia 30, 43–174 Łaziska Górne, tel. +48 32 2241100, fax +48 32 2247416, www.tauron-wytwarzanie.pl/oddzialy/laziska/Strony/informacje.aspx — *synthetic gypsum*.
- Zespół Elektrowni Pątnów-Adamów-Konin S.A. (Pątnów-Adamów-Konin Power Plants Complex Joint Stock Co.), ul. Kazimierska 45, 62–510 Konin, tel. +48 63 2473000, fax +48 63 2473030, www.zepak.com.pl — *synthetic gypsum*.
- GDF SUEZ Energia Polska S.A. w Połańcu (GDF SUEZ Polish Energy Joint Stock Co. of Połaniec), Zawada 26, 28–230 Połaniec, tel. +48 15 8656565, fax +48 15 8656688, www.gdfsuez-energia.pl — *synthetic gypsum*.
- PGE GiEK S.A. Oddział Zespół Elektrowni Dolna Odra (PGE GiEK Joint Stock Co. Division of Dolna Odra Power Plants Complex), 74–105 Nowe Czarnowo 76 k. Gryfina, tel. +48 91 3165100, fax +48 91 4162000, www.zedolnaodra.pgegiek.pl — *synthetic gypsum*.
- ENEA Wytwarzanie S.A. (ENEA Wytwarzanie Joint Stock Co.), Świerże Górne, gm. Kozienice, 26–900 Kozienice 1, tel. +48 48 6142414, fax +48 48 6143516, www.elko.com.pl — *synthetic gypsum*.
- ENERGA Elektrownie Ostrołęka S.A. w Ostrołęce (ENERGA Ostrołęka Power Plants Joint Stock Co.), ul. Elektryczna 5, 07–401 Ostrołęka, tel. +48 29 7692000, fax +48 29 7691145, www.energa-elektrownie-ostroleka.zeo.pl — *synthetic gypsum*.
- EDF Polska Oddział Rybnik (EDF Poland – the plant in Rybnik), ul. Podmiejska 28, 44–207 Rybnik, tel. +48 32 7391000, fax +48 32 4227894, polska.edf.com — *synthetic gypsum*.
- PGNiG TERMIKA S.A. w Warszawie, Elektrociepłownia Siekierki (PGNiG TERMIKA Joint Stock Co. of Warsaw, Siekierki Heat and Power Plant), ul. Augustówka 30, 02–981 Warszawa, tel. +48 22 8422041, fax +48 8423842, www.termika.pgnig.pl/o-firmie/nasze-zaklady/elektrocieplownia-siekierki — *synthetic gypsum*.
- Knauf Bełchatów Sp. z o.o. w Rogowcu (Knauf Bełchatów Ltd. of Rogowiec), 97–427 Rogowiec, tel. +48 44 7315500, fax +48 44 7315502, www.knauf.pl — *gypsum plasterboards*.
- Knauf Bełchatów Sp. z o.o. w Rogowcu, Zakład Produkcyjny w Brzeziu k. Opola (Knauf Bełchatów Ltd. of Rogowiec, Production Plant in Brzezie near Opole), ul. Norweska 1, 46–081 Brzezie, tel./fax +48 77 4516115 — *gypsum plasterboards*.
- Knauf Jaworzno III Sp. z o.o. w Jaworznie (Knauf Jaworzno III Ltd. of Jaworzno), ul. Promienna 51, 43–603 Jaworzno, tel. +48 32 7549900, fax +48 32 7549902, www.knauf.pl — *gypsum binders*.
- Megaron S.A. (Megaron Joint Stock Co.), ul. Pyrzycka 3 e,f, 70–892 Szczecin, tel. +48 91 4664540, fax +48 91 4664541, www.megaron.com.pl — *gypsum binders*.
- Piotrowice III Sp. z o.o. (Piotrowice Ltd.), ul. Golejowska 71, 44–207 Rybnik, tel. +48 32 7396280, fax +32 7396281, piotrowice.com.pl — *gypsum products*.
- Franspol Sp. z o.o. w Koninie (Franspol Ltd. of Konin), ul. Fabryczna 10, 62–510 Konin, tel. +48 63 2408553, fax +48 63 2408517, www.franspol.com.pl — *gypsum products*.

- Kreisel – Technika Budowlana Sp. z o.o. Poznań (Kreisel – Technika Budowlana Ltd. of Poznań), ul. Szarych Szeregów 23, 60–462 Poznań, tel. +48 61 8467900, fax +48 61 8467909, www.kreisel.pl — *gypsum binders*.
- Alpol Gips Sp. z o.o. w Fidorze (Alpol Gips Ltd. of Fidor), Fidor, 26–200 Końskie, tel. +48 41 3721100, fax +48 41 3721284, www.alpol.pl — *gypsum binders*.
- Arel–Gips Bełchatów S.A. w Rogowcu (Arel–Gips Bełchatów Joint Stock Co.), Rogowiec, 97–427 Rogowiec, tel. +48 44 7353637, www.arel-gips.com.pl — *gypsum binders*
- VG-ORTH Polska Sp. z o.o. w Jaworznie (VG-ORTH Polska Ltd. of Jaworzno), ul. Promienna 51, 43-603 Jaworzno, tel. +48 022 369 65 90, fax. +48 022 369 65 92, www.multigips.pl — *gypsum binders*, *gypsum plasterboards*.

HAFNIUM

Overview

Hafnium (**Hf**) occurs as an isomorphous admixture in ***zircon $ZrSiO_4$*** (the sole source of hafnium), from which it is recovered during the production of ***metallic zirconium***. There are known rare minerals of hafnium, but no deposits have ever been found. ***Zircon concentrates*** usually contain 65–66% ZrO_2+HfO_2, including 1–7% HfO_2. Zirconium and hafnium exhibit nearly identical properties and are not treated separately in most applications (except for certain nuclear ones). The basic commercial hafnium products are **hafnium sponge** and **metallic hafnium**, containing 97–99% Hf, as well as chemical compounds, mainly **hafnium oxide**.

The main areas of **hafnium** applications are nuclear power engineering (where it is used in reactor control rods to regulate the fission process through neutron absorption) and super-alloys production. Therefore it is considered a strategic element. However, the specificity of hafnium recovery (in course of metallic zirconium that requires Hf total removal) makes that in recent years there has been more hafnium available than can be consumed. Surpluses have been stockpiled in the form of **hafnium oxide**.

Sources

There are no sources of ***hafnium*** minerals occurring in Poland.

Production

No data on ***hafnium commodities*** production in Poland is available.

Trade

Demand for ***hafnium commodities*** in Poland has been covered by imports of small quantities of ***raw hafnium***. In 2009 these deliveries amounted to 16 kg and came from the United Kingdom, the US and Switzerland, in the years 2010–2011 imports came exclusively from Switzerland and amounted to 3 kg and 6 kg, respectively. In the last two years the importation decreased to 1 kg and 2 kg, respectively, and it was sourced from the US and Switzerland again.

Consumption

The domestic demand for ***hafnium commodities*** has been satisfied by imports, though in fact there are no reliable statistics available.

HARD COAL AND ANTHRACITE

Overview

Hard coal is one of the most important fuels in the world economy, although recently demand has declined, mainly due to reduced consumption in the steel making industry, transportation, and also in households (the last one primarily in Western European countries). It forms huge coal basins or small individual deposits, mainly of late Paleozoic (Upper Carboniferous and Permian age) and Mesozoic age, rarely of Cenozoic age, all around the world.

There are several hard coal classifications in use — e.g. international, American, Australian, Polish — which distinguish numerous classes, types, and grades, depending on the calorific value, sulfur and ash contents, moisture, sinterability, etc. The most important distinction is between **coking** (**metallurgical**) **coal** and **steam** (**thermal**) **coal**. The borderline between **hard coal** and **brown coal** is not always very sharp, e.g. in Western Europe hard coal has calorific value above 5,700 kcal/kg (23,865 kJ/kg) on an ash-free but moist basis, while coal of calorific value below 5,700 kcal/kg is considered as brown coal. In Poland, the border is drawn at 3,000 kcal/kg (12,560 kJ/kg). Brown coals are usually divided into **subbituminous coals** (the hard form, with calorific value between 4,165 kcal/kg and 5,700 kcal/kg) and **lignite** (the soft form, with calorific value below 4,165 kcal/kg — 17,438 kJ/kg). In some countries, such as the US, Australia, Belgium, Finland, France, Japan, New Zealand, Portugal, China, Poland, and Russia, subbituminous coals are included in the category of hard coal.

Sources

Hard coal deposits in Poland occur in three coal basins, all of Upper Carboniferous age: **Upper Silesian** (**GZW**), **Lower Silesian** (**DZW**), and **Lublin** (**LZW**). The total recognized resources of the 151 deposits were 51,415 Mt of coal, including 19,485 Mt in 52 developed deposits (49 extracted deposits and 3 deposits under development, as of 31 December 2013). The available reserves in exploited deposits were estimated at 3,828 Mt. The difficult geological conditions, the growing ecological pressure, and the low quality of coal, especially from the LZW and the eastern part of the GZW, render the future enlargement of available reserves unlikely. There is no reason to expect that new deposits will be recognized in other regions.

The **Upper Silesian Coal Basin** (**GZW**), including 133 deposits with total resources of 41,465 Mt, is the largest one. In 2013 resources increased by ca. 3,200 Mt due to recognition of new deposits: Brzezinka 1 (152 Mt), Dąb (1,086 Mt), Oświęcim-Polanka 1 (534 Mt), and Śmiłowice (513 Mt). There were 30 underground mines in operation with total resources of 17,254 Mt, including 3,219 Mt of available reserves. These deposits contain different types of coal, mainly ***steam coal*** (bituminous and subbituminous), but also ***coking coal*** and ***anthracite***. Due to the low quality of the coal from the eastern part of the GZW, specifically its low calorific value and high sulfur and ash contents (more than 2% and 20% respectively), it could be classified as brown coal (the so-called ***lignite polonaise***). The difficulties encountered in selling this type of coal have caused that some deposits in this area have been abandoned. On the other hand, coal from the western and northern parts of the Upper Silesian Coal Basin is characterized by good quality parameters: high calorific value (ave. 26.4 MJ/kg), low ash content (ca. 13%), and low sulfur content (ave. 0.8%).

The **Lublin Coal Basin** (**LZW**), located in the eastern part of Poland, consists of 11 recognized deposits, out of them only one - **Bogdanka** has been operated. The total resources of this basin (as of 31 December 2013) amounted to 9,590 Mt, mostly of ***steam coal***. Because of difficult geological and mining conditions, only 305 Mt of coal were classified as available reserves in the **Bogdanka** deposit. Coal from the Lublin Basin is characterized by average calorific value of 25.9 MJ/kg, 1.36% sulfur, and 14.6% ash.

The resources of the deposits in the **Lower Silesian Coal Basin** (**DZW**) are practically exhausted, and the remaining coal resources were reclassified as uneconomic. These deposits occur in very difficult geological and mining conditions, in spite of the presence of ***coking coal*** and ***anthracite***, which are scare commodities on the domestic market. In 2011 around 360 Mt previously uneconomic resources in 7 abandoned deposits were qualified as economic (as of 31 December 2013).

Production

In the period of 2009–2013 the production of ***hard coal*** was reduced by ca. 1.0 Mtpy. The exception was 2012 when the hard coal production increased for the first time since 2001 (Tab. 1). Poland has remained an important world producer of hard coal. The share of hard coal in primary energy generation in Poland has slowly decreased, down to 61%.

Tab. 1. Hard coal statistics in Poland — CN 2701

'000 t

Year	2009	2010	2011	2012	2013
Total production	78,064	76,728	76,448	79,813[r]	77,017
— *steam coal*	*69,524*	*65,070*	*65,012*	*68,085*[r]	*64,901*
— *coking coal*	*8,540*	*11,658*	*11,436*	*11,738*	*12,116*
Imports	10,793	14,107	14,955	10,166	10,515
Exports	8,396	10,547	7,007	7,070	10,846
Consumption[a]	80,461	80,288	84,396	82,909[r]	76,686
Stocks change	4,731	-4,500	869	6,839	-2,097
Consumption	75,730	84,788	83,527	76,070[r]	78,783

Source: ***The Central Statistical Office (GUS)***

The main type of hard coal produced is ***steam coal*** (ca. 84% of the total), but in the years 2009–2013 its output decreased by 4.6 Mtpy (Tab. 1). Due to the introduction of new air protection requirements since 1990, some improvement in coal quality parameters has been recorded in recent years, i.e. the calorific value, ash and sulfur contents. However, Polish power plants have still utilized inferior types of steam coal (calorific value below 22.0 MJ/kg), while the better types have been exported. Another type of hard coal produced is ***coking coal***, the output of which rose by 3.6 Mtpy in the years 2009-2013 (Tab. 1).

At the end of 2013, hard coal was extracted in 31 mines, including: 15 mines of **Kompania Węglowa** (**KW**, Coal Company), 5 mines of **Jastrzębska Spółka Węglowa** (**JSW**, Jastrzębie Coal Company), 4 mines of **Katowicki Holding Węglowy** (**KHW**, Katowice Coal Holding), 2 mines of **Południowy Koncern Węglowy** (**PKW**, Southern Coal Company owned by Tauron Polska Energia), **LW Bogdanka** (Bogdanka Lublin Coal), **Kazimierz-Juliusz** (owned by KHW), **Siltech** (private mine), **PG Silesia** (owned by Energeticky a Prumyslovy Holding from the Czech Republic) and **EKO-PLUS** (private mine). KW (Coal Company) has been recently the largest mining company in the European Union, with total capacities ca. 40 Mtpy.

Since the mid-2009 **LW Bogdanka** has been listed on the Warsaw Stock Exchange. In 2010 the State Treasury sold the majority of the remaining shares, decreasing its share to under 5%. In December 2010, **Silesia** mine was sold by **KW** to **Energeticky a Prumyslovy Holding (EPH)**, and in January 2011 **PG Silesia** was established. In 2011, **EKO-PLUS** started to mine **Bytom I-1** deposit on the basis of infrastructure of the former **Powstańców Śląskich** mine (later: **ZG Bytom I**). Since the mid-2011 **JSW** has been listed on the Warsaw Stock Exchange. At the end of 2013 the State Treasury had ca. 55% shares of this company. In the beginning of 2010 **Murcki** and **Staszic** mines were merged into one mine by **KHW**, and **Knurów** and **Szczygłowice** mines were merged by **KW**, while in the begining of 2011 **Borynia** and **Zofiówka** mines were merged by **JSW**.

Trade

In the years 2009–2013 Polish ***coal*** exports increased by 30% to almost 11 Mtpy, mostly in 2013 (Tab. 2). Level of exportation has been strictly correlated with purchases of European countries, being its main recipients (ca. 94% of Polish hard coal exports in 2013). Among the importers, the leading positions have been held by EU countries: Germany, the Czech Republic, Austria, Slovakia, the United Kingdom, France, and others. ***Steam coal*** has been the main variety sold — ca. 79%. The rest consisted mostly of ***coking coal*** and marginal quantities of ***other hard coal products***.

Only high-quality coal grades that comply with the requirements of international markets are exported. There are several companies involved in foreign trade. The most important has been **Węglokoks**, specialized in the marketing and exportation of hard coal and coke.

In 2008, for the first time in the history, Poland become net importer of ***hard coal***. In 2009–2011 total hard coal imports rose by 45%, to 15.0 Mtpy, exceeding by 8.0 Mtpy the volume of exports. In 2012 this tendency was stopped and imports decreased to 10.2 Mt, but still were 3.1 Mt higher than exports. In 2013 imports rose slightly to 10.5 Mt, while exports jumped to 10.9 Mt, and Poland became again a net exporter of hard coal (Tab. 2, 3). Moreover, some imports of ***anthracite*** were reported. ***Steam coal*** and ***anthracite*** were imported mainly from Russia, the Czech Republic, Ukraine (***anthracite***), and Kazakhstan, while ***coking coal*** from the US, Australia, the Czech Republic and Colombia.

Tab. 2. Polish exports of hard coal, by country — CN 2701

'000 t

Year	2009	2010	2011	2012	2013
Exports	**8,396**	**10,551**	**7,021**	**7,072**	**10,849**
• ***steam coal***	***6,671***	***8,523***	***5,237***	***5,289***	***8,595***
• ***coking coal***	***1,725***	***2,024***	***1,770***	***1,780***	***2,252***
• ***other hard coal products***	***0***	***4***	***13***	***2***	***2***
Austria	1,212	818	432	786	806
Belgium	79	229	1	80	450
Bosnia and Herzegovina	40	46	7	267	169
Czech Republic	1,452	1,551	1,865	1,547	1,627
Denmark	91	455	59	60	553
Finland	224	185	37	148	358
France	390	603	1	212	534
Germany	2,661	4,290	2,669	2,762	3,376
Hungary	76	188	135	95	88
Ireland	240	247	206	134	179
Lithuania	0	1	1	0	0
Morocco	–	–	–	–	387
Netherlands	165	73	0	0	148
Norway	66	73	76	117	102
Romania	0	0	0	26	38
Serbia	1	1	0	6	0
Slovakia	487	639	578	335	764
Spain	73	23	60	17	19
Sweden	59	132	105	103	184
Turkey	478	292	–	147	214
Ukraine	20	66	150	139	131
United Kingdom	577	639	634	89	668
Others	5[r]	0	5	2	54

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Polish imports of hard coal, by country — CN 2701

'000 t

Year	2009	2010	2011	2012	2013
Imports	**10,820**	**14,150**	**14,991**	**10,193**	**10,528**
• ***steam coal***	***8,534***	***10,831[e]***	***12,691[e]***	***8,568[e]***	***8,210[e]***
• ***coking coal***	***2,259***	***3,276[e]***	***2,263[e]***	***1,597[e]***	***2,305[e]***
• ***other hard coal products***	***27***	***43***	***36***	***27***	***13***
Australia	64	283	137	356	1,013
Belgium	0	69	0	0	1
Canada	–	–	0	65	120

China	5	5	6	4	4
Colombia	255	344	323	87	60
Czech Republic	1,751	2,618	2,928	1,572	1,648
Germany	30	55	38	28	14
France	12	11	0	–	3
Kazakhstan	298	267	341	283	182
Netherlands	0	41	0	0	0
Norway	–	36	0	–	38
Russia	7,075	8,155	9,310	6,568	6,541
South Africa, Republic of	3	–	–	0	–
Ukraine	352	402	568	396	377
USA	963	1,852	1,319	796	521
Venezuela	–	–	–	32	–
Others	12	12	21	6	6

Source: ***The Central Statistical Office (GUS)***

In 2009-2012 ***hard coal*** trade balance were negative. In 2011 the deficit deepened to 2,905 million PLN, while in 2012 it improved to 908 million PLN. On the other hand - in 2013, the surplus of 214 million PLN was reported (Tab. 4). Crucial factor has been volume of trade, because prices of exported ***steam coal*** have been generally higher than in imports, while in the case of ***coking coal*** import prices have been usually higher (Tab. 5).

Tab. 4. Value of hard coal trade in Poland — CN 2701

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	2,965,037	3,596,160	3,407,531	3,154,751	3,900,212
Imports	3,305,137	5,209,265	6,312,725	4,062,864	3,686,157
Balance	**-340,100**	**-1,613,105**	**-2,905,194**	**-908,113**	**+214,055**

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Average unit values of hard coal trade in Poland

Year	2009	2010	2011	2012	2013
Hard coal CN 2701					
Exports unit values					
— PLN/t	353.2	340.8	485.3	446.1	359.5
— USD/t	113.8	112.9	165.7	136.7	114.3
Imports unit values					
— PLN/t	305.5	368.1	421.1	398.6	350.1
— USD/t	98.3	121.8	143.0	121.9	111.5

Steam coal CN 2701 19					
Exports unit values					
— PLN/t	339.9[e]	290.5	396.4	390.7	325.6
— USD/t	109.2[e]	96.3	134.9	119.7	103.5
Imports unit values					
— PLN/t	258.9[e]	273.8[e,r]	342.5[e]	329.2[e]	289.2[e]
— USD/t	83.5[e]	90.9[e,r]	116.3[e]	100.7[e]	92.1[e]
Coking coal CN 2701 12					
Exports unit values					
— PLN/t	402.9[e]	552.0	740.4	603.3	477.2
— USD/t	131.2[e]	182.6	253.9	184.4	151.9
Imports unit values					
— PLN/t	481.3[e]	660.5[e]	818.3[e]	678.9[e]	547.1[e]
— USD/t	153.9[e]	217.7[e]	277.5[e]	207.4[e]	174.3[e]

Source: ***The Central Statistical Office (GUS)***

Consumption

In the years 2009–2013 domestic ***hard coal*** consumption varied from 75.7 to 84.8 Mtpy (Tab. 6), with a remarkable 12% increase between 2009 and 2010 and significant reduction in 2013. The share of ***hard coal*** in the structure of primary energy demand in Poland increased from 44% in 2009 to 46% in 2010-2012, while in 2013 it decreased to only 41%.

Tab. 6. Structure of hard coal consumption in Poland

'000 t

Year	2009	2010	2011	2012	2013
Total consumption	**75,730**	**84,788**	**83,527**	**76,070**[r]	**78,783**
• Energy transformation	56,444	63,501	61,831	57,925[r]	58,709
— *power stations*[1]	*47,009*	*50,393*	*49,216*	*45,761*[r]	*45,923*
— *coke plants*	*9,435*	*13,108*	*12,615*	*12,164*[r]	*12,786*
• Direct consumption	17,554	18,661	17,521	19,432[r]	18,902
• Balance losses and differences	1,732	2,626	4,175	-1,288[r]	1,172

[1] coal-fired power plants and central heating plants

Source: ***The Central Statistical Office (GUS)***

Steam coal has been consumed mainly in the energy sector for generation of electricity and heat. The total consumption of this sector increased from 47 Mt in 2009 to 50 Mt in 2010, and in the following years it was reduced, down to 46 Mt in 2013 (Tab. 6). The share of power plants and district heating stations in the total consumption amounted to ca. 58%. Significant amounts of steam coal have been also directly consumed in the heavy industry, construction, transportation, and in households. Recently, some amounts of imported ***anthracite*** has started to be used e.g. in soda plants, instead of expensive ***coke***.

Coking coal is transformed by thermal processing in cokeries into ***coke***, ***semi-coke***, ***crude coal pitch***, ***crude benzole***, and their derivatives. It is also utilized in non-ferrous metals smelters, as a fuel and reduction agent.

Another application of coal, anthracite, and coke is the manufacture of coal products, such as graphitized, metallo-graphite, and coal-ceramic products, etc.

Companies involved in hard coal production in Poland as of December 2013

- Kompania Węglowa S.A. (Coal Company Joint Stock Co.), controlling 15 mines — ul. Powstańców 30, 40–039 Katowice, tel. +48 32 2553353, fax +48 32 2555453; www.kwsa.pl — *steam* and *coking coal*.
- Jastrzębska Spółka Węglowa S.A. (Jastrzębie Coal Company Joint Stock Co.), controlling 5 mines — ul. Armii Krajowej 56, 44–330 Jastrzębie Zdrój, tel. +48 32 7564113, fax +48 32 4762671; www.jsw.pl — *coking* and *steam coal*.
- Katowicki Holding Węglowy S.A. (Katowice Coal Holding Joint Stock Co.), controlling 4 mines — ul. Damrota 16–18, 40–022 Katowice, tel. +48 32 7573069, fax +48 32 7573150; www.khw.pl — *steam coal*.
- Lubelski Węgiel Bogdanka S.A. (Bogdanka Lublin Coal Joint Stock Co.) — 21–013 Puchaczów, tel. +48 81 4625100, fax +48 81 4625191; www.lw.com.pl — *steam coal*.
- Południowy Koncern Węglowy S.A. (Southern Coal Company Joint Stock Co.), controlling 2 mines — ul. Grunwaldzka 37, 43–600 Jaworzno, tel. +48 32 6185000, fax +48 32 6164476, www.pkwsa.pl — *steam coal*.
- KWK Kazimierz-Juliusz Sp. z o.o. (KWK Kazimierz-Juliusz Ltd.) — ul. Ogrodowa 1, 41–215 Sosnowiec, tel. +48 32 3685000, fax +48 32 2968474 — *steam coal*.
- SILTECH Sp. z o.o. (SILTECH Ltd.) — ul. Szybowa 2, 41–808 Zabrze, tel. +48 32 2744546, fax +48 32 2753429 — *steam coal*.
- PG Silesia Sp. z o.o. (PG Silesia Ltd.) — ul. Górnicza 60, 43-502 Czechowice-Dziedzice, tel. +48 32 2152451, fax +48 32 2152230, www.pgsilesia.pl — *steam coal*.
- ZG EKO-PLUS Sp. z o.o. (ZG EKO-PLUS Ltd.) — ul. Strzelców Bytomskich 127d, 41-933 Bytom, tel. +48 32 787 80 31, www.ekoplus-kopalnia.pl — *steam coal*.

HELIUM

Overview

Helium (**He**) belongs to the noble gases, i.e. chemically inert, not forming chemical compounds. Like other noble gases, it occurs in atmospheric air (obtained in relatively small amounts). The main sources of **helium** are deposits of ***nitrogen-rich natural gas***, where helium occurs as an accompanying element.

Due to its cryogenic properties (the lowest liquefaction temperature -269°C), **helium** has no substitutes in low temperature and superconductor applications.

Sources

Helium is present in the deposits of ***natural gas*** in the **Polish Lowland** area. Between Nowa Sól and Ostrów Wielkopolski there are 16 deposits of gas containing economic concentrations of ***helium*** (min. 0.08% He). Their total resources amounted to 27.49 Mm^3, including 12.86 Mm^3 in the largest one, i.e. **Bogdaj-Uciechów** (as of 31 December 2013).

Production

Helium has been recovered from ***nitrified natural gas*** by the **Polish Oil and Gas Company** (**POGC**) — **Odolanów Unit** (formerly: Natural Gas Denitriding Plant KRIO in Odolanów) and new denitriding plant in **Grodzisk Wielkopolski** (a part of **POGC - Zielona Góra Unit**). Plant in Odolanów has produced ***liquid*** and ***gaseous helium***, while plant in Grodzisk Wielkopolski – only ***liquid helium***. In 2010–2013, according to POGC, these plants produced 3.0–3.4 Mm^3py of ***helium*** (Tab. 1). ***Liquid helium*** has made over 90% of total production, while ***gaseous helium*** the remaining under 10%. Data on helium mining output, officially reported in the ***Mineral Resources Datafile***, are significantly lower than the commercial production. It is a consequence of a fact that the some helium has been recovered from gases with subeconomic concentrations of helium. The helium bearing gas came primarily from three deposits: **Bogdaj-Uciechów** (with over 0.27% He), **Wilków**, and **Grochowice**. Very small amounts of ***helium*** have been recovered from the air by some domestic commercial gases plants, e.g. in Łódź. Only estimated data on total domestic helium production are available.

Trade

Helium foreign trade is listed in separate CN position, but in the weight units, what makes impossible to evaluate properly helium management in Poland. Almost the entire production of ***helium*** has been exported. In 2010–2013, exports decreased by ca. 20%

Tab. 1. Helium statistics in Poland

Mm³

Year	2009	2010	2011	2012	2013
Production from natural gas deposits	1.05	1.01	0.97	0.91	0.84
Production[e,1]	2.50	3.10	3.40	3.30	3.00

Source: ***Mineral Resources Datafile,*** [(1)]***POGC***

Tab. 2. Polish exports of helium, by country — CN 2804 29 10

t

Year	2009	2010	2011	2012	2013
Exports	**647.8**	**474.6**	**545.3**	**500.7**	**520.2**
Armenia	–	–	–	1.0	2.5
Austria	0.2	15.0	35.6	76.8	56.3
Belgium	120.9	364.0	281.6	9.4	0.8
Bulgaria	1.1	0.2	1.4	1.7	0.4
Czech Republic	6.0	2.2	6.0	12.3	5.7
Denmark	2.4	2.4	2.2	0.5	0.0
France	–	1.0	47.6	145.9	90.2
Germany	227.5	5.7	66.6	171.5	217.5
Greece	23.8	–	0.1	4.8	4.3
Hungary	0.9	0.3	2.6	4.7	0.5
India	–	9.3	–	–	–
Italy	84.7	–	–	0.4	23.0
Latvia	0.1	0.5	0.3	0.3	0.5
Lithuania	0.7	1.6	1.6	1.6	0.8
Netherlands	–	–	0.1	0.0	4.4
Romania	0.1	0.1	0.6	1.2	1.9
Russia	–	–	0.2	2.0	13.8
Slovakia	0.3	1.1	2.0	0.4	0.2
Turkey	57.1	58.4	60.0	41.7	89.2
Ukraine	5.8	12.8	36.5	6.1	2.7
United Arab Emirates	4.6	–	–	–	–
United Kingdom	111.1	–	0.0	18.4	4.9
Others	0.5	0.0	0.3[r]	0.0[r]	0.6

Source: ***The Central Statistical Office (GUS)***

and the main recipients were Germany, Belgium (until 2012), France, Austria, and other EU countries, as well as Turkey, Ukraine and Russia (Tab. 2). In the years 2010–2012 imports of ***helium*** decreased, from ca. 69 t to ca. 28 t, while in 2013 they rose up to ca. 52 t. In the last years the largest quantities were bought in Algeria, Austria, Germany, and Hungary.

The trade balances in ***helium*** has been consistently positive. In 2012–2013 it rose rapidly to 154 million PLN, due to strong increase of exports unit values (Tabs. 3, 4).

Imports unit values after decrease in 2010 to ca. 118,000 PLN/t, in 2011–2013 recovered to over 164,000 PLN/t.

Tab. 3. Value of helium trade in Poland — CN 2804 29 10

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	23,371	35,380	46,156	126,020	162,978
Imports	8,147	8,139	5,098	4,288	8,607
Balance	**+15,224**	**+27,241**	**+41,058**	**+121,732**	**+154,371**

Source: ***The Central Statistical Office*** *(GUS)*

Tab. 4. Average unit values of helium exports from Poland — CN 2804 29 10

Year	2009	2010	2011	2012	2013
PLN/t	36,078	74,554	84,645	251,674	313,300
USD/t	11,478	24,925	28,793	77,092	100,216

Source: ***The Central Statistical Office*** *(GUS)*

Consumption

There are no data available on the structure of ***helium*** consumption in Poland.

Companies involved in helium production in Poland as of December 2013

- PGNiG S.A. Oddział w Odolanowie (Polish Oil and Gas Company Joint Stock Co., Odolanów Unit), ul. Krotoszyńska 148, 63–430 Odolanów, tel. +48 62 7364441, fax. +48 62 7365989, www.pgnig.pl/odolanow — *liquid helium, gaseous helium*.
- PGNiG S.A. Oddział w Zielonej Górze (Polish Oil and Gas Company Joint Stock Co., Zielona Góra Unit), ul. Bohaterów Westerplatte 15, 65–034 Zielona Góra, tel. +48 68 3291216, fax. +48 68 3291337, www.zielonagora.pgnig.pl/zielonagora — *liquid helium.*

INDIUM

Overview

In spite of considerable contents of **indium** (**In**) in the Earth's crust (comparable to the amount of silver), its concentrations are rare. Indium occurs in over 100 minerals, mainly in ***zinc***, ***tin***, ***lead***, ***tungsten***, and ***iron ores***, or ***pyrite***. **Black indium** is a primary commodity of indium obtained in course of hydrometallurgical extraction from the ***cinders of sulfide zinc ore***. **Indium metal** is most often recovered from ***black indium*** by electrochemical processing, vacuum distillation (at a billing temperature of approx. 2,045°C), and zone refining.

In recent years the most dynamically growing **indium** application has been the production of thin films on glass (especially for the liquid crystal monitors of ***high definition*** TV sets, portable computers, video display sets, etc.), as well as on the surface of silver or other metals. To a lesser extent it is used for the production of solders and other very important alloys.

Sources

There are no ***indium-bearing ore*** deposits in Poland.

Production

No data about the production of ***indium*** in Poland are available.

Trade

Domestic demand has been covered by variable imports of ***indium metal***, which in 2009 amounted to 48 kg, in 2010 soared up to 20,051 kg (mostly some very cheap indium-bearing material from Germany), in 2012 dropped to only 9 kg, with an increase up to 130 kg in 2013 (Tab. 1). The major and most regular supplier were the US, while other countries, such China, Belgium, Germany (in 2010), Japan and the United Kingdom, delivered indium on occasional basis (Tab. 1). ***Indium*** occurs also in many other products traded in Poland, e.g. electronic elements, but these are not evaluated statistically.

The trade balances of indium metal have been always negative (Tab. 2) and the size of the deficit has depended on the quality of traded material, quantity of imports and market price, influencing the unit value of imports, especially in 2010 (Tab. 3).

Tab. 1. Indium statistics in Poland — CN 8112 92 81

kg In

Year	2009	2010	2011	2012	2013
Imports	**48**	**20,051**	**66**	**9**	**130**
China	–	2	–	4	1
Germany	5	20,017	–	1	0
Italy	–	6	2	0	7
Japan	12	8	2	–	–
USA	31	15	57	4	121
United Kingdom	–	3	5	0	1
Exports	**–**	**20**	–	–	–
Consumtion[a]	**48**	**20,031**	**66**	**9**	**130**

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Value of indium trade in Poland — CN 8112 92 81

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	–	36	–	–	–
Imports	75	120	119	18	274
Balance	**-75**	**-84**	**-119**	**-18**	**-274**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit value of indium imports to Poland — CN 8112 92 81

Year	2009	2010	2011	2012	2013
PLN/kg	1,563	6	1,800	2,023	2,110
USD/kg	510	2	633	616	672

Source: ***The Central Statistical Office (GUS)***

Consumption

There are no data available on the structure of ***indium*** consumption in Poland.

IODINE

Overview

Iodine (**I**) forms its own minerals, which may be found in ***nitrate rocks*** (***Chile saltpeter***). However, its main sources are brines: ***iodine***, ***iodine-bromine***, and ***bromine-iodine*** (see: **BROMINE**), which occur either individually or in ***natural gas*** and ***petroleum*** deposits. ***Sea water*** is a potential unlimited source of iodine, as are certain seaweeds, e.g. from the ***Laminaria*** family.

Iodine reacts with almost all elements, except sulphur, selenium, and noble gases, which accounts for the multitude and diversity of its uses. In the form of ***iodine tincture*** it has been widely used to disinfect wounds. Since the mid-1800s iodine has also come to be important as a chemical reagent in photography and chemistry. In many applications it has no substitutes, e.g. in catalysts, drugs, food additives.

Sources

In Poland there are ***bromine-iodine*** and ***iodine-bromine brines***, which are utilized for balneological purposes, e.g. in **Rabka** and **Łapczyca** near Bochnia. The ***brines*** contain from 5 to above 120 mg/l (in **Dębowiec** deposit) of ***iodine***. Total investigated domestic resources of ***iodine-bromine brines*** are estimated at 32.2 Mm^3. Moreover, ***water pumped from coal mines*** in the **Upper Silesia** contains considerable amounts of iodine.

Production

Iodine has not been recovered in Poland from existing sources. The only attempt was made in the 1970s when the technology for complex utilization of ***iodine-bromine brines*** from the **Bochnia** region was developed, where it was produced in a pilot scale. Since the early 2000s the ***curative*** and ***cosmetic salts*** rich in J and Br have been obtained by the **Iodine-Bromide Brine Processing Plant Salco** of **Łapczyca**. The salt has been produced in boiling pan through water evaporation from the brine extracted from the **Łapczyca** deposit. Between 2009 and 2012 the salt production increased slowly, up to 902 t. In 2013 the production decreased to 750 t (see: **BROMINE**).

Trade

The domestic demand for ***iodine commodities*** is satisfied entirely by imports, ranging between 10 and 25 tpy. In recent years the major deliveries have come from Azerbaijan, United Kingdom Italy and Chile (Tab. 1). Among other ***iodine commodities***, there were also ***iodides*** and ***oxyiodides*** regularly purchased (Tab. 2). In 2009 their deliveries increased up to 127 t, but in the following years they came back to the usual volume of 40-50 tpy. There were also some re-exports of iodine in the range of several tpy (except for 2010), the recipients of which were the neighbouring countries (in 2012 mainly Ukraine). The trade balances in both ***iodine*** and their commodities have been consistently negative, depending on the import volume and iodine prices (Tab. 3). In 2013 the deficit in ***iodine*** and ***iodine compounds*** trade deepened to 2.5 and 4.4 million PLN, respectively.

Tab. 1. Imports of iodine to Poland, by country — CN 2801 20

t

Year	2009	2010	2011	2012	2013
Imports	**10**	**25**	**12**	**12**	**22**
Azerbaijan	–	9	6	3	9
Belgium	6	6	0	1	0
Chile	4	2	1	1	2
Italy	–	4	5	4	3
United Kingdom	–	–	0	4	8
Others	–	4	–	–	–
Exports	**5**	**16**	**4**	**3**	**2**
Consumption[a]	**5**	**9**	**8**	**9**	**20**

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Iodides and oxyiodides statistics in Poland — CN 2827 60

t

Year	2009	2010	2011	2012	2013
Imports	127	52	36	41	41
Exports	24	23	10	13	14
Consumption[a]	103	29	26	28	27

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Value of iodine commodities trade in Poland

‘000 PLN

Year	2009	2010	2011	2012	2013
Iodine CN 2801 20					
Exports	471	1,566	436	968	518
Imports	936	2,188	1,945	3,094	3,045
Balance	**-468**	**-622**	**-1,509**	**-2,126**	**-2,527**
Iodides and oxyiodides CN 2827 60					
Exports	2,017	1,962	1,232	2,374	2,322
Imports	3,508	4,192	4,324	6,995	6,743
Balance	**-1,491**	**-2,230**	**-3,092**	**-4,621**	**-4,421**

Source: ***The Central Statistical Office (GUS)***

The unit values of ***iodine*** imports to Poland followed the tendencies on the international market, reflecting the rise in prices in recent years, as well as stocks changes. However, they depended on the terms of contracts between buyers and sellers and costs of transportation (Tab. 4).

Tab. 4. The unit value of iodine imports to Poland — CN 2801 20

Year	2009	2010	2011	2012	2013
PLN/t	89,144	87,882	169,165	257,795	138,988
USD/t	30,479	29,115	56,433	77,770	44,322

Source: ***The Central Statistical Office (GUS)***

Consumption

The consumption of ***iodine*** and ***iodine compounds*** by end-users in Poland is difficult to ascertain. These commodities are primarily utilized for the production of catalyst and pharmaceuticals, photography, and as an additive to edible salt.

Companies involved in iodine commodities production in Poland, as of December 2013

- Zakład Przeróbki Solanek Jodowo-Bromowych Salco S.C. (Iodine-Bromide Brine Processing Plant Salco), 32–744 Łapczyca 445, tel. +48 14 6127519, fax. +48 14 6127922, www.salco.pl — *iodine-bromide curative and cosmetic salt*.

IRON AND STEEL

Overview

Iron (**Fe**) is one of the most common elements in the lithosphere. **Iron oxide ores** and **concentrates** (mainly of ***hematite*** Fe_2O_3 and ***magnetite*** Fe_3O_4) are the basic primary commodities for pig iron, and for direct reduced iron. Other types of iron ore, such as **carbonate** (**siderite**) **ore**, **silicate ore**, **iron-bearing sand**, are not regarded as economic in most of the world.

Pig iron is obtained in blast furnaces by the coke reduction of ***iron oxide ores*** and ***concentrates***, which are ***sintered*** or ***pelletized*** before being fed into the furnace. Pig iron is produced in two grades: **foundry pig iron** (for **cast iron** and **cast steel** production) and **steelmaking pig iron**. In recent years, the importance of **direct reduced iron** (**DRI**) has been continually increasing. It competes with pig iron, having comparable production costs and energy consumption.

A batch of pig iron for the **raw steel** production is supplemented with **steel** and **cast iron scrap**, or with the appropriate ***ferroalloys*** for **alloyed steel**. The raw steel production process is carried out in ***open-hearth furnaces***, recently replaced by ***oxygen converters*** and ***electric furnaces***, more and more frequently using the ***continuous steel casting*** method. The **raw steel** is further processed by plastic working and thermal operations. Two main types are distinguished: **carbon steel** (containing considerable amounts of carbon) and **alloyed steel**. On the basis of its different applications, steel types are sub-divided into ***construction***, ***tool***, and ***special steel***, manufactured in many varieties and types, standardized and marked with trade marks. The production of **carbon steel** (***unalloyed***, ***ordinary***, ***commercial steel***) has been decreasing, with an attendant increase of the production of **alloyed steel** (***quality***, ***noble steel***), modified by additives of Co, Cr, Mn, Mo, Nb, Ni, Ta, Ti, V, Zr, etc. Raw steel is used to make a variety of **rolled products** (sheets, zinc-plated sheets, tin-plated sheets, steel pipes, cold rolled bands, sheet-metal sections, etc.) and **forged** or **drawn products** (bars, wires). **Pure iron** is produced in very small amounts, for special purposes.

Iron Ore and Concentrates

Sources

Poland has no recognized deposits of any type of ***iron ore***.

Production

Since 1990 there has been no production of ***iron ore*** in Poland.

Trade

The Polish steel industry has utilised exclusively imported ***iron ores*** and ***concentrates***. In the years 2009–2013 these supplies varied between 3.8 Mt and 6.6 Mt, with stabilization in the last years at the level of 6.6 Mtpy (Tab. 1). Imports volume has reflected unstable economical condition of the Polish steel industry, connected with trends on the international steel market.

Tab. 1. Iron ores and concentrates statistics in Poland — CN 2601

'000 t (gross weight)

Year	2009	2010	2011	2012	2013
Imports	3,792	6,489	5,977	6,576	6,640
Exports	15	16	4	2	30
Consumption[a]	3,777	6,473	5,973	6,574	6,610

Source: ***The Central Statistical Office (GUS)***

The main sources of ***iron ores and concentrates*** imports to Poland have been Ukraine, Russia, Bosnia and Herzegovina, Canada, and - in the last two years – Liberia, Slovakia and Brazil (Tab. 2). Following world trends, the demand for ***ores*** and ***agglomerates*** has declined in favour of ***concentrates*** and ***pellets***. Some small amounts of ***iron ores and concentrates*** have been exported from Poland (Tab. 1).

Tab. 2. Polish iron ores and concentrates imports, by country — CN 2601

'000 t (gross weight)

Year	2009	2010	2011	2012	2013
Imports	**3,791.9**	**6,489.4**	**5,977.4**	**6,576.5**	**6,640.1**
Bosnia and Herzegovina	116.0	90.0	229.2	429.9	243.5
Brazil	64.7	–	–	0.5	82.8
Canada	–	134.9	68.3	67.7	81.3
Liberia	–	–	–	97.8	736.1
Norway	10.5	13.7	17.4	13.9	77.7
Russia	514.0	941.7	835.9	1,368.3	1,137.4
Slovakia	–	–	49.0	290.0	53.8
Sweden	17.0	11.0	11.1	16.3	65.6
Ukraine	3,006.4	5,297.9	4,765.9	4,291.4	4,161.6
USA	62.8	0.0	0.0	0.0	0.0
Others	0.5	0.2	0.6	0.7	0.3

Source: ***The Central Statistical Office (GUS)***

The balance of ***iron ores and concentrates*** trade has always been negative, in the years 2009–2013 varying between 773 and 2,160 million PLN/y (Tab. 3). The size of the deficit has depended on imports volume, but in recent years also on the unit values of their imports, especially in 2012–2013, when increased imports volume did not deepen the negative balance of trade (Tab. 3 and 4). The unit values of iron ores and concentrates imports expressed in USD/t have reflected the changes of iron ore prices on the international markets (Tab. 4).

Tab. 3. Value of iron ore and concentrate trade in Poland — CN 2601

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	3,483	9,610	17,554	6,705	13,539
Imports	776,714	1,840,387	2,136,144	2,036,512	2,173,908
Balance	**-773,231**	**-1,830,777**	**-2,118,590**	**-2,029,807**	**-2,160,369**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Average unit value of iron ores and concentrate imports to Poland — CN 2601

Year	2009	2010	2011	2012	2013
PLN/t	204.8	283.7	357.4	309.7	327.4
USD/t	69.5	92.8	120.1	94.7	103.8

Source: ***The Central Statistical Office (GUS)***

Consumption

Iron ores and concentrates are consumed entirely for the ***pig iron*** production by domestic steelworks.

Pig Iron

Production

Poland is a significant producer of ***pig iron***. In 2009 the output decreased to almost 3.1 Mt, while in 2010-2013 the production increased to 4.0 Mtpy (Tab. 5). The production drop in 2009 was caused mainly by limited production in the biggest Polish steel producer — **ArcelorMittal Poland.** In October 2008 it closed temporarily for routine repair two blast furnaces – one in Dąbrowa Górnicza and one in Kraków, and these works were continued in the first half of 2009. Since 2007, only ***steelmaking pig iron*** has been manufactured in Poland, while ***foundry pig iron*** manufacturing was stopped (Tab. 5).

Tab. 5. Pig iron statistics in Poland — CN 7201

'000 t

Year	2009	2010	2011	2012	2013
Production	3,095.0	3,638.0	3,974.9	3,944.0	4,013.9
Imports	156.4	178.8	228.7	200.4	156.2
Exports	10.2	67.7	0.9	80.4	49.0
Consumption[a]	3,241.2	3,749.1	4,202.4	4,064.0	4,121.1

Source: ***The Central Statistical Office (GUS)***

Currently, ***steelmaking pig iron*** has been produced in two large metallurgical plants of **ArcelorMittal Poland:** in Dąbrowa Górnicza at the level of 2.0–3.5 Mtpy, and in Kraków — 1.0–1.5 Mtpy.

Trade

In the years 2009–2013 ***pig iron*** imports ranged from 156,200 to 228,700 t (Tab. 5). By contrast, exports of ***pig iron***, mainly to Western European countries, varied widely: between 80,400 t and only 900 tpy (Tab. 5).

The trade balances in ***pig iron*** had negative values in the years 2009–2013, changing between 146.7 and 371.7 million PLN (Tab. 6).

Tab. 6. Value of pig iron trade in Poland — CN 7201

‘000 PLN

Year	2009	2010	2011	2012	2013
Exports	10,973	46,886	3,935	126,394	74,531
Imports	157,722	248,750	375,622	325,303	221,893
Balance	**-146,749**	**-201,864**	**-371,687**	**-198,909**	**-147,362**

Source: ***The Central Statistical Office (GUS)***

Consumption

Steelmaking pig iron is used entirely for ***steel*** production. ***Foundry pig iron*** is used for the production of ***cast iron*** and ***cast steel***.

Iron and Steel Scrap, and other Secondary Iron-Bearing Materials

Production (recovery)

Iron scrap consists of the waste from the on-going operations of steelworks, scrapped steel, used cast steel or cast iron constructions, and used machinery and equipment collected from outside. Until the end of 2000 the collection of used ***steel***, ***cast steel***, and ***cast iron*** was recorded by the **Central Statistical Office**. In 2000 the supply of collected scraps reached the level of 1.9 Mtpy. These were mainly ***steel scrap***, with only small amounts of ***cast steel*** and ***cast iron*** (26,000 t). ***Iron-bearing wastes*** were also collected, at the level of 296,000 t in 2000. The steel scrap recovery in steelworks was estimated to be even higher than the level of scrap collection, i.e. more than 3.0 Mtpy. In the years 2001-2008 there were recorded data about production of steel scrap only, while the production of other types of scrap were not available (Tab. 7). Domestic production of ***steel scrap*** in 2008 amounted to 1.4 Mt (Tab. 7), while the data for the period 2009–2013 are not available.

Trade

Iron and ***steel scrap*** exports from Poland in 2009 amounted to less than 1.0 Mt, but in 2010-2013 it reached nearly 2.0 Mtpy (Tab. 7). The scrap was shipped mainly to Western European countries. By 2011 large amounts (up to 29,900 tpy) of ***iron-bearing wastes***

Tab. 7. Secondary iron materials statistics in Poland

'000 t (gross weight)

Year	2009	2010	2011	2012	2013
Iron and steel scrap CN 7204					
Production	NA	NA	NA	NA	NA
— *steel scrap*	*NA*	*NA*	*NA*	*NA*	*NA*
Imports	603.2	382.3	408.8	383.4	509.4
Exports	960.0	1,396.6	1,889.3	1,989.2	1,972.4
Consumption[a]	NA	NA	NA	NA	NA
Iron bearing wastes CN 2619					
Production	NA	NA	NA	NA	NA
Imports	3.3	1.7	26.7	20.4	15.5
Exports	9.3	29.9	20.7	2.6	0.2
Consumption[a]	NA	NA	NA	NA	NA

Source: ***The Central Statistical Office (GUS)***

were also exported, but in the last two years these exports sharply decreased, down to only 224 t (Tab. 7). Imports of ***iron*** and ***steel scrap***, which in 2009 amounted to 603 kt, with the Czech Republic as the main supplier, in the years 2010–2013 was at lower level of 380–510 ktpy (Tab. 7), and originated from the Czech Republic, Slovakia and Russia. Imports of ***iron-bearing wastes*** increased from a few thousand tons in 2009-2010 to around 27 kt in 2011, and slightly declined in the subsequent years.

In the years 2009–2013 the trade balance in ***secondary iron commodities*** was characterized by very high values, ranging between 0.65–2.4 billion PLN/y (Tab. 8). The exception was ***iron-bearing wastes***, the trade balances of which turned negative in 2012–2013 (Tab. 8).

Tab. 8. Value of secondary iron materials trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Iron and steel scrap CN 7204					
Exports	1,090,583	1,972,758	2,882,939	2,918,139	2,590,826
Imports	444,528	421,175	549,858	514,534	610,687
Balance	**+646,055**	**+1,551,583**	**+2,333,081**	**+2,403,605**	**+1,980,139**
Iron-bearing wastes CN 2619					
Exports	3,534	18,185	15,029	1,893	153
Imports	443	307	3,743	3,045	1,942
Balance	**+3,091**	**+17,878**	**+11,286**	**-1,152**	**-1,789**

Source: ***The Central Statistical Office (GUS)***

Consumption

The share of ***iron*** and ***steel scrap*** in the input for ***raw steel*** production has been estimated at nearly 40% in recent years (approx. 60% of the input is ***steelmaking pig iron***). This scrap is even more important in the foundry industry. Its share in the input for ***cast iron*** and ***cast steel*** production is estimated at as much as 60–70% (the rest consists of ***foundry pig iron***).

Steel and Steel Products

Production

Poland is a significant European producer of ***raw steel*** and ***steel products***. There have been 17 active steelworks producing raw steel and/or steel products, including two large plants belonging to the **ArcelorMittal Poland**: in **Kraków** and in **Dąbrowa Górnicza**. Only five steelworks are located outside of the Upper Silesia, i.e.: **ArcelorMittal** plant in Kraków, **ISD Częstochowa, CELSA Huta Ostrowiec**, **Stalowa Wola,** and **Arcelor Warszawa** in Warsaw.

In the years 2009–2013 the production of ***raw steel*** varied widely, from a minimum of 7.1 Mt in 2009 to 8.2-8.8 Mtpy in years 2010-2013 (Tab. 9).

Tab. 9. Crude steel statistics in Poland — CN 7206

'000 t

Year	2009	2010	2011	2012	2013
Production	7,128	7,996	8,777	8,539	8,199
— *from electric arc furnace*	*3,893*	*4,001*	*4,353*	*4,206*	*3,679*
— *from converters*	*3,235*	*3,995*	*4,424*	*4,333*	*4,520*
Imports	7	1	1	1	1
Exports	12	21	26	24	27
Consumption[a]	7,129	7,976	8,752	8,516	8,173

Source: ***The Central Statistical Office (GUS)***

In 2013 approximately 45% of the raw steel was produced in electric arc furnaces at **CMC Zawiercie, CELSA Huta Ostrowiec, ISD Huta Częstochowa, Arcelor Warszawa, Stalowa Wola, Batory,** and **Ferrostal Łabędy**. The largest production capacity has had **CMC Zawiercie** (ca. 1.2 Mtpy), while **CELSA Huta Ostrowiec** and **ISD Częstochowa** - 0.6–0.8 Mtpy each. The other 4 plants are of minor importance, with production significantly below 0.4 Mtpy. The remaining 55% of the raw steel was produced in oxygen-blown converters in the two largest steelworks of **ArcelorMittal Poland** in **Dąbrowa Górnicza** and in **Kraków**.

Crude steel breakdown by grades has been stable in recent years. From the total crude steel melted in Poland, low-alloy represented around 93.6%, while high-alloyed accounted for approx. 6.4% and stainless steel production is very marginal, for example in 2013 amounted to only 0.02%.

The **Iron and Steel Restructuring Program** implemented in 2001 by the Polish Cabinet ended in 2007. The biggest Polish steel company — **Polskie Huty Stali** (**PHS**), which existed as a single State Treasury-owned company and was consisted of four companies: **Huta Katowice**, **Huta im. T. Sendzimira**, **Huta Cedler**, and **Huta Florian,** was finally sold to **ArcelorMittal Poland** in 2007**.** Implemented restructuring programme has changed the domestic steel industry in a positive way. Technical developments, organizational changes and privatization process made this whole sector a modern and sustainable one.

The difficult economic situation of Polish steel industry in the first years of 21st century beated several plants to declare insolvency, and forcing them to change ownership and organizing structure. Bankruptcy was declared in the case of **Częstochowa, Baildon, Ostrowiec, Małapanew, Jedność,** and **Andrzej** plants. Basing on their productive assets, new companies were created, for example **Huta Stali Częstochowa**, **Małapanew Zakłady Odlewnicze**, and others. Spanish concern **CELSA** became the new owner of **Huta Ostrowiec**. Moreover, **American Commercial Metals Company** signed the contract to buy 71% of **Huta Zawiercie** shares from **Impexmetal**. Furthermore, there were further changes in the ownership of Polish steel mills. Huta **Batory**, Huta **Bankowa** and Huta **Andrzej** have been took over by a listed company **Alchemia**, **Huta Stali Częstochowa** - by the **Industrial Union of Donbas** from Ukraine, **Ferrostal Łabędy** and **HSW Quality Steel Unit** - by **ZŁOMREX**, which is specialised in scrap processing, while the **Arcelor Group** became the new owner of **Huta Lucchini-Warszawa**, and Russian concern **Severstal** became the owner of **Technologie Buczek** in Sosnowiec.

Trade

Generally speaking, international trade in ***raw steel*** is of marginal importance (Tab. 9).

Consumption

The level of domestic ***raw steel*** consumption has shown similar tendencies to those of the production (Tab. 9).

The most important final products of steelworks are ***hot and cold rolled products***, ***pipes***, ***bars***, and ***wires*** (Tab. 10). Most of the steelworks specialize in certain product assortments. For example:

- *hot rolled sheets* — **ArcelorMittal Poland Unit** in **Kraków**, **ISD Częstochowa**, **Pokój**, **Batory**, **Stalowa Wola**;
- *cold rolled sheets* and *tinplated sheets* — **ArcelorMittal Poland Unit** in **Kraków** and **Stalowa Wola;**
- *galvanized sheets* — **ArcelorMittal Poland Unit** in **Kraków** and **ArcelorMittal Poland Unit** in **Świętochłowice**;
- *cold rolled strips* — **ArcelorMittal Poland S.A. Unit** in **Kraków**, **ArcelorMittal Poland Unit** in **Świętochłowice**, **ArcelorMittal Poland Unit** in **Sosnowiec**, **Arcelor Warszawa**;
- *pipes* — **ArcelorMittal Poland Unit** in **Kraków**, **ISD Częstochowa**, **Andrzej**, **Ferrum**, **Batory**, **Severstallat Silesia.**

Almost all the steelworks produce ***hot rolled products*** (excluding sheets). The exceptions are **Andrzej, Severstallat Silesia, ISD Częstochowa,** and **Ferrum.** The **Małapanew,** and **Zabrze** steelworks do not produce steel products at all, but only ***cast iron*** and ***cast steel***.

Tab. 10. Production of the main steel products in Poland

'000 t

Year	2009	2010	2011	2012	2013
• Hot rolled rails	164.3	259.8	245.9	157.6[r]	176.4
• Hot rolled bars and sections	4,102.4	4,533.9	4,906.1	3,441.9[r]	3,457.7
• Hot rolled sheets	1,917.6	2,113.3	2,295.6	1,969.2	2,120.9
• Cold rolled sheets	557.7	834.7	806.6	1,353.5	1,459.7
• Cold rolled galvanized sheets	395.9	455.2	453.1	676.3[r]	914.0
• Cold rolled roll-formed sections	531.5	545.4	596.8	577.9	494.5
• Pipes	346.5	383.7	407.8	592.2	607.4
• Wires	213.6	258.0	197.5[r]	186.0[r]	211.9

Source: ***The Central Statistical Office (GUS)***

The structure of steelworks production has been characterized by a high proportion of ***hot rolled bars***, ***sections***, and ***semis***. One negative feature, in discordance with world trends, is still inadequate production of ***hot rolled sheets***, and slow increase of production of ***galvanized sheets***. Implemented Restructuring Program improved condition of the Polish steel industry. **Arcelor Mittal Poland** has built in **Kraków Unit** a completely new and the most modern in Europe hot-rolling mill (instead of modernization of existing one); in Dąbrowa Górnicza Unit there was built the steel continuous casting line of the production capacity of ca. 3.0 Mtpy; in Sosnowiec unit there was modernized the quality blank mill; in Świętochłowice Unit there was constructed the new coated sheets production line. Arcelor Mittal Poland, the largest steel maker in Poland, which produces ca. 65% of Polish steel, became a modern producer, offering the wide assortment of steel products, capable of competing on international markets. In recent years the modernization works were continued at several Polish steel companies, i.e. **ArcelorMittal Poland** has commissioned a new caster and a tundish, and has modernized blast furnace; **ArcelorMittal Warszawa** has commissioned new bar mill; **Celsa Huta Ostrowiec** modernized caster and electric arc furnance; **ISD Huta Częstochowa** has commissioned three chamber furnaces for plate heat treatment and modernized Heavy Plate Mill's furnace; and **CMC Zawiercie** commissioned a new rod mill. Moreover, two new hot rolling mills for long products were launched (in **Celsa Huta Ostrowiec** and in **CMC Zawiercie**) and cold rolling mill for thin sheets was upgraded (in **ArcelorMittal Poland Unit** in **Kraków**). Thanks to these investments steel plants extended and improved their product range, which provided the customers with a comprehensive range of technologically advanced products.

In 2009 the situation in the domestic steel market was influenced by global economic crisis, which was more extensive and heavier than previously forecasted. As a result, recession experienced by industries consuming steel heavily impacted the volume of the production of steel plants (in most regions of the world, in Europe, as well as in Poland) and revenues in the whole steel industry and for several other major industries. Domestic steel consumption in 2009 decreased by as much as 30% in comparison to 2008, which led to reduction in steel production by approximately 26%. In the years 2010–2011 Poland's economy began to recover, and GDP grew by 8.1%, mainly due to high internal demand

and investments coming back. Positive impact was brought by infrastructural projects co-financed from the European Union, for example Cohesion Fund. As a result steel consuming industries recorded further production increase, in spite of intra-EU market slowdown, and in effect domestic steel consumption in this period has risen by as much as 31%. In the years of 2012-2013 the rate of economic growth in Poland slowed down to 1.6%, and it was the slowest rate for 4 years. In addition, the effects of global economic downturn were also influencing the condition of domestic steel mills. Steel production decreased by 6.5%, which clearly reflected the attitude and condition of the buyers. Poland's contribution to the overall EU steel production was 5%, at the same level as in 2011. In 2013, the average capacity utilization of the domestic steel industry decreased by 5% in comparison to 2011, and amounted to ca. 63%, however this coefficient in steel mills operating electric arc furnaces was well above 85%. All the installations for the production of pig iron, as well as steel from oxygen-blown converters and electric arc furnaces in the domestic steel mills are advanced and fully meet the requirements of BAT.

Steel products are among of the Poland's main export commodities. However, their imports have also increased in recent years. The value of the exports in 2009 amounted to 7.1 billion PLN, in 2010 grown up to 8.7 billion PLN, while in last three years stabilized at the level of 11.4–13.2 billion PLN (Tab. 11). However, the domestic demand for steel products has been met only partly by the Polish steelworks. Therefore, the imports of these products have been rapidly increasing in recent years, coming mainly from the UE and CEFTA countries. In 2009 the metallurgical industry was one of the most badly affected by the crisis. Almost 30% decline in steel consumption caused reduction of domestic steel production, while low demand contributed to the significant decrease in finished goods prices. As an effect the value of exports decreased by almost 42%, and value of imports decreased by 32%. In the years 2010–2012 there was recorded significant improvement in domestic economic condition, so imports value rose by 67% and amounted to 23.3 billion PLN, while exports value increased by almost 85% and amounted to 13.2 billion PLN. The foreign sales of steel products in 2013 went down by 6% compared with 2012 (Tab. 11). Among steel products the main imported item were highly processed flat products (65% in 2013), while predominantly exported goods were longs. Semis and ingots accounted for a large portion of exportation, while their imports were negligible. Steel products imports to Poland in 2009 amounted to 5.2 Mt, while exports reached 4.0 Mt. In the years of 2010-2012 owing to steel market recovery the trade in steel products sharply increased: in 2012 the record of 8.1 million tons were imported, while 5.6 million tons were exported. In 2013 imports decreased by 2% to 7.9 Mt, while exports - by 12%, to 4.9 Mt.

In 2013 apparent consumption of finished steel products in Poland amounted to 10.3 million tons, and was by 6.4% lower as compared to 2011. Recorded decline in apparent consumption in the years of 2012-2013 was a consequence of the decrease in real domestic consumption of steel in the second half of 2012, which continued in first three quarters of 2013. In recent years the structure of domestic consumption of finished steel products has been dominated by flat products, that in 2013 accounted for 57% of the total apparent consumption. The share of long products in the total domestic consumption was 33%, and pipes and hollow sections - the remaining 10%.

Tab. 11. Value of steel products trade in Poland — CN 7207–7217, CN 7219–7223, CN 7225–7229

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	7,136,058.7	8,703,997.8	11,982,836.1	13,194,614.4	11,375,226.8
Imports	13,954,292.6	18,144,762.3	23,201,012.2	23,307,368.2	21,977,760.1
Balance	**-6,818,233.8**	**-9,440,765.5**	**-11,218,176.1**	**-10,112,753.8**	**-10,602,533.3**

Source: ***The Central Statistical Office (GUS)***

As a consequence, the balance of ***steel products*** trade in the past five years was negative, exceeding 10 billion PLN/y in the years 2011-2013 (Tab. 11).

Companies involved in iron and steel production in Poland as of December 2013

- Walcownia Rur Andrzej Sp. z o.o. w Zawadzkiem (Andrzej Tube Mill Ltd. of Zawadzkie) ul. Ks. Wajdy 1, 46–059 Zawadzkie, tel. +48 77 4561300, fax +48 77 4561115, www.wra.pl — *pipes and tubes.*
- Huta Bankowa Sp. z o.o. w Dąbrowie Górniczej (Bankowa Steelworks Ltd. of Dąbrowa Górnicza), ul. Sobieskiego 24, 41–300 Dąbrowa Górnicza, tel. +48 32 2957400, fax. +48 32 2623628, www.hutabankowa.com.pl — *hot rolled products.*
- Huta Batory Sp. z o.o. w Chorzowie (Batory Steelworks Ltd. of Chorzów) ul. Dyrekcyjna 6, 41–506 Chorzów, tel. +48 32 7722237, fax +48 32 7722061, www.hutabatory.com.pl — *raw steel, special steels, pipes, tubes.*
- Severstallat Silesia Sp. z o.o. w Sosnowcu (Severstallat Silesia Steelworks Ltd. of Sosnowiec) ul. Nowopogońska 1, 41–200 Sosnowiec, tel. +48 32 3642401, fax +48 32 3642302, www.severstallat.eu — *pipes, tubes, rolls.*
- ArcelorMittal Poland S.A., Oddział w Krakowie (ArcelorMittal Poland S.A., Unit in Krakow) ul. Ujastek 1, 30–969 Kraków, tel. +48 12 6449866, fax +48 12 6447496, www.arcelormittal.com/poland — *steelmaking pig iron, raw steel, hot rolled products, cold rolled products, pipes, cast iron, tinplated sheets, galvanized sheets.*
- ArcelorMittal Poland S.A., Oddział w Dąbrowie Górniczej (ArcelorMittal Poland S.A., Unit in Dabrowa Gornicza) Al. Piłsudskiego 92, 41–308 Dąbrowa Górnicza, tel. +48 32 7945333, fax +48 32 7955200, www.arcelormittal.com/poland — *steelmaking pig iron, raw steel, hot rolled products, cast steel.*
- ArcelorMittal Poland S.A., Oddział w Świętochłowicach (ArcelorMittal Poland S.A., Unit in Swietochlowice) ul. Metalowców 5, 41–600 Świętochłowice, tel. +48 32 2452071, fax +48 32 2455363, www.arcelormittal.com/poland — *raw steel, hot rolled products, galvanized sheet, cold rolled strip.*
- ArcelorMittal Poland S.A., Oddział w Sosnowcu (ArcelorMittal Poland S.A., Unit in Sosnowiec) ul. Niwecka 1, 41–200 Sosnowiec, tel. +48 32 2994550, fax +48 32 2993966, www.arcelormittal.com/poland — *hot rolled products, cold rolled strip, cast iron.*
- ISD Huta Częstochowa Sp. z o.o. w Częstochowie (ISD Częstochowa Steelworks Ltd. of Częstochowa) ul. Kucelińska 22, 42–207 Częstochowa, tel. +48 34 3231261, fax +48 34 3230904, www.hcz.com.pl — *steelmaking and foundry pig iron, raw steel, hot rolled sheets, pipes, cast iron.*

- FERROSTAL Łabędy Sp. z o.o. w Gliwicach (FERROSTAL Łabędy Ltd. of Gliwice) ul. Zawadzkiego 47, 44–109 Gliwice, tel. +48 32 2347600, fax +48 32 2347650, www.ferrostal.com.pl — *raw steel, semi-finished hot rolled products, bars.*
- Huta Ferrum S.A. w Katowicach (Ferrum Steelworks Joint Stock Co. of Katowice) ul. Hutnicza 3, 40–241 Katowice, tel. +48 32 2555677, fax +48 32 2554150, www.ferrum.com.pl — *pipes.*
- Huta Królewska Sp. z o.o. w Chorzowie (Królewska Steelworks Ltd. of Chorzów) ul. Metalowców 13, 41–500 Chorzów, tel. +48 32 2412221, fax +48 32 2416821, www.hutakrolewska.pl — *hot rolled products, rails, bars.*
- Arcelor Huta Warszawa Sp. z o.o. w Warszawie (Arcelor Huta Warszawa Steelworks Ltd. of Warsaw) ul. Kasprowicza 132, 01–949 Warszawa, tel. +48 22 8350011, fax +48 22 8354222, www.arcelormittal.com/poland — *raw steel, special steels, hot rolled products, cold rolled strip.*
- Huta Łabędy S.A. w Gliwicach (Łabędy Steelworks Joint Stock Co. of Gliwice) ul. Zawadzkiego 45, 44–109 Gliwice, tel. +48 32 2347201, fax +48 32 2342141, www.hutalab.com.pl — *hot rolled products.*
- CELSA Huta Ostrowiec Sp. z o.o. w Ostrowcu Świętokrzyskim (CELSA Huta Ostrowiec Steelworks Ltd. of Ostrowiec Świętokrzyski) ul. Samsonowicza 2, 27–400 Ostrowiec Świętokrzyski, tel. +48 41 2492302, fax +48 41 2492222, www.celsaho.com/po/zonapublica/index.aspx — *raw steel, rods, hot rolled products.*
- Huta Pokój S.A. w Rudzie Śląskiej (Pokój Steelworks Joint Stock Co. of Ruda Śląska) ul. Niedurnego 79, 41–709 Ruda Śląska, tel. +48 32 7721111, fax +48 32 2486709, www.hutapokoj.com.pl — *hot rolled products, rails.*
- Huta Stalowa Wola S.A. w Stalowej Woli (Stalowa Wola Steelworks Joint Stock Co.) ul. Kwiatkowskiego 1, 37–450 Stalowa Wola, tel. +48 15 8434111, fax +48 15 8435310, www.hsw.com.pl — *raw steel, hot rolled products, cold rolled sheet.*
- Huta Zabrze S.A. w Zabrzu (Zabrze Steelworks Joint Stock Co. of Zabrze) ul. Bytomska 1, 41–800 Zabrze, tel. +48 32 2713211, fax +48 32 2753505, www.huta-zabrze.com.pl — *raw steel, cast iron, cast steel.*
- CMC Zawiercie S.A. w Zawierciu (CMC Zawiercie Steelworks Joint Stock Co. of Zawiercie) ul. Piłsudskiego 82, 42–400 Zawiercie, tel. +48 32 6721621, fax +48 32 6722536, www.cmcpoland.com — *raw steel, hot rolled products, cast iron, cast steel.*

IRON OXIDE PIGMENTS

Overview

Iron oxide pigments are the most widely used kind of inorganic pigments. They are nontoxic, relatively low-cost, and have a wide range of applications, mainly as **mineral colours** for the production of paints and varnishes, and for cements, bricks, roof tile, and mortars used in building construction, as well as for rubber, plastics, paper, glass, cosmetics, inks, and animal feed. **Natural iron oxide pigments** usually contain a few iron oxides, with one of them predominating, which determines the color of pigment, e.g. ***black*** — based on magnetite (Fe_3O_4); ***red*** — on hematite (Fe_2O_3); ***brownish*** and ***yellow*** pigments — on goethite (FeOOH). There are also some traditional names of natural pigments, known and used for centuries, for example: ***ocher***, ***sienna***, and ***umber***.

The scarcity of deposits of natural iron oxide pigments, as well as increased demand for high quality pigments, has resulted in the development of **synthetic iron oxide pigments** production, usually obtained from basic chemicals.

Sources

Occurrences of ***natural iron oxide pigments*** are known in the area of the Świętokrzyskie Mountains (e.g. **Dolina Kamienna** and **Baranów**), the Cracow-Silesia Monocline (**Jaroszowiec** near Klucze), the Sudety Mountains (**Kowary**, **Nowa Ruda**), and the Carpathian Mountains (**Janowice** and a recently discovered small deposit in **Czerwonki Hermanowskie** with resources ca. of 3,000 t). Moreover, in the Kielce region (**Końskie**) there are two recognized deposits of ***clays***, in which ***ochers*** form lenses, i.e. the **Buk** (reserves exhausted in 1976) and the **Baczyna** (undeveloped) with three varieties of ***ocher***, i.e. ***yellow***, ***red***, and ***brown*** of total resources of 578,000 t (as of 31 December 2013).

As a source for the production of ***iron oxide pigments*** there are also utilized waste materials such as spent pickle liquor from steelmaking rich in iron salts, and waste Fe-rich residues from water purification. The huge potential source for iron oxides recovery is the waste dump of the **Police Chemical Plant**.

Production

Natural iron oxide pigments make currently margin of production and almost entirely have been displaced by ***synthetic pigments*** obtained in course of synthesis of a variety of secondary materials. The characteristic feature of recent years is also production of iron oxide pigments based on natural components imported from China and India, being properly mixed and processed in the domestic plants. **Ferrokolor** of

Częstochowa is currently the sole manufacturer of ***natural iron oxide pigments*** (***yellow ocher*** with 8–10% of iron oxide contents). Small production of 50-60 tpy, based on ***ocher clays*** occurring in Kielce region, especially in **Końskie** and **Przysucha,** rose to 135 t only in 2012. The total production of mineral pigments containing more then 70% Fe_2O_3 and synthetic pigments recorded in PKWiU 20121910 position, grew to more than 6,500 t in 2013 (Tab. 1), wherein the synthetic pigments may represent more than 80% of the total production of this group of materials. Most of the manufacturers for economic reasons discontinued the synthesis of iron oxide pigments in the recent years. Instead of this synthesis they conduct only so-called standardization process, consisting of physical processes (mixing or grinding) of iron oxide powders without chemical modification.

Tab. 1. Iron oxide pigments statistics in Poland

t

Year	2009	2010	2011	2012	2013
Iron oxide pigments* **CN 2821 10-20, PKWiU 20121910**					
Production	4,006	6,217	6,161	6,099	6,579
Imports	14,080	18,364	20,492	18,835	16,074
Exports	2,616	4,053	3,382	3,947	3,793

* production of both groups: synthetic and mineral iron oxide pigments registered together

Source: ***The Central Statistical Office (GUS)***

The most important producers of ***synthetic iron oxide pigments*** are as follows:

- the **Ferrokolor** of **Częstochowa**, supplying mainly ***synthetic iron oxide pigments***, including ***blacks*** (over 57% of production), ***reds*** (20%), ***browns***, and ***ferrite yellow iron oxide*** (21%) in total amount of over 3,500 t in 2011 and slightly lower 3,000-3,100 tpy in 2012-2013, small amount of which (ca. 14-20%) was exported to Moldova and Baltic states;
- the **Boruta-Zachem Kolor** in **Bydgoszcz** (in **Ciech** structure), with production of recent years of 750–890 tpy; primarily of ***ferrite yellow iron oxide*** (38-48% of supply) and, in smaller quantities, ***synthetic blacks*** (16-31%), ***reds***, and ***browns*** for the domestic market and export; in 2010 due to economical reasons, the company discontinued own synthesis, sellling pigments obtained by standardization of the finished ground powders of oxides of domestic origin (waste) or imported currently from Ukraine;
- **Nofar** in **Mroczków** near **Bliżyn** with production of 130–280 tpy of synthetic iron oxides, including 60 t of ***red iron-BH*** – the only one pigment manufactured in company, while the other pigments of ***red, black, browns*** and ***yellows*** were obtained by a mixture of powders of the appropriate colors of waste oxides of domestic origin or imported from China.
- **Permedia Chemical Enterprise** of **Lublin**, supplying a wide range of ***synthetic reds***, ***blacks***, ***browns***, and ***ferrite yellow iron oxide***, due to the economic reasons ceased their synthesis in 2009 and offered to acquire only iron oxide pigments manufactured by simple mixing of finished products imported from China; the production volume in 2008, the last year when the synthesis was conducted, did not exceed 12 t; the

level of pigments manufactured by mixing recorded by the Central Statistical Office reached 200 t in 2011, but dropped to 100-110 tpy in the following years 2012-2013.

Trade

The domestic demand has been satisfied by imports of both ***synthetic*** and ***natural pigments***. The total supply of both type of pigments after falling to less than 14,000 t in 2009, began to increase significantly since 2010, reaching maximum volume in 2011, what was justified by a significant development of construction projects in the same period (Tab. 1). However, in the following two years pigments imports were reduced to only 16,000 t in 2013, what is directly related to the fluctuations in construction.

Synthetic pigments (***iron oxides*** and ***hydroxides***) were purchased basically from Germany (58-75% of imports) and the Czech Republic, and most recently — from China (7%), Austria (13%) and Denmark (5%). Since 2011, the group of suppliers of ***mineral iron oxides pigments*** was supplemented by Spain, and the volume of purchases from this country accounted for more than 32% in 2012 and 27% in 2013. Periodically increased deliveries to China, especially in the group of oxides and hydroxides (60–82% of export during last years), has a character of re-exports. The trade balance in all kinds of ***iron oxide pigments*** has been consistently negative (Tab. 2). The deep deficit in trade in all species of pigments, especially for synthetic pigments (Tab. 2), confirms the advantage of foreign materials on the Polish market.

Tab. 2. Value of trade in iron oxide pigments in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Synthetic pigments[1] CN 2821 10					
Exports	11,993	19,251	16,682	19,858	18,904
Imports	51,892	57,606	65,635	63,804	50,634
Balance	**-39,899**	**-38,355**	**-48,953**	**-43,946**	**-31,730**
Mineral iron oxide pigments[2] CN 2821 20					
Exports	68	94	145	63	240
Imports	2,361	2,868	4,982	4,534	4,728
Balance	**-2,293**	**-2,774**	**-4,837**	**-4,471**	**-4,488**

[1] iron oxides and hydroxides [2] containing more then 70% Fe_2O_3

*Source: **The Central Statistical Office (GUS)***

The average unit values of imports of ***mineral iron oxide pigments*** has shown significant fluctuations in recent years from a peak of almost 6,000 PLN/t in 2009 to slightly more than 4,700 PLN/t in 2011 and 2013. The drop in imports prices was associated with the appearance of Spain in the group of suppliers. The raw material imported from this direction in large quantities, had the lowest unit value of imports - less than 2,000 PLN/t. The unit values of imported ***iron oxides*** and ***hydroxides*** (***synthetic pigments***) showed a similar fluctuations, but their level was much lower – 3,200-3,700 PLN/t (Tab. 3).

Tab. 3. The unit value of iron oxide pigments imports to Poland

Year	2009	2010	2011	2012	2013
Synthetic pigments[1] CN 2821 10					
PLN/t	3,793	3,231	3,377	3,557	3,360
USD/t	1,224	1,062	1,166	1,088	1,066
Mineral iron oxide pigments[2] CN 2821 20					
PLN/t	5,947	5,349	4,721	5,040	4,703
USD/t	1,849	1,769	1,650	1,545	1,491

[1] iron oxides and hydroxides [2] containing more then 70% Fe_2O_3

Source: ***The Central Statistical Office (GUS)***

Consumption

The consumption of ***iron oxide pigments*** is dominated by two branches: the paint and varnish industry, where they are principally used for anti-corrosive paints, and the building construction to manufacture color cements, concrete mix, mortars, plasters, roofing tiles, pitchers, joints, bricks, terrazzo, etc. They are also used as a colorant and filler in the production of plastics, ceramics, rubber, glass, leather, textile; as polisher in abrasives; and as powder for casting mould in the foundry engineering. ***Micaceous iron pigments***, due to their mica-like structure, are utilized in the production of high quality waterproof anti-corrosive coating, resistant to atmospheric oxygen, pollution, and UV radiation.

The level of apparent consumption both natural and synthetic pigments is difficult to ascertain because significant part of domestic production is based on natural semi-products imported from China and India.

Companies involved in synthetic and natural iron oxide pigments production in Poland, as of December 2013

- Ferrokolor Sp. z o.o. (Ferrokolor Ltd.), ul. Ks. Piotra Skargi 37/39, 42–209 Częstochowa, tel. +48 34 3604010, fax +48 34 3643280, www.ferrokolor.pl — *synthetic red, black, and brown iron oxide; synthetic ferrite yellow; natural ocher*.
- Boruta-Zachem Kolor Sp. z o.o. w Bydgoszczy (Boruta-Zachem Kolor Ltd. of Bydgoszcz), ul. Wojska Polskiego 65, 85–825 Bydgoszcz, tel. +48 52 3747100, fax +48 52 3610962, www.zachembarwniki.pl — *synthetic red, black, and brownish iron oxide pigments; synthetic ferrite yellow*.
- Nofar Co., Mroczków 4, 26–120 Bliżyn, tel./fax +48 41 2541019, www.nofar.pl — *synthetic red, brown and black iron oxide pigments*.
- Zakłady Chemiczne Permedia S.A. w Lublinie (Permedia Chemical Plant Joint Stock Company of Lublin), ul. Grenadierów 9, 20–331 Lublin, tel. +48 81 7441271, tel./fax +48 81 7440374, www.permedia.pl — *synthetic red, black, brown, and yellow iron oxide pigments*.

KAOLIN

Overview

Kaolin is a rock wealthy in ***kaolinite***, formed by the weathering of aluminosilicate rocks rich in feldspar and mica, e.g. granite, gneiss, or arkose. The amount of kaolinite in typical kaolin is 20–30% by weight.

Kaolin is applied as ***unprocessed*** raw material in the production of quartz-chamotte refractory materials, while in a ***processed*** form (***water washed***, ***calcined***, ***airfloated***, ***delaminated***) it is commonly utilised by the ceramic industry, especially for the production of porcelain tableware, and also for paper coating and filler applications, fiberglass production, in the paint and rubber industry, for petroleum cracking catalyst (***calcined kaolin***), etc.

Sources

Deposits of ***primary kaolin*** occur in Lower Silesia in the ***granite massifs*** of **Strzegom-Sobótka** and **Strzelin-Otmuchów**. They are not operated, though their total resources amount to 109.0 Mt. The source for kaolin production are deposits occurring in the **Bolesławiec Syncline** in Lower Silesia, especially the **Maria III** deposit (79.8 Mt of reserves) of ***kaolin sandstone*** containing about 22% kaolinite. Kaolin is also recovered (in negligible quantities) from the **Dunino** deposit (previously classified as ***halloysite***) as well as from deposits of ***glass-grade*** and ***foundry sands***, where kaolinite occurs as an accompanying mineral, i.e.: **Osiecznica II** in the **Bolesławiec Syncline**, as well as deposits in the **Tomaszów Syncline**: **Biała Góra** and **Grudzeń Las**. The total domestic resources of ***kaolin*** amounted to 212.6 Mt (as of 31 December 2013), excluding kaolin in deposits of kaolinite-rich quartz sand.

Production

The domestic output of ***washed kaolin***, after significant drop to 125,000 t in 2010, in the following years ranged from 138,000 to 166,000 tpy (Tab. 1). The structure of domestic production of kaolin has been overwhelmed by ceramic grades, utilized basically in manufacturing of ceramic tiles. In recent years the share of these grades has oscillated around 90%, while the proportion of paper grades has ranged from 3 to 6% showing a slight increase (Tab. 2).

Kaolin has been supplied by the following domestic manufacturers:

- **Surmin-Kaolin** in **Nowogrodziec**, supplying 70,000–87,000 tpy of various kaolin grades obtained from its own **Maria III** deposit of kaolinite-rich sandstone, and from waste material of quartz sand processing at the **Osiecznica** mine (40,000-46,000 tpy, except 2012 when it was 29,000 t);

Tab. 1. Kaolin statistics in Poland

'000 t

Year	2009	2010	2011	2012	2013
Kaolin sands					
Mining output[1]	261.0	238.0	285.2	249.1	267.7
Raw and washed kaolin CN 2507 00 20					
Production[2]	136.0	124.6	163.6	137.8	166.0
Imports	89.3	107.7	118.9	120.0	131.1
Exports	11.6	8.0	12.8	11.1	10.0
Consumption[a]	213.7	224.3	269.7	246.7	287.1

1 the output from the **Maria III** and **Dunino** deposits

2 includes kaolin obtained at the **Surmin-Kaolin** by processing of kaolin-containing waste material from the **Osiecznica** mine

Source: ***The Central Statistical Office (GUS), Mineral Resources Datafile, producer's data***

Tab. 2. Structure of kaolin production in Poland

'000 t

Year	2009	2010	2011	2012	2013
Total production	**136.0**	**124.6**	**163.6**	**137.8**	**166.0**
• ceramic grade[1]	124.0	112.3	150.2	122.7	149.6
— *for ceramic tiles[e]*	*105.0*	*93.0*	*125.0*	*105.0*	*123.8*
• paper grade[2]	5.4	5.0	4.8	5.3	6.8
• for rubber, paint, polymers etc.[2]	6.6	7.3	7.4	9.8	9.6

1 production from **Surmin-Kaolin** (including fiber-glass and refractory grades), **Biała Góra**, and **Grudzeń Las**

2 production only from **Surmin-Kaolin**

Source: ***Producers' data***

- **Grudzeń Las** in **Sławno** near Opoczno — kaolin recovered in course of quartz sand washing from its own deposits: **Grudzeń Las** and **Piaskownica Zajączków Wschód** (the total output of 40,000-65,000 tpy);
- **Biała Góra Mineral Mines of Tomaszów** in **Smardzewice** — kaolin recovered as a by-product of silica sand processing from its own deposits, i.e. **Biała Góra I** and **II Wschód**, and **Unewel Zachód** (total production 14,000-19,000 tpy);
- **Dunino Mine Ltd.**, operating the **Dunino** deposit of the kaolinite raw material (previously classified as halloysite) which has been utilised by the **Intermark**, Gliwice for the production of ***sorbents*** and ***geomats***. Other potential uses included: coagulants, feed additives, fertilizers, mineral pigments.

Among Polish producers, the largest and the only one offering both a wide range of high-purity washed ceramic grades and those for non-ceramic applications, is **Surmin-Kaolin** of Nowogrodziec. The main shareholder of the company's stocks is **Quarzwerke Group**. The recent **Surmin**'s share in the total domestic production has ranged between

50 and 55%. The company offers a broad assortment of ***kaolin grades***, including the ***ceramic*** — 80% of the total output in 2013, as well as ***glass fibre***, ***paper*** (***filler***), for the ***rubber***, ***paint***, and ***polymers*** industries.

The remaining Polish manufacturers provide kaolin, usually with relatively high content of colouring oxides (above 2% Fe_2O_3), only for the ceramics, e.g. for wall tiles, and to lesser extent — also sanitaryware and semi-vitreous chinaware. The majority of the output at the **Biała Góra Mineral Mines** of **Tomaszów** has been utilized for the production of ceramic tiles at the **Opoczno** and **Paradyż Group** plants. Also another producer of glass and foundry sand in the region, **Grudzeń Las**, offers the by-product kaolin suitable for the ceramic applications other than porcelain. Its principal customers have been the largest tile manufacturers in Poland: **Opoczno**, **Paradyż Group**, **Końskie Group**, and **Tubądzin**. The main shareholder of the company is **Atlas**, the leading domestic producer of mortars for the building industry.

Trade

Most of ***kaolin*** offered by domestic producers has not met the requirements of the whiteware industry, due to relatively high content of Fe_2O_3. Therefore, the demand for higher purity grades has been met by importation. In the last two years the share of foreign kaolin in the domestic consumption approached 49% and 46% respectively, while in 2009 it was 42% (due to significant drop in the importation of Ukrainian raw materials). The principal recipients of foreign kaolin in Poland were: the porcelain (tableware, electrical porcelain, and porcelain sanitaryware), and the paper industries. The tiles manufacturers have utilised basically the domestic raw material.

Tab. 3. Polish imports of kaolin, by country — CN 2507 00 20

'000 t

Year	2009	2010	2011	2012	2013
Imports	**89.3**	**107.7**	**118.9**	**120.0**	**131.1**
Austria	0.0	0.1	0.0	–	0.0
Belgium	–	0.5	0.3	0.0	0.0
China	–	–	–	0.5	0.6
Czech Republic	24.9	30.3	38.4	30.6	28.1
France	1.2	3.4	2.1	1.4	1.5
Germany	55.2	63.4	67.4	73.2	89.7
Italy	0.2	0.1	0.1	0.1	0.3
Spain	0.1	0.1	0.1	0.0	1.2
Ukraine	2.2	4.2	4.8	5.5	3.7
United Kingdom	3.5	4.2	4.4	7.0	4.0
USA	1.7	1.1	1.1	1.6	2.0
Others	0.3	0.3	0.2	0.1	0.0

Source: ***The Central Statistical Office (GUS)***

The major suppliers of ***washed kaolin*** were Germany (basically **Amberger Kaolinwerke**) — 68% of the total deliveries in 2013, and the Czech Republic (**Keramika**

Horni Briza — a part of **Lasselsberger**, and **Sedlecky Kaolin**, **Kaolin Hlubany/WBB**) — 21%. Much smaller quantities were supplied by the United Kingdom (**Imerys**) and Ukraine.

The regular but rather small exportation of kaolin (8,000–13,000 tpy) should be attributed to foreign sales of **Surmin-Kaolin** through the **Quarzwerke** commercial network, and probably re-exports of material of foreign origin (Tab. 1). The most regular export recipient was Germany, while the largest in 2012 and 2013 - Slovakia. The ***kaolin*** trade balances have been always negative. In recent years the deficit has stabilized at around 48-50 million PLN per year (Tab. 4).

Tab. 4. Value of kaolin trade in Poland — CN 2507 00 20

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	3,183	2,555	3,673	3,573	3,218
Imports	36,322	50,447	51,830	51,703	52,837
Balance	**-33,139**	**-47,892**	**-48,157**	**-48,130**	**-49,619**

Source: ***The Central Statistical Office (GUS)***

The unit values of kaolin importation to Poland followed the quotations of ceramic and porcelain grades on the British market. Since 2010 they have decreased from 155 to 128 USD/t (Tab. 5). In 2013 the unit cost of importation from Ukraine amounted to around 190 USD/t (while in 2008 it was 55 USD/t), from the Czech Republic – to 128 USD/t (a decrease from 193 USD/t in 2011), from Germany — to 98 USD/t, while the unit value of high-grade kaolin imported from the United Kingdom — to 418 USD/t.

Tab. 5. The average unit value of kaolin imports to Poland — CN 2507 00 20

Year	2009	2010	2011	2012	2013
PLN/t	407	468	436	431	403
USD/t	131	155	148	132	128

Source: ***The Central Statistical Office (GUS)***

Consumption

Last year the domestic demand for kaolin amounted to around 287,000 t, which exceeded the amount utilized in the previous year by 16.4% (Tab. 1). The main consumer of kaolin in Poland has been the ceramic tile industry. Current tile capacities of domestic factories are estimated at 120-140 Mm^2py, and Poland has ranked the fourth largest producer of ceramic tiles in Europe.

The important consumers of kaolin have been also manufacturers of ***chinaware***, especially of ***porcelain tableware***. There were eight producers involved in this sector, with total capacities of about 40,000 tpy, among which the largest were: **Lubiana** near **Kościerzyna** (15,000 tpy), which together with **Porcelana Chodzież** and **Ćmielów** was incorporated into one holding of combined capacity of 23,000 tpy. The remaining producers, manufacturing up to 6,000 tpy, were the following: **Karolina** (6,000 tpy),

Wałbrzych (in liquidation), **Krzysztof** (**Wawel** trade mark), and **Porcelana Śląska/ Giesche** (until 2009, since then the porcelain goods have been manufactured in Bangladesh, but decorated in Poland and sold under Porcelana Śląska trade mark). By 2012 the production of porcelain tableware has distinctly declined, to 24,000-25,000 tpy. That resulted from unfavourable exchange rates and a "flood" of imported ceramic goods from Asia (especially from China) that affected all the domestic manufacturers and forced them to reduce their production. In 2013 however, the output of tableware slightly increased, approaching 28 kt. Nevertheless, the proportion of these goods sold abroad in the total production decreased from over 80% to 72-73% in 2011-2013 (Tab. 6). The most important recipients were western European countries, i.e. Germany, Italy, France, Spain, and the Netherlands. Small production and exports of ***electrical porcelain*** (by e.g. **Radpol Elektroporcelana** of **Ciechów**, **ZPE Zapel** of **Boguchwała, Argillon Polska** of **Jedlina-Zdrój** – former **Zofiówka Electrical Porcelain Plant**) stabilized in recent years at ca. 8,000 and 2,000 tpy, respectively.

Tab. 6. Porcelain statistics in Poland

'000 t

Year	2009	2010	2011	2012	2013
Tableware CN 6911 10–90, 6913 10					
Production	24.0	25.4	23.7	24.3	27.8
Imports	9.2	12.5	16.1	13.7	9.6
Exports	15.8	17.5	17.0	17.8	20.0
Consumption[a]	17.4	20.4	22.8	20.2	17.4
Sanitaryware CN 6910					
Production	89.1	93.8	93.3	83.7	91.4
Imports	18.6	20.2	19.6	18.0	18.4
Exports	59.3	67.6	70.3	67.0	71.2
Consumption[a]	48.4	46.4	42.6	34.7	38.6
Porcelain sanitaryware CN 6910 10					
Production	*38.8*	*36.0*	*38.9*	*30.1*	*40.3*
Imports	*5.7*	*4.7*	*4.4*	*4.9*	*4.3*
Exports	*15.6*	*28.6*	*28.4*	*24.8*	*27.9*
Consumption[a]	*28.9*	*12.1*	*14.9*	*10.2*	*16.7*
Electrical porcelain CN 6909 11, 8546 20					
Production	5.4	8.6	8.0	8.0	8.2
Imports	0.3	0.4	1.2	1.0	1.2
Exports	0.9	1.2	2.2	2.1	2.5
Consumption[a]	4.8	7.8	7.0	6.9	6.9

Source: ***The Central Statistical Office (GUS)***

In 2013 the production and exportation of ***sanitaryware*** increased by 9 and 6%, respectively, as compared to the previous year (Tab. 6). There were seven producers in the domestic market, among which the largest were: **Cersanit I** of Krasnystaw (a part of publicly listed **Cersanit Group –** in 2012 renamed for **Rovese Group**) — 3.5 million items per year, and **Sanitec Koło** (belonging to the **Sanitec-Metra Group**) operating plants in Koło and Włocławek — total production capacity of 3.0 million items per year. The remaining smaller producers were the following: **Roca Polska** in Gliwice (1.3 million items per year), **Jopex** in Zabrze (in liquidation since 2009), **Ceramika Pilch** in Jasienica near Bielsko Biała, **Hybner** in Środa Wielkopolska, and **Deger Ceramika** in Jezuicka Struga near Inowrocław. Last year the foreign sales of sanitaryware made 78% of the domestic output (66–81% in previous years). A significant contribution to the production and exportation of these goods has been usually made by ***porcelain sanitaryware***. The largest foreign recipients have been Ukraine, Germany, Russia, France, the Czech Republic, and Lithuania.

The remaining consumers, such as white cement and stoneware, had little contribution to the total kaolin demand in Poland. Relatively small consumption has been also reported by the paper industry, as the majority of domestic factories replaced ***kaolin*** by ***precipitated calcium carbonate*** (**International Paper** of Kwidzyn, **Frantschach** of Świecie, **Konstans** of Konstancin Jeziorna, and **Stora Enso Poland** of Ostrołęka – formerly **Intercell**). The consumption pattern of kaolin can be assumed as follows: ***ceramics*** and ***glass*** — ca. 85–90% (including production of ***tiles*** — 70–75%, ***porcelain tableware*** — 10–15%, ***sanitaryware*** — 10–15%, ***electrical porcelain*** and ***semi-vitreous chinaware*** — around 2% each), the ***papermaking*** — 5–7%, ***polymers*** and others — 7–8%.

Companies involved in kaolin production in Poland as of December 2013

- Kopalnie Surowców Mineralnych Surmin-Kaolin S.A. w Nowogrodźcu, (Surmin-Kaolin S.A. of Nowogrodziec), ul. Kaolinowa 35, 59–730 Nowogrodziec, tel. +48 75 7350044, fax +48 75 7350043, www.quarzwerke.com/surmin — *kaolin for ceramics, paper, rubber, polymers, and fiberglass applications*.
- Grudzeń Las Sp. z o.o. (Grudzeń-Las Ltd.), 26–332 Sławno near Opoczno, Grudzeń Las 28, tel. +48 44 7550910, tel./fax +48 44 7573234, www.grudzenlas.pl — *ceramic kaolin*.
- Tomaszowskie Kopalnie Surowców Mineralnych Biała Góra Sp. z o.o. (Biała Góra Mineral Raw Materials Mines of Tomaszów Ltd.), 97–213 Smardzewice, ul. Łozińskiego 6, tel. +48 44 7261801, fax +48 44 7245760, www.piasek.com.pl — *ceramic kaolin*.
- Kopalnia Dunino Sp. z o.o. (Dunino Mine Ltd.), Krotoszyce 9, 59–223 Krotoszyce, tel./fax +48 60 6906231, www.intermark.pl/haloizyt — *sorbents and geomats*.

LEAD

Overview

Lead (**Pb**) forms many minerals, but the main commercial one is ***galena***, which usually occurs together with ***sphalerite*** and other sulfide or carbonate minerals in many deposits. Galena concentrate is obtained from ***lead*** and ***zinc ore***, and to a lesser extent from ***silver*** and ***copper ore***, ***barite***, and others.

Another important source of **lead** is ***lead-bearing scrap and waste***, basically of spent lead-acid batteries. Despite environmental constraints, lead is considered a strategic metal in the world economy due to its numerous applications, e.g. in the production of batteries, ammunition, building construction materials, coverings for power and communications cables, alloys, and anticorrosive agents.

Sources

There are no individual deposits of ***lead ore*** in Poland of commercial importance. The primary sources of ***lead*** are ***zinc-lead ore*** deposits of Mississippi Valley type in the **Silesia-Cracow** region, with reserves of 1.34 Mt Pb, 19% of which in operating mines (as of 31 December 2013), and ***copper ore*** deposits in the **Fore-Sudetic Monocline** with approximate reserves of 1.6 Mt Pb (ca. 84% in deposits currently extracted).

An important secondary source of ***lead metal*** is ***lead-bearing scrap***, basically of lead-acid batteries, as well as of power cable coverings, lead alloys etc. The proportion of secondary lead in the total domestic supplies reached almost 70% in the last two years. There are two domestic companies specialized in handling scrapped lead-acid batteries, i.e. **Orzeł Biały** of **Bytom**, and **Baterpol** of **Świętochłowice**, which combined processing capacities are estimated at ca. 170,000 tpy of spent lead-acid batteries. These plants have recycled almost 100% of spent automotive batteries from the domestic market. Some quantities of scrapped batteries have been also imported. Taking into account the number of cars registered in Poland, by 2014 the amount of lead-acid batteries scrap available in the market should approach around 130,000 tpy.

Lead Ores and Concentrates

Production

The mining output of ***lead*** in Zn-Pb ore has been on constant decrease in recent years. In 2013 it dropped to below 25,000 t (Tab. 1). That basically resulted from the depletion of the ore extracted by the **Olkusz-Pomorzany** mine (from 1.46% in 2009 to 1.05% Pb in 2013) and the closure of the **Trzebionka** mine in the mid-2009. The sufficiency of reserves in the **Silesia-Cracow** region is estimated until 2016. Although there are some prospects for development of new reserves in this region, i.e. to the north and west of deposits currently operated (**Olkusz**, **Pomorzany**, and **Klucze I**). Furthermore, in 2011 the only Polish mine producer of lead - **ZGH Bolesław,** took over the **Gradir Montenegro** Zn-Pb-Ag ore mine in Montenegro and started exploration for zinc ores in Serbia. In 2013 around 3,200 tons of galena concentrates came from its foreign subsidiary. Currently, **ZGH Bolesław** is dominant company in a capital group, comprising 7 subsidiaries, including **HC Miasteczko Śląskie**, **Boloil**, **Bolesław Recycling**, and **Gradir Montenegro**.

Tab. 1. Lead ore and concentrates statistics in Poland — CN 2607 00

'000 t Pb

Year	2009	2010	2011	2012	2013
Mining output	80.4	60.2	53.1	89.0	79.0
— *from Zn-Pb deposits*	*51.5*	*35.3*	*28.2*	*26.6*	*24.5*
— *from Cu deposits*	*28.9*	*24.9*	*24.9*	*62.4*	*54.5*
Concentrates production	36.9	23.1	18.1	17.1	16.0
Imports[1]	0.8	2.3	2.5	2.2	2.1
Exports	38.8	21.5	17.2	37.0	34.9
Concentrates apparent consumption	-1.1	3.9	3.4	-17.7	-16.8

[1] excludes imports of collective concentrates to the **Miasteczko Śląskie** smelter — the official statistics give the importation of Zn-Pb and Zn concentrates together under a code of **CN 2608 00**

Source: ***The Central Statistical Office (GUS)***

Galena has been also extracted in association with ***copper ore*** from the deposits of the **Fore-Sudetic Monocline**. In the last two years the output of lead in run-off-mine increased significantly due to extraction of richer in Pb part of the deposit (Tab. 1). The lead percentage in particular types of copper-bearing rocks varied widely, from 0.01% in sandstone and 0.11% in limestone to 0.67% in shales (approaching 11.3% Pb locally in the **Lubin** mine). Neither ***galena concentrate*** nor ***mixed Cu-Pb concentrate*** are obtained in course of ***copper ore*** processing. Lead contained in ***copper concentrate*** (1.0–3.0% Pb) is recovered in a form of ***pig lead*** from various waste materials of metallurgical processes, particularly those accumulated in the process of furnace gases dedusting.

Galena concentrates have been exclusively obtained from ***Zn-Pb ore***. Over the last five years their domestic supply decreased by almost 57%, down to 16,000 t in 2013 (Tab. 1). The concentrates have been manufactured at the **Olkusz Processing Plant** of **ZGH Bolesław**. There were obtained: ***flotation concentrate*** of ***galena*** with around 61% Pb, and mixed ***zinc-lead*** and ***zinc-lead-silver concentrates***, both graded at about 13% Pb.

Trade

The most important lead concentrate sold abroad is the ***galena*** one. Its total foreign sales were gradually decreasing, down to around 17,000 t Pb in 2011, as **Trzebionka plant** reduced and finally stopped the production (Tab. 1). However, in subsequent two years the exportation increased, to 37,000 and 35,000 t, respectively. From among recipients of Polish lead concentrates the most regular was China (Tab. 2). In 2012 Belgium emerged as the major customer, while in 2013 – almost 96% of foreign sales fell on China. In the last couple of years some small quantities of galena concentrates were also imported - in 2010-2013 basically from the United Kingdom (Tab. 1). The trade statistics of ***lead concentrates*** exclude ***bulk Zn-Pb concentrates*** which are included in the statistics for ***sphalerite concentrates***. Until 2011 the values of trade balance have showed a decrease, while in the following two years the trade financial revenues rose by 27% and further 5% as a result of the LME quotations improvement (Tab. 3). In 2012-2013 the unit values of concentrates exportation were significantly reduced as compared to 2011, probably as a result of the growth of their foreign sales (Tab. 4).

Tab. 2. Polish exports of lead concentrates, by country — CN 2607 00

'000 t (gross weight)

Year	2009	2010	2011	2012	2013
Exports	**59.8**	**34.8**	**28.0**	**60.5**	**56.8**
Belgium	–	–	2.8	56.8	–
Bulgaria	9.9	11.1	3.0	–	–
China	35.4	16.7	15.7	3.7	54.4
Germany	8.0	–	1.5	–	2.4
Romania	6.5	7.0	5.0	–	–

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Value of lead concentrates trade in Poland — CN 2607 00

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	113,050	96,879	92,428	113,905	119,006
Imports	1,704	6,182	6,587	5,163	4,620
Balance	**+111,346**	**+90,697**	**+85,841**	**+108,742**	**+114,386**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. The unit value of lead concentrate exports from Poland — CN 2607 00

Year	2009	2010	2011	2012	2013
PLN/t	1,892	2,781	3,300	1,881	2,096
USD/t	594	916	1,118	577	665

Source: ***The Central Statistical Office (GUS)***

Pig Lead

Production

Pig lead (with 96–99% Pb) has been manufactured at the following plants: the **Miasteczko Śląskie Zinc Smelter** (mostly primary), the **Lead Plant** at the **Głogów**

Copper Smelter (recovered from metallurgical waste), **Orzeł Biały**, **Baterpol**, and **ZAP Sznajder Batterien** (secondary). Over the last five years the total domestic ***pig lead*** supplies varied between 70,000 and 130,000 tpy, showing an upward trend (Tab. 5).

Tab. 5. Pig lead production in Poland — CN 7801 99 10

'000 t Pb

Year	2009	2010	2011	2012	2013
Total pig lead	**69.6**	**71.7**	**96.6**	**86.3**	**130.4**
— primary	19.6	20.3	24.7	22.7	23.2
— recovered	24.1	22.0	30.0	30.0	26.7
— secondary	25.9	29.4	41.9	33.6	70.5

Source: ***Producers' data***

Substantial quantities of ***pig lead*** have been recovered from wastes of pyrometallurgical processing of copper concentrate at the **Lead Division** of **Głogów I Copper Smelter** of **KGHM Polska Miedź**. The capacity of the smelter has been recently expanded to 30,000 tpy of pig lead. The principal raw materials for its production have been ***lead-bearing converter dust*** (45–55% Pb) and ***electric furnace dust*** (32–44% Pb), as well as ***shaft slimes*** (38–50% Pb). Other waste materials, such as ***coarse shaft dust*** with 9–11% Pb, ***converter slag*** with 3–10% Pb, ***anode slime*** with 25–37% Pb, as well as ***waste slag*** from **Kaldo** furnace of **Głogów Smelter Precious Metals Plant** (65% Pb) have not been utilized. The technology utilized at the **HM Głogów I** involves one-stage melting in rotary and rocking Dörschel-type furnaces to recover 30–31% of lead contained in the concentrate. The material has been processed in KGHM's **Refining Department** at the **Legnica Smelter**.

Secondary pig lead obtained from scrapped lead-acid batteries at the **Orzeł Biały** has been entirely processed into ***refined lead*** and ***lead alloys***. The **Orzeł Biały** operates the installation for comprehensive lead-acid battery recycling (recovery of pure electrolyte H_2SO_4, polypropylene granulate and 99% of metal) of annual processing capacity of 100,000 t of scrapped lead-acid batteries and lead-bearing wastes. Another domestic recycler — the **Baterpol** operates an installation for recycling of scrapped lead-acid batteries licensed by the **Engitec Impianti** of Italy (processing capacity of 70,000 tpy) in Świętochłowice-Lipiny and the **Refining Section** in Katowice-Szopienice. In 2011 another secondary pig lead producer debuted on the market – **ZAP Sznajder Batterien** of Piastów, being hitherto one of the domestic manufacturers of car batteries. Secondary lead obtained from around 11,000 tpy of scrapped lead-acid batteries is basically utilized for the production of new batteries, while electrolyte — for manufacturing of sodium sulfate for the chemical, glass, paper and textile industries.

Trade

Pig lead was traded on a limited scale as the majority of this material was domestically refined and processed into lead products (Tab. 9). Some amounts, of the order of ca. 1,000 t in 2009, and only 10-50 tpy in the following years, were exported, principally to Germany. Negligible quantities were also occasionally imported. The trade balances, which in the years 2009–2010 were positive, in the last two years turned negative.

Refined Lead

Production

Refined lead was produced at the following plants:

- **HC Miasteczko Śląskie — *refined lead*** (recently 18-22 ktpy), registered at the London Metal Exchange as ***standard lead*** of **H.20MS** brand (99.97%), and other ***refined metal*** grades (ave. 99.9% Pb), e.g.: **Pb990** (99.99%), **Pb985R** (99.985%) and **STP06002** (with reduced contents of Ag and Bi); the production has based on ***pig lead*** obtained in-house and sometimes imported, and occasionally on some secondary materials (scraps, waste, oxides).
- **KGHM Polska Miedź**, **Lead Refinery** at the **Legnica Copper Smelter** of the capacity of 35,000 tpy of ***refined lead*** — grade ***Pb985R*** and ***lead alloys*** (total production of 25,000-28,000 tpy in 2011-2012); the raw materials utilised were: ***pig lead*** obtained in-house, and small amounts of lead scrap.
- **Refining Section** of **Baterpol — *refined lead*** in four grades **PB990R**, **PB985**, **PB970R**, **PB940R** with 99.99%, 99,985%, 99.97% and 99.94% Pb respectively, and various ***lead alloys*** (total production of around 36,000-39,000 tpy in recent years); the plant is sourced entirely from secondary sources, basically metallic fraction obtained in-house from recycled lead-acid batteries; Baterpol has been also the only domestic manufacturer of ***rolled and extruded lead products***;
- **Orzeł Biały — *refined lead*** (99.97-99.99% Pb) - since 2010 brand registered under the name **EAGLE 9997**, and ***alloys*** (***Pb-Sb***, ***Pb-Ca, Pb-As***) from its own ***secondary pig lead***; in 2013 the plant's output approached 54,000 t (growth from 52,000 t in 2012), following the expansion and modernization of the pyrometallurgical section and developing of ***lead alloys*** manufacturing;
- **ZAP Sznajder Batterien** (since 2011) – ***secondary refined lead*** from scrapped lead-acid batteries (6,000 tpy).

The domestic ***refined lead*** production, after a contraction to 100,000 t in 2009, in the following years significantly improved exceeding 140,000 tpy in the last two years (Tab. 6). Its substantial percentage has come from secondary sources and from the lead refining section at the **Legnica Copper Smelter**. That compensated reduced supplies from the **Miasteczko Śląskie Zinc Smelter**.

Tab. 6. Refined lead statistics in Poland — CN 7801 10

'000 t Pb

Year	2009	2010	2011	2012	2013
Production	100.4	120.3	135.5	141.0	145.4
Imports	13.0	19.8	24.5	24.2	26.0
Exports	38.5	31.6	40.6	48.1	44.7
Consumption[a]	74.9	108.5	119.4	117.1	126.7

*Source: **The Central Statistical Office (GUS)**, producer's data*

Trade

Refined lead has been traditionally exported from Poland in quantities varying from 32,000 to 48,000 tpy). Recently the largest recipients have been the Czech Republic and

Germany (Tab. 7). In the last five years the importation of lead to Poland doubled (Tab. 8). The largest quantities have come from Sweden, Romania, and Germany (Tab. 8). The trade revenues that exceeded 150 million PLN in 2012, last year dropped by 21% due to reduced sales and increase in foreign deliveries (Tab. 10). The unit values of both importation and exportation of ***refined lead*** followed the changes in its LME quotations (Tab. 11). It is worth mentioning that almost each year these values were higher than the respective average market prices. In 2013 they increased distinctly, owing to improvement of international lead prices quotations.

Tab. 7. Exports of refined lead from Poland, by country — CN 7801 10

'000 t Pb

Year	2009	2010	2011	2012	2013
Exports	**38.5**	**31.6**	**40.6**	**48.1**	**44.7**
Austria	9.1	1.4	2.2	0.7	1.0
Belgium	0.2	0.2	0.2	0.4	0.2
Bulgaria	–	–	–	–	2.3
Czech Republic	15.6	17.2	21.8	22.1	20.0
Germany	4.4	3.7	4.7	11.1	12.2
Greece	–	–	0.7	0.2	–
Italy	–	1.2	4.3	5.6	1.5
India	0.7	0.5	–	–	–
Japan	–	0.4	–	–	–
Romania	2.4	2.4	2.5	2.0	0.5
Slovakia	–	–	–	0.6	1.7
Slovenia	–	2.1	1.8	1.4	2.9
Sri Lanka	0.5	–	–	–	–
Switzerland	0.2	0.3	0.3	0.3	0.3
Taiwan	0.5	–	–	–	–
Turkey	0.6	–	–	–	–
Ukraine	–	–	–	–	0.7
United Kingdom	3.3	1.9	2.0	3.2	0.7
Others	1.0	0.3	0.1	0.5	0.7

Source: ***The Central Statistical Office (GUS)***

In the last five years the exportation of ***lead wastes and scrap*** varied from 950 to 1,500 tpy. Simultaneously, the importation of these commodities, after reduction in the years 2011-2012 to ca. 6,000 and 5,000 t respectively, last year jumped almost twice, exceeding 10,000 t. The resulting trade balances were negative, deepening to -54 million PLN due to much higher volume and costs of importation than foreign sales. Two other important export lead commodities are ***lead alloys*** and ***antimonial lead*** (Tab. 9). The sales of ***lead alloys*** varied widely from 3,000 to almost 12,000 tpy, while last year it exceeded 11,000 t. That was followed by distinct growth in trade revenues, from 19 million PLN in 2012

Tab. 8. Imports of refined lead to Poland, by country — CN 7801 10

'000 t Pb

Year	2009	2010	2011	2012	2013
Imports	**13.0**	**19.8**	**24.5**	**24.2**	**26.0**
Belgium	–	0.6	0.3	0.4	0.0
Bosnia and Herzegovina	–	–	0.4	0.1	–
Bulgaria	–	0.4	1.5	0.6	4.3
Czech Republic	0.5	0.1	0.0	–	0.0
Estonia	–	0.3	0.7	1.0	1.4
Germany	0.6	1.9	4.1	4.7	6.9
Italy	–	0.8	–	–	0.1
Kazakhstan	0.1	0.1	0.4	–	–
Netherlands	–	–	–	1.7	1.7
Romania	3.0	3.3	5.4	6.0	4.2
Russia	0.9	2.4	3.2	0.3	0.1
Serbia	–	0.6	–	0.1	–
Sweden	4.1	7.2	7.5	8.3	6.2
Ukraine	3.5	1.9	0.2	–	–
United Kingdom	–	–	0.0	0.4	0.4
Others	0.3	0.2	0.8	0.6	0.7

Source: ***The Central Statistical Office (GUS)***

to over 70 million PLN in 2013 (Tab. 10). The prevalence of importation over the sales of ***antimonial lead*** generated negative financial results of that commodity turnover, varying from 35 to 101 million PLN. In the case of ***lead oxides***, despite significant fluctuations of both imports and exports, until 2011 their trade balances have been improving year by year. In the last two years their trade values decreased a lot due to a drop in the sales.

Tab. 9. Trade in selected lead commodities (other than refined lead) in Poland

t

Year	2009	2010	2011	2012	2013
Lead oxides (minium, massicot) CN 2824					
Imports	628	491	589	674	473
Exports	4,159	5,966	5,086	2,014	1,106
Nonrefined antimonial lead CN 7801 91					
Imports	10,523	18,635	19,536	16,955	16,211
Exports	5,081	5,132	6,187	8,509	6,233

Lead for refining with >0.02% Ag (pig lead) CN 7801 99 10					
Imports	0	0	320	168	0
Exports	967	10	47	24	0
Lead alloys CN 7801 99 90					
Imports	1,655	3,841	7,661	2,647	2,360
Exports	3,160	6,820	11,715	5,272	11,427
Lead wastes and scrap CN 7802 00					
Imports	2,276	7,164	6,365	5,306	10,370
Exports	1,517	1,506	947	1,277	1,046

Source: ***The Central Statistical Office (GUS)***

Tab. 10. Value of selected lead commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Lead oxides (minium, massicot) CN 2824					
Exports	24,394	34,646	40,625	15,716	8,765
Imports	3,872	4,558	5,439	5,850	4,381
Balance	**+20,522**	**+30,088**	**+35,186**	**+9,866**	**+4,384**
Refined lead CN 7801 10					
Exports	195,246	197,600	285,784	324,069	315,410
Imports	68,801	131,176	184,719	170,158	193,607
Balance	**+126,445**	**+66,424**	**+101,065**	**+153,911**	**+121,803**
Unrefined antimonial lead CN 7801 91					
Exports	20,865	26,693	38,368	50,591	41,536
Imports	55,883	118,885	139,504	118,382	118,103
Balance	**-35,018**	**-92,192**	**-101,136**	**-67,791**	**-76,567**
Lead for refining with > 0.02% Ag (pig lead) CN 7801 99 10					
Exports	9,958	295	1,628	485	0
Imports	0	0	2,376	1,196	0
Balance	**+9,958**	**+295**	**-748**	**-711**	**0**
Lead alloys CN 7801 99 90					
Exports	19,677	47,760	90,950	38,681	87,979
Imports	12,228	25,535	57,234	19,553	17,291
Balance	**+7,449**	**+22,225**	**+33,716**	**+19,128**	**+70,688**

Lead wastes and scrap CN 7802 00					
Exports	6,163	7,355	4,792	7,095	6,002
Imports	9,850	35,099	35,372	37,840	60,259
Balance	**-3,687**	**-27,744**	**-30,580**	**-30,745**	**-54,257**

[1] the total for the **CN 7801 99**

Source: ***The Central Statistical Office (GUS)***

Tab. 11. The unit values in refined lead trade in Poland — CN 7801 10

Year	2009	2010	2011	2012	2013
Import unit value					
PLN/t	5,299	6,616	7,531	7,030	7,455
USD/t	1,755	2,202	2,567	2,155	2,381
Export unit value					
PLN/t	5,070	6,245	7,030	6,740	7,060
USD/t	1,647	2,086	2,404	2,060	2,248

Source: ***The Central Statistical Office (GUS)***

Consumption

In the analysed period the apparent consumption of ***refined lead*** in Poland has ranged from 75,000 to 127,000 tpy showing a general upward trend. That was connected with the overpassing the crisis in the automotive industry, being one of the dominant lead end-user. In the last five years the production of lead-acid batteries in Poland usually has oscillated around 6 million units per year, except 2010 when it reached 7.7 million units. Other important applications, beside the production of lead-acid batteries, include: manufacturing of coverings for cables, shot, tubes and sheets (protection shields against ionizing radiation), and chemical compounds, i.e. ***minium*** (***red lead***), ***massicot*** (***litharge***), and ***battery powder***. ***Minium*** is utilized in manufacturing of anticorrosive paint, ceramic glazes, putties, and lead glass, while ***massicot*** — for the production of other lead compounds, e.g. solid solutions of lead zirconate and titanate which have piezoelectric properties. The domestic output of ***lead oxides***, including ***minium*** for glass (26-33% PbO_2) and batteries (25-33% PbO_2) as well as ***battery powder*** called ***Barton*** (65-82% PbO), has ranged from 8,000 to 10,000 tpy. Its principal producer has been the **Oława Smelter** (since 2007/2008 a subsidiary of **Silesia Metallurgical Plant** in the **Impexmetal Group**) — one of the largest ***lead oxides*** manufacturer in Europe (around 7,000 tpy in recent years). Relatively smaller quantities (1,000-3,000 tpy) have been produced at the **Złoty Stok Lead Minium Plant** – also a subsidiary of **ZM Silesia**. One of the most important consumers of lead commodities was **Hutmen Wrocław**, manufacturing ***lead alloys*** and ***tin-lead solders*** and ***wire***. ***Lead alloys*** (***Sn-Pb*** and ***Pb-Sb***) have been also recovered from various tin-lead containing residues by the **Fenix Metals** of Tarnobrzeg.

Companies involved in lead commodities production in Poland, as of December 2013

- ZGH Bolesław S.A. (Bolesław Mining and Smelting Plant Joint Stock Co.), Kolejowa 37, 32–332 Bukowno, tel. +48 32 2955100, fax +48 32 2955000, www.zgh.com.pl — *Zn-Pb ore, galena and complex sphalerite-galena concentrates*.
- KGHM Polska Miedź S.A. w Lubinie (KGHM "Polska Miedź" Joint Stock Co.), Skłodowskiej-Curie 48, 59–301 Lubin, tel. +48 76 8478200, fax +48 76 8478500, www.kghm.pl — *Pb as an accompanying element in Cu ore run off mine, pig lead (primary), refined lead*.
- Huta Cynku Miasteczko Śląskie S.A. (Miasteczko Śląskie Zinc Smelter Joint Stock Co.), 42–610 Miasteczko Śląskie, Woźnicka 36, tel. +48 32 2888444, fax +48 32 2851885, www.hcm.com.pl — *pig lead (primary), refined lead*.
- Orzeł Biały S.A. (Orzeł Biały Joint Stock Co.), Siemanowicka 98, 41–902 Bytom, tel. +48 32 2813481, fax. +48 32 2813491, www.orzel-bialy.com.pl — *antimonial lead, refined lead (secondary).*
- Baterpol S.A. (Baterpol Joint Stock Co.), Obrońców Westerplatte 108, 40–335 Katowice, tel. +48 32 7792000, fax +48 32 7792009, www.baterpol.pl — *pig lead (secondary), refined lead*.
- ZM Silesia S.A., Oddział Huta Oława, Oddział Złoty Stok (Metallurgical Plant Silesia Joint Stock Company, Oława Smelter Division, Zloty Stok Division), 55–200 Oława, Sikorskiego 7, tel. +48 71 3134031, fax +48 71 3134035, www.silesiasa.pl — *lead oxides*.
- ZAP Sznajder Batterien S.A., 05-820 Piastów, Warszawska 47, tel. +48 22 7237711, www.zap.pl – *secondary pig and refined lead*.

LIGNITE

Overview

Lower grades of coal, with a calorific value less than 24 MJ/kg, are classified as **brown coal**, which forms both small and huge deposits, mainly of Tertiary and late Mesozoic age. Brown coal is divided into **subbituminous coal** (hard form, with calorific value above 17.5 MJ/kg) and **lignite** (soft form, with calorific value below 17.5 MJ/kg). In many countries lignite is one of the most common and inexpensive sources of energy. It is usually consumed directly at nearby power stations. Exports or imports are now occasional.

Sources

Deposits of ***lignite***, mainly of the Miocene age, occur in the central and western Poland. The raw material is characterized by low calorific value (7–11 MJ/kg), soft form, low alkali content, and — in the majority of deposits — low sulphur content (0.2–1.2% S in exploited deposits, 0.4–3.9% S in undeveloped deposits). High moisture (above 50%) and rather high ash content (4–12% in extracted deposits, 11–28% in undeveloped deposits) in the run-off-mine do not allow most of this lignite to be chemically processed.

The total resources of 90 deposits were 22,684 Mt (as of 31 December 2013). In 2011, their volume rose significantly (by ca. 3,000 Mt, to 22,663 Mt) due to recognition of 5 new deposits and actualization of resources of deposits previously recognized. In 2013, one new deposit was recognized, and resources of 3 deposits were updated, so total reserves rose by 180 Mt. As a result, in the years 2012-2013 domestic lignite resources remained almost the same. Nine deposits were developed with total reserves of 1,509 Mt, including 1,165 Mt of available reserves.

Production

Poland is now the world's seventh largest producer of ***lignite***. In the years 2009-2010 the production declined to ca. 56.5 Mt, while in the years 2011–2013 it dynamically increased by 16.5%, approaching 65.9 Mt (Tab. 1). Lignite's share in the structure of primary energy generation in Poland amounted to ca. 18%.

Lignite is extracted in four large mines (**Bełchatów**, **Turów**, **Konin**, and **Adamów**), and one small one (**Sieniawa**). The largest mine is **Bełchatów** with two open-pits: **Bełchatów** and **Szczerców**, and total annual capacity of over 42 Mt (output 42.1 Mt in 2013). New large **Szczerców** open-pit started in 2009, the production of which achieved 13.6 Mt in 2011, while in 2012-2013 it decreased to 9.1 Mt. The total resources of the deposit were ca. 844 Mt, while its available reserves - ca. 589 Mt. **Szczerców** open-pit should achieve maximal capacity of ca. 38 Mtpy. It will gradually replace **Bełchatów**

Tab. 1. Lignite statistics in Poland — CN 2702 10

'000 t

Year	2009	2010	2011	2012	2013
Production	57,108	56,510	62,841	64,280	65,849
Exports	68	115	145	134	218
Stocks change	-14	-174	63	138	-108
Consumption	57,084	56,569	62,633	64,008	65,739

Source: ***The Central Statistical Office (GUS)***

open-pit (planned reserves exhaustion in 2019). The **Turów** mine extracting **Turów** deposit, located close to the Czech and German borders in the extreme southwest corner of Poland, has an annual output capacity of ca. 11 Mtpy. However, its output has fallen to 9.5–10.5 Mtpy in recent years. The **Konin** mine of annual capacity of ca. 11 Mt (10.2 Mt in 2013) has operated 3 open-pits: **Drzewce**, **Pątnów IV**, and **Tomisławice** (commenced in 2011, when **Pątnów III** open-pit was closed). There are also a few satellite deposits, which are planned for future exploitation. The **Adamów** mine of annual output of 4–5 Mt (4.3 Mt in 2013) has operated 2 open-pits: **Adamów** and **Koźmin** (**Władysławów** open-pit closed in 2012), and a few small satellite deposits. Unique small Sieniawa lignite mine has been managed by private company **Sieniawa Lignite Mine** (output 0.1 Mt in 2013).

After significant organization and ownership changes in the Polish power industry in the years 2002-2009 (see: **MINERALS YEARBOOK…, 2002-2009**), in 2010 significant structural changes occurred in the dominant company on the Polish lignite market - **Polish Power Group Capital Group (Grupa Kapitałowa Polska Grupa Energetyczna S.A. - PGE S.A.**). Thirteen joint stock companies were consolidated into one company - **PGE Mining and Conventional Power Industry (PGE Górnictwo i Energetyka Konwencjonalna S.A.)**. **Bełchatów** and **Turów** mines, as well as adjacent **Bełchatów** and **Turów** power plants started to be dependent units of this company. In July 2012 **Zespół Elektrowni Pątnów-Adamów-Konin S.A.** (**ZE PAK S**.**A**.), controlling four power plants: **Pątnów**, **Pątnów II**, **Konin** and **Adamów**, bought **Konin** and **Adamów** lignite mines from the State Treasury. Lignite for Pątnów, Pątnów II and Konin power plants has been delivered by Konin lignite mine, while Adamów power plant has been supplied by Adamów lignite mine. **Sieniawa** lignite mine remains the only independent domestic lignite mine.

Trade

In 2009–2013 exports of ***lignite*** rose to from 68 to ca. 218 ktpy, with the Czech Republic as the main recipient, and smaller amounts sold to Austria, Germany, Hungary, and Slovakia (Tab. 2). In the years 2009–2013, the Central Statistical Office reported ***lignite*** imports in item **CN 2702 10** (ca. 30,140, 24,880, 76,480, 147,260, and 194,550 t respectively). High unit values of these imports (Tab. 4) suggest, that probably ***lignite briquettes*** were purchased, not ***lignite***. ***Lignite briquettes*** were imported from the Czech Republic and Germany in the total amounts of ca. 37,300 t in 2009, ca. 50,100 t in 2010, ca. 92,800 t in 2011, ca. 186,900 t in 2012, and 231,400 in 2013.

Tab. 2. Polish exports of lignite, by country — CN 2702 10

'000 t

Year	2009	2010	2011	2012	2013
Exports	**68.3**	**115.2**	**144.6**	**133.5**	**217.9**
Austria	0.8	0.5	0.9	0.7	0.7
Czech Republic	62.6	110.6	141.9	131.4	214.3
Germany	0.5	3.1	0.1	0.0	0.1
Hungary	4.2	0.9	1.6	0.4	1.2
Slovakia	0.1	0.0	0.1	1.0	1.5
Others	–	–	–	–	0.1

Source: ***The Central Statistical Office (GUS)***

In 2009-2010 trade balance in ***lignite*** and ***lignite briquettes*** was negative and trade deficit amounted to 7.8 million PLN. In the years 2011-2013, due to increased importation of expensive ***lignite briquettes***, the deficit deepened to 54–57 million PLN (Tabs. 3, 4).

Tab. 3. Value of lignite and lignite briquettes trade in Poland — CN 2702

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	7,091	12,816	17,513	16,400	27,022
Imports	15,522	20,568	36,476	73,150	81,250
Balance	**-8,431**	**-7,752**	**-18,963**	**-56,750**	**-54,228**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Average unit values of lignite trade in Poland

Year	2009	2010	2011	2012	2013
Lignite CN 2702 10					
Exports unit values					
— PLN/t	103.6	106.2	111.4	122.8	124.0
— USD/t	34.9	36.2	36.8	37.7	39.8
Imports unit values					
— PLN/t	430.3	526.9	412.5	428.4	360.9
— USD/t	139.6	174.8	137.9	131.3	114.8
Lignite briquettes CN 2702 20					
Imports unit values					
— PLN/t	356.1	295.7	301.5	253.6	299.7
— USD/t	121.4	99.7	101.0	76.4	95.6

Source: ***The Central Statistical Office (GUS)***

Consumption

Almost all ***lignite*** is consumed in Poland by the energy sector (Tab. 5), so the level of production is dependent on domestic electricity demand. Level of consumption depends on the capacities of the neighbouring power plants — **Bełchatów**, **Turów**, **Pątnów**, **Pątnów II**, **Adamów**, and **Konin** — and their utilization. In 2011 a new 858 MW power unit was commenced in Bełchatów power plant. Total capacities of Polish power plants based on lignite rose from 9.1 GW to 9.9 GW. Lignite has met 12% of the total domestic ***primary energy*** demand, and has accounted for 33% of the production of ***electric energy***. Electricity generated from lignite is the cheapest type of energy in Poland, apart from renewable sources of power.

Tab. 5. Structure of lignite consumption in Poland — CN 2702 10

'000 t

Year	2009	2010	2011	2012	2013
Consumption	**57,054**	**56,569**	**62,633**	**64,008**	**65,739**
Energy transformation	56,059	55,732	61,800	63,334	65,069
Direct consumption	901	1,020	909	822	865
Balance losses and differences	94	-183	-76	-148[e]	-195[e]

Source: ***The Central Statistical Office (GUS)***

Less than 1.0% of lignite is consumed as a fuel by the small-scale industry and households. Marginal amounts are used as a ***fertilizer***. In 2001, the only domestic ***lignite briquette*** plant **Marantów** of **Konin Lignite Mine** (with a capacity of 160,000 tpy) was closed. It is probable, that some small installation for lignite briquetting has been producing such briquettes or products qualified as lignite briquettes. There is a lack of data on it.

Companies involved in lignite production in Poland, as of December 2013

- PGE Górnictwo i Energetyka Konwencjonalna (PGE GiEK) S.A. – Oddział Kopalnia Węgla Brunatnego Bełchatów w Rogowcu (PGE Mining and Conventional Power Industry Joint Stock Co. – Bełchatów Lignite Mine Unit of Rogowiec), Rogowiec, ul. Św. Barbary 3, 97–400 Bełchatów, P.O. Box nr 100; tel. +48 44 7373000, 7374000, fax +48 44 7373456; www.kwbbelchatow.pgegiek.pl — *lignite*.
- PGE Górnictwo i Energetyka Konwencjonalna (PGE GiEK) S.A. – Oddział Kopalnia Węgla Brunatnego Turów w Bogatyni (PGE Mining and Conventional Power Industry Joint Stock Co. – Turów Lignite Mine Unit of Bogatynia), ul. Górników Turowa 1, 59–916 Bogatynia 3; tel. +48 75 7735300, 7735200, fax +48 75 7733000; www.kwbturow.pgegiek.pl — *lignite*.
- PAK Kopalnia Węgla Brunatnego Konin S.A. w Kleczewie (PAK Konin Lignite Mine Joint Stock Co. of Kleczew), ul. 600 Lecia 9, 62–540 Kleczew; tel. +48 63 2476000, fax +48 63 2476514; www.kwbkonin.pl — *lignite*.
- PAK Kopalnia Węgla Brunatnego Adamów S.A. w Turku (PAK Adamów Lignite Mine Joint Stock Co. of Turek), ul. Uniejowska 9, 62–700 Turek; tel. +48 63 2787302, fax +48 63 2785109; www.kwbadamow.com.pl — *lignite*.
- Kopalnia Węgla Brunatnego Sieniawa Sp. z o.o. w Sieniawie (Sieniawa Lignite Mine Ltd. of Sieniawa), Os. Górnicze 11A, 66–220 Łagów, Sieniawa Lubuska; tel./fax +48 68 3412022, www.sieniawa.com — *lignite*.

LIMESTONE AND LIME

Overview

Limestone is sedimentary rock, containing mainly ***calcite*** $CaCO_3$, isomorphous with magnesite $MgCO_3$, ***siderite*** $FeCO_3$ and other ***anhydrous carbonates***. Therefore limestone often contains admixtures of Mg, Fe, etc. **Limestone** is of ***organic origin***, formed in a maritime environment (concentrations of calcite in the skeletons of living organisms) or, rarely, of ***chemical origin*** (precipitated calcium carbonate, e.g. **travertine**). Only a few types are of land origin, of which the most important is **limestone** of ***lake origin***, sometimes called **lake chalk** (***Seekreide***). In limestone, calcite is accompanied by clay minerals, quartz, and others. When the proportion of clay minerals amounts to 5–20%, the rock is called **marly limestone**. Limestone containing more clay minerals is known as **marl**, or even **clay marl**. Similarly, the transition types between limestone and organogenic siliceous rock types are **gaizes**, whereas the transition types between limestone and sandstone are **sandy limestone** and **calcareous sandstone**. Very often limestone contains admixtures of ***dolomite*** $CaMg[CO_3]_2$ in mixed rock: thus there is **dolomitic limestone** and **limestone dolomite**. **Chalk** is a special variety of limestone rock, owing to both its genesis as well as properties and utilization. In conditions of high pressure and high temperature limestone re-crystallizes into **marble**. Other limestones, re-crystallized at lower temperatures, increased their compactness and mechanical strength as geologic time elapsed. They are called **marbles** and are used as dimension stones.

One of the most important derivatives of limestone, apart from **cement**, is **lime**, generally obtained by burning of relatively pure limestone. It is one of the oldest binding materials used in the residential construction. **Lime** is a generic name for variety of products used also as a raw material in metallurgy and chemistry, and in other industries, such as paper-making and sugar-making. The most important varieties are **burnt lime** in lumps or milled, **slack lime** (**lime putty**), **hydrated lime**, and **hydraulic lime**. Various grades of **ground limestone** (**ground calcium carbonate**) are the other important group of limestone products. The most important grades are: **for bituminous mixes**, **for glass & ceramics**, **sorbent for flue gas desulfurization**, **explosion-proof**, **fodder chalk**, **technical chalk**. The lime industry also offers **limestone** (**carbonate**) and **lime** (**oxide**) **fertilizers**, made of waste fine fraction, and sometimes **crushed aggregates**. Some plants produce significant amounts of **limestone for sale**, used in metallurgy as **flux** in blast furnaces, or by sugar plants to make **burnt lime** for the sugar production process. **Limestone** and **lime fertilizers** are produced by milling limestone or lime, respectively. They are also obtained from ***limestone of lake origin***, ***soda waste***, ***sulfur cake***, ***cellulose waste***, and other sources.

Sources

Poland has numerous deposits of ***limestone rock***, except for the most valuable ***sculpture*** and ***architectonic marbles***. The resources of limestone are divided, according to their applications, into ***limestone for the lime industry***, ***limestone*** and ***marl for the cement industry***, ***crushed*** and ***dimension limestones***, and ***limestone of lake origin*** (***"lake chalk"***).

Deposits of ***limestone for the lime industry*** occur mainly in the Świętokrzyskie voivodeship (60% of the total resources), and Łódzkie, Opolskie and Śląskie voivodeships (10–11% each). At the end of 2013 the total resources of 11 deposits amounted to 5,641 Mt. The total resources of 70 deposits of ***limestone*** and ***marl for the cement industry*** amounted to 12,795 Mt (see: **CEMENT**).

Approximately 90% of the reserves of ***crushed*** and ***dimension limestone*** are concentrated in the Świętokrzyskie voivodeship. Many deposits of limestone of this grade are located in the Silesia-Cracow region, and a few also in the Carpathians, the Lower Silesia (marbles), the Lublin Plateau, and elsewhere. In 2013 the total resources of ***construction*** and ***building limestone*** amounted to 2,014 Mt in 145 recognized deposits, but in 8 of them limestone occurs together with dolomite, whereas the resources of in 11 deposits of ***marbles*** were 53.5 Mt. ***Calcite***, a related mineral, is competitive to the purest grades of limestone, but its resources in four undeveloped deposits near Kielce are only 0.29 Mt (as of 31 December 2013).

Deposits of ***limestone of lake origin*** (***"lake chalk"***) occur in the northern part of Poland (Zachodniopomorskie, Pomorskie, and Warmińsko-Mazurskie voivodeships). In 2013 the reserves of ***"lake chalk"*** were 163.2 Mt in 173 recognized deposits.

There are only limited ***secondary sources*** of raw materials for the production of lime products. In the construction industry, ***carbide residue*** (at least 65% CaO+MgO in dry mass) is obtained during the production of acetylene. Larger amounts of ***soda waste***, ***sulfur cake***, and ***cellulose waste*** are used in the production of ***carbonate fertilizers***.

Production

In 2013 limestones of different types and quality were mined in 76 mines, including 14 mines of limestone (or marl) for the cement industry, 16 mines of limestone for the lime industry, 2 mines of limestone for cement & lime industry, 44 mines of limestones (or marble) for crushed aggregates and dimension stone, and one mine of "lake chalk" A lot of open pits of "lake chalk" have stopped operation due to unprofitability of the limestone fertilizers production (Tab. 1). Due to the significant increase of demand for building materials, stimulated by utilisation of EU funds in the construction sector (mainly road construction) and implementation of investments connected with EURO 2012, considerable growth of limestone output was observed, up to 69.6 Mt in 2011 (Tab. 1). In the following years the total mining output dropped significantly, to ca. 52.7 Mt in 2013. The largest decrease (over 23%) was recorded in a group of ***limestone for the lime industry*** (Tab. 1).

Limestone is used in the production of ***cement*** (see: **CEMENT**), ***lime*** and ***limestone products***, ***limestone crushed aggregates***, ***dimension stone***, and ***fertilizers***. Lime and limestone products are manufactured by over a dozen plants, the majority of which

Tab. 1. Limestone statistics in Poland — CN 2521

'000 t

Year	2009	2010	2011	2012	2013
Mining output	**43,764**	**53,116**	**69,632**	**56,906**	**52,713**
— *limestone for the cement industry*	20,278	22,431	27,303	24,322	22,268
— *limestone for the lime industry*	14,881	17,588	21,703	16,728	16,812
— *limestone for crushed aggregates and fertilizers*	8,560	13,080	20,610	15,840	13,605
— *lake limestone for fertilizers*	45	17	16	16	28
Production, recorded	**29,821**	**33,235**	**40,977**	**38,211**	**35,353**
— *limestone for sale*	*12,316*	*14,882*	*19,799*	*18,960*	*17,543*
Imports	**52**	**40**	**77**	**168**	**132**
Exports	**224**	**150**	**387**	**414**	**501**
Consumption[a]	**29,649**	**33,125**	**40,667**	**37,965**	**34,984**

Source: ***The Central Statistical Office (GUS), Minerals Resources Datafile***

was privatised with the participation of foreign investors. Lime products are currently produced in six plants belonging to two international concerns:

- two large plants in Bielawy and Sitkówka, both belonging to Irish concern **CRH**, jointed to one company **Trzuskawica**, with production level of almost 600–700 ktpy;
- four plants of Belgian group **Lhoist** — three production units situated in: **Tarnów Opolski**, **Górażdże** and **Wojcieszów** incorporated into the **Lhoist Lime Plant Joint Stock Company** (in July 2011) and one separate big plant: **Lhoist Bukowa**, with total estimated production of 900–1,100 ktpy.

Unburnt limestone products in very wide assortment, from limestones for sale, limestone fertilizers, and limestone aggregates, to ground limestone, ground calcium carbonate, fodder chalk, sorbent for desulfurization, and others — have been produced in the following plants: Sitkówka (in the structure of **Trzuskawica**), all plants of **Lhoist** concern, and moreover in **Czatkowice Limestone Mine** (with the production of over 2 Mtpy); **Nordkalk** — exploiting the deposits of **Ostrówka** and **Ołowianka**, **Chęciny-Wolica**, and **Owadów Brzezinka**; **Labtar**, **Road Materials Quarries** of **Kielce**, **Piotrowice**, **Minerał** of **Wałcz**, **APG** of **Sokołów,** and recently also **GiGa** of **Płaza**.

Limestone for sale has been also delivered in significant amounts by some limestone aggregates producers, e.g. **Road Materials Quarries** of **Kielce**, **Morawica Limestone Mine** and a few smaller producers in the Kielce area. The share of suppliers from the Świętokrzyskie voivodeship exceeded 40% of the total supply of this limestone product. Total deliveries of ***limestone for sale*** increased significantly from 12.3-12.8 Mtpy in 2008-2009 to 19.8 Mt in 2011, but in the following two years were reduced, to 17.5 Mt in 2013 (Tab. 1). Apart from the metallurgical branch it is consumed in the sugar-making and the chemical industries.

The production ***lime*** after a drop to around 1.7 Mt in 2009, began to rebuild in the next years, reaching a level of more than 2.0 Mt in 2011 (Tab. 2). Similarly as in the case of limestone, a decline of lime production was observed in 2012 and 2013, and its production returned to the level of 2009 (Tab. 2). The structure of lime production has been dominated by ***burnt lime***, which accounted for about 85% of the total production and the level of this production has been related to changes in economic conditions in the construction sector. In recent years the production of ***hydrated lime*** has shown a declining trend, and ***hydraulic lime*** has made up less than one percent of the total production (0.1%, Tab. 2). About 85% of its production originated from the lime plants listed above (mostly from Świętokrzyskie voivodeship – over 55%), the rest - from the lime units at the **Arcelor Mittal Poland** steelworks in Kraków and Dąbrowa Górnicza, and the sugar-making industry, mainly in Mazowieckie, Wielkopolskie, Lubelskie, Podkarpackie, Podlaskie and Pomorskie voivodeships. The share of sugar-making industry in the lime production is now below 1% due to EU regulations that forced reduction of the sugar production in Poland.

Tab. 2. Lime statistics in Poland — CN 2522

'000 t

Year	2009	2010	2011	2012	2013
Production	1,715.9	1,798.9	2,036.3	1,798.8	1,710.0
— *burnt lime*	*1,229.0*	*1,392.4*	*1,738.7*	*1,517.1*	*1,449.4*
— *hydrated and other lime*	*472.5*	*404.4*	*294.9*	*279.3*	*260.3*
Imports	54.8	58.8	100.3	61.2	59.8
Exports	37.0	88.3	98.1	93.7	91.0
Consumption[a]	1,733.6	1,769.4	2,038.5	1,766.3	1,678.8

Source: ***The Central Statistical Office (GUS)***

Burnt lime in lumps for sale has made up about 25–35% of total burnt lime supply and has been delivered mainly from **Trzuskawica**, **Lhoist** plants in **Tarnów Opolski**, **Bukowa**, and **Górażdże**. The rest of burnt lime has been sold in the form of ***ground burnt lime***, coming entirely from four plants: **Trzuskawica** plants in **Trzuskawica** and **Bielawy**, and **Lhoist** plants in **Bukowa** and **Tarnów Opolski**. The production of ***hydrated lime*** and ***other grades of lime*** (***dolomitic***, ***hydraulic***) delivered mainly from the plants: **Trzuskawica** plants in **Trzuskawica** and **Bielawy**, **Lhoist** plants in **Tarnów Opolski**, **Bukowa**, **Górażdże** and **Wojcieszów**, has dramatically declined in recent years (Tab. 2). Various grades of ***ground limestone*** (***ground calcium carbonate***) are the important group of limestone products. Their combined production has probably risen to over 3 Mtpy. They have been manufactured at the following plants:

- ***sorbent for flue gas desulfurization*** at **Lhoist** plants in **Tarnów Opolski** and **Bukowa** and **Górażdże**, **Trzuskawica**, **Czatkowice**, **Nordkalk**, and **Płaza**;
- ***grades for bituminous mixes*** at **Trzuskawica**, **Lhoist** plants in **Tarnów Opolski**, **Bukowa**, and **Górażdże, Płaza**, **Nordkalk**, and **Road Materials Quarries** of **Kielce**;
- ***grades for glass & ceramics*** at **Trzuskawica**, **Lhoist Bukowa**, **Omya**, and **Nordkalk**;
- ***explosion-proof grade*** for hard coal mines at **Labtar**, **Lhoist Bukowa**, and **Road Materials Quarries** of **Kielce**;
- ***fodder chalk*** at **Lhoist** plants in **Tarnów Opolski** and **Bukowa**, **Labtar**, **Warta Cement Plant**, and **Minerał** of **Wałcz**;
- ***technical chalk*** at **Trzuskawica**, **Piotrowice**, **Lhoist Bukowa**, and **APG Sokołów**.

Limestone crushed aggregates are produced by aggregates manufacturers, as well as by some lime plants. The fine fraction after crushed aggregates production is often used to produce ***calcium carbonate fertilizers***. Most of them come from the Świętokrzyskie Mountains, mainly from large producers such as: the **Morawica Limestone Mine**, exploiting the **Morawica** deposit; the **Trzuskawica S.A.** in **Trzuskawica** and **Bielawy** plants; **Dolomite Quarries** of **Sandomierz**, extracting limestone from the **Budy** and **Wymysłów** deposits; the **Road Materials Quarries** of **Kielce**, extracting the **Górki Szczukowskie**, **Głuchowiec**, **Józefka**, and **Kostomłoty** deposits; the **Mineral Mines** of **Kielce**, mining the **Jaźwica** dolomite and limestone deposit; **Granit Quarry of Kamienna Góra**, operating the **Celiny I** deposit; **Surowce Mineralne** of **Kielce**, mining the **Ptasznik**, **Gnieździska-Góra Maćkowa**, and **Drugnia-Rządowa** deposits. Limestone aggregates are also produced in a few smaller quarries, in the Silesia-Cracow region (e.g. **Kosbud** mining the **Leszna Górna** deposit), and in other regions of the country.

Limestone dimension elements (***blocks***, ***slabs***) are also produced basing on the output from the deposits of limestone and related rocks for building and road construction. Structure of their production and the major suppliers is discussed in a separate chapter (see: **STONE, DIMENSION**).

Lime (***oxide***) and ***limestone*** (***carbonate***) ***fertilizers*** are produced from waste limestone by lime plants and cement-lime plants, and by manufacturers of aggregates. The majority of their production (carbonate fertilizers only) was obtained from ***limestone of lake origin*** (***"lake chalk"***) extracted by private producers in the northern part of Poland. Their extraction that in 2009 was carried out from four deposits in Zachodniopomorskie, Warmińsko-Mazurskie and Wielkopolskie voivodeships, has been systematically decreasing. Since 2010 only one Lubiatowo III deposit in the Zachodniopomorskie voivodeship was exploited. The total production of limestone fertilizers registered by Central Statistical Office since 2009 has been included into position PKWiU 08.11.00000101 ***Mineral agents for agricultural lime (oxide and carbonate)*** and probably fertilizers made a majority of this group. In the years 2009-2013 (except for 2010) their production ranged between 450 and 505 kt CaO per year (i.e. 1.0-1.2 Mtpy gross weight). However, the actual production of calcium fertilizers could be a little higher than reported by the **Central Statistical Office**, because small producers are not obliged to report it.

Trade

From among all lime products ***burnt lime*** has been a traditional export product, coming mainly from the **Lhoist** plant in **Bukowa** and **Tarnów Opolski**, with a smaller contribution of **Lhoist Górażdże** and **Trzuskawica**. Since 2010 the total exportation has risen significantly, ranging from 88 to 98 ktpy (Tab. 3). The main importers of lime have been in recent years: Lithuania, Finland, Ukraine, and Germany – though of declining importance (Tab. 3).

The main foreign suppliers of lime to Poland have been Germany and Slovakia, occasionally also the Czech Republic and Belarus (Tab. 4). Burnt lime has recently made up 60-80% of imports, predominating its structure. In recent years the increase of hydrated lime imports has been reported, with Germany as a main supplier (Tab. 4). Since 2009 the positive balance in lime trade has been recorded (Tab. 5), mainly due to the limitation of imports and expansion of exports, especially of ***burnt lime*** (Tab. 3, 4).

Tab. 3. Polish exports of lime, by country — CN 2522

'000 t

Year	2009	2010	2011	2012	2013
Exports	**37.0**	**88.3**	**98.1**	**93.7**	**91.0**
• ***burnt lime***	***24.9***	***73.3***	***80.9***	***77.0***	***74.1***
• ***hydrated lime***	***11.8***	***14.8***	***17.1***	***16.6***	***16.5***
• ***hydraulic lime***	***0.3***	***0.2***	***0.1***	***0.1***	***0.4***
Belgium	0.2	0.0	0.0	5.5	0.0
Belarus	0.7	0.8	0.0	5.5	0.8
Czech Republic	0.7	2.6	0.9	0.7	0.0
Denmark	1.7	1.9	0.1	0.0	0.3
Estonia	–	0.0	4.2	1.3	5.2
Finland	0.0	43.4	0.2	4.5	26.6
France	–	–	35.3	15.7	–
Germany	3.0	5.0	5.6	5.5	5.1
Ghana	2.0	1.5	–	–	–
Latvia	–	–	4.0	5.1	2.9
Lithuania	15.3	21.0	21.9	26.8	32.4
Russia	1.8	2.2	3.0	3.4	3.7
Slovakia	3.6	1.0	8.0	5.5	4.5
Ukraine	7.1	8.6	14.2	19.4	8.7
Others	1.1	0.3	0.7	0.3	0.8

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Polish imports of lime, by country — CN 2522

'000 t

Year	2009	2010	2011	2012	2013
Imports	**54.8**	**58.8**	**100.3**	**61.2**	**59.8**
• ***burnt lime***	***39.0***	***35.0***	***77.1***	***44.7***	***38.8***
• ***hydrated lime***	***15.4***	***23.5***	***23.0***	***16.3***	***20.4***
• ***hydraulic lime***	***0.4***	***0.3***	***0.2***	***0.2***	***0.6***
Belarus	5.0	2.1	0.3	0.4	-
Czech Republic	0.7	0.5	21.7	6.4	3.2
Germany	32.8	35.7	40.5	34.8	35.3
Slovakia	16.1	20.3	37.4	18.7	20.7
Others	0.2	0.2	0.4	1.0	0.6

Source: ***The Central Statistical Office (GUS)***

Exports of ***limestone*** dropped to around 150 kt in 2010 (Tab. 1). However, in the following years the sales were increasing, to 501 kt in 2013. Limestone has been sold almost entirely to Germany. As compared to exports, limestone imports have been of minor importance, though they rose to over 100,000 tpy (Tab. 1). They come mainly

Tab. 5. Value of lime and limestone trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Limestones CN 2521					
Imports	2,838	2,708	5,505	9,599	7,120
Exports	6,846	4,740	15,327	21,721	29,549
Balance	**+4,008**	**+2,032**	**+9,822**	**+12,122**	**+22,429**
Lime CN 2522					
Imports	16,677	18,507	33,086	22,191	21,528
Exports	13,358	34,205	40,997	39,132	39,033
Balance	**+3,319**	**+15,698**	**+7,911**	**+16,941**	**+17,505**

Source: ***The Central Statistical Office (GUS)***

from the Czech Republic. Export/import proportion has resulted in positive limestone trade balances (Tab. 5). ***Ground limestone*** trade is reported in common item **CN 2521** with limestone rock. Some trade in ***dimension limestone*** and ***marble*** has been also noted (see: **STONE, DIMENSION**).

In the last five years the average unit values of the production of ***limestone rock*** varied between 10.6-11.6 USD/t (Tab. 6). The average unit values of exports in the same period showed a strong increase, up to 18.8 USD/t in 2013 (Tab. 6). Domestic prices of ***ground limestone*** have varied widely, depending on proportions between various grades, as well as on competition between domestic producers. Since 2005 their average unit values have been difficult to ascertain, because their production has been registered together with limestone rock. According to the price list published on the web sites of the domestic producers they ranged from 120 to 210 PLN/t in 2013.

The average unit values of ***burnt lime*** imports (101–111 USD/t) are comparable to their domestic prices (97–108 USD/t, Tab. 6). The average unit values of ***burnt lime*** exports were distinctly higher than domestic prices. Domestic prices of ***hydrated lime*** were variable, showing a general increasing tendency. Until 2013, they have exceeded values of imports and exports (Tab. 6).

Consumption

The structure of domestic ***limestone*** consumption is very complicated due to its numerous possible applications. ***Limestone*** is used mainly by steelworks as ***blast furnace flux*** (it enables the binding of SiO_2 and Al_2O_3 in slag) and for in-house production of ***burnt lime***. It is also applied as a flux in the nonferrous metals industry. Considerable amounts of limestone are utilized by the chemical industry in the production of ***calcined soda***, ***carbide***, ***nitro-chalk*** and other calcium compounds. Limestone is also used at sugar plants, which produce ***burnt lime*** after the sugar campaign to clarify beet saft, and by the paper-making industry for the production of ***cellulose*** in the sulfite process. The road-building industry is also an important consumer of limestone, which is utilised for road foundations and for the production of aggregates for bituminous pavements, and after grinding in a form of GCC as a component of aggregates/asphalt mixture (2–11% of mixes).

Tab. 6. Average unit values of limestone and lime production and trade in Poland

Year	2009	2010	2011	2012	2013
Limestone CN 2521					
Production unit values					
— PLN/t	35.9	34.8	33.7	35.4	33.3
— USD/t	11.5	11.6	11.4	10.9	10.6
Exports unit values					
— PLN/t	30.6	31.7	39.6	52.5	59.0
— USD/t	9.6	10.7	13.0	16.0	18.8
Imports unit values					
— PLN/t	54.9	68.0	71.5	57.2	54.0
— USD/t	18.9	23.1	24.2	17.5	17.3
Lime, burnt CN 2522 10					
Production unit values					
— PLN/t	301.8	298.9	317.7	341.5	340.6
— USD/t	96.8	99.3	107.2	104.9	108.1
Exports unit values					
— PLN/t	359.5	392.4	439.7	432.3	429.2
— USD/t	116.9	130.1	150.7	132.3	136.2
Imports unit values					
— PLN/t	312.9	330.5	328.2	361.2	346.6
— USD/t	100.9	109.7	110.8	110.9	110.3
Lime, hydrated CN 2522 20					
Production unit values					
— PLN/t	323.6	330.6	NA	381.3	379.1
— USD/t	103.8	109.8	NA	117.1	120.5
Exports unit values					
— PLN/t	376.9	364.4	311.2	348.3	429.5
— USD/t	117.2	116.7	107.4	106.4	136.5
Imports unit values					
— PLN/t	283.8	290.4	334.8	366.5	388.1
— USD/t	92.9	95.9	114.9	111.3	123.3

Source: ***The Central Statistical Office (GUS)***

The most important material produced from limestone is ***burnt lime***, which may be ***milled*** or ***hydrated***. Burnt lime in lumps is used mainly in the chemical industry (e.g. for the production of ***carbide***), in metallurgy (as ***flux*** in the steel-making process), in the sugar-making industry (for sugar plants that do not produce their own lime), in the cellulose and paper-making industries (for softening water and boiling rags), etc.

The majority of the ***milled burnt lime*** is used in the production of ***lime-sand products***, some types of ***cellular concrete***, and other construction materials such as dry plaster mortars. Moreover, it is utilised for soil drying in highway engineering, in paints & varnishes (as well as technical chalk and hydrated lime), in the chemical industry for the production of chemical compounds, e.g. epichlorohydrin and propylene oxide etc. Almost all the ***hydrated lime*** production is consumed by the construction industry. In small amounts (1–2% of mixes) it is also utilised as a component of aggregates/asphalt mixture, improving physical properties of mixes. This solution is not popular in Poland, but commonly applied in the US and many European countries. Application mentioned above, and some factors such as: improvement in the domestic highway engineering and construction sector, and rising possibilities of lime utilisation in the environment protection, makes prospect for growth of future hydrated lime consumption. According to the Central Statistical Office the structure of the lime consumption in 2013 was as follows: steel-making processes in the metals production - 41.6%, manufacture of lime-sand products and cellular concrete - 24.6%, electricity generation, mostly for the gases desulfurization – 7.5%, chemical industry - 6.7%, construction (hydrated lime for mortars and plasters) – 5.1%, underground mining - 2.3%, water and waste treatment - 1.3%, pulp and paper industry - 0.3%, sugar industry - 0.3%, the production of rubber and plastic - 0.2%, others -10.1%.

Until recently, fine-grained assortments of limestone, unsuitable for the production of burnt lime or aggregates, were considered waste material and dumped. Currently, this material is utilized, mainly for the production of ***limestone fertilizers*** for agriculture. Fine grained wastes after lime burning, utilized as ***lime*** (***oxide***) ***fertilizers***, are also used for the same purpose. Other fine-grained assortments of limestone are used at the following applications: ***standard grade of ground calcium carbonate*** - as a filler in bituminous mixes for road pavements, ***high purity ground calcium carbonate*** - for the glass and ceramics industries, ***explosion-proof grade*** - in hard coal mines, ***fodder chalk*** - as a nutritive supplement for animals, ***technical chalk*** - by the paints & varnishes, plastics, rubber, paper, chemical, and construction industries, ***limestone sorbents*** - to desulfurize the off-gases from power plants, which have also the largest potential for future growth of demand.

Limestone aggregates are offered by aggregates producers, and are also a by-product of lime plants. Due to physical and mechanical parameters (the compression strength usually below 100 MPa), limestone aggregates are used in the production of low and medium class concrete, and in the road-building industry. In practice, limestone aggregates are not used for railroad building. Some amounts of ***limestone grits*** are applied in the production of ***terrazzo***. The so-called ***dimension marbles*** from the Świętokrzyskie Mountains and the Cracow area, like the ***marbles*** from the Lower Silesia, are utilized in the construction industry as ***dimension slabs*** and similar elements.

Principal companies involved in the production of limestone and lime products in Poland, as of December 2013

Lhoist plants

- Zakłady Wapiennicze Lhoist S.A. (Lhoist Lime Works Joint Stock Company) consisting of three plants:
  - Plant in Tarnów Opolski, ul. Świerczewskiego 5, 46–050 Tarnów Opolski, tel. +48 77 4516375, fax +48 77 4516377, www.lhoist.pl — *burnt lime, milled burnt lime, hydrated lime, ground calcium carbonate for bituminous mixes, fodder chalk, sorbent for desulfurization, limestone for sale, lime fertilizers,*
  - Plant in Górażdże, 47–316 Górażdże, ul. Fabryczna 22, tel. +48 77 4530291, fax +48 77 4671049, www.lhoist.pl — burnt lime, hydrated lime, ground calcium carbonate for bituminous mixes, sorbent for desulfurization, limestone for sale, limestone and lime fertilizers.
  - Plant in Wojcieszów, 56–550 Wojcieszów, ul. B. Chrobrego 77B, tel./fax +48 75 7512339, www.lhoist.pl — *burnt lime, hydrated lime, aggregates, limestone for sale, lime fertilizers*.
- Lhoist Bukowa Sp. z o.o. w Bukowej (Lhoist Bukowa Ltd. of Bukowa), ul. Osiedlowa 10, 29–105 Krasocin, tel. +48 41 3889105, fax +48 41 3889106, www.lhoist.pl — *burnt lime, milled burnt lime, hydrated lime, ground calcium carbonate for bituminous mixes and coal mines, fodder chalk, technical chalk, sorbent for desulfurization, limestone for sale, lime fertilizers*.

CRH plants

- Trzuskawica S.A. w Sitkówce consisting of two plants:
  - Trzuskawica S.A. w Sitkówce (Trzuskawica Joint Stock Co. of Sitkówka), 26–052 Sitkówka, tel. +48 41 3469130, fax +48 41 3466139, www.trzuskawica.pl — *burnt lime, milled burnt lime, hydrated lime, ground calcium carbonate for glass & ceramics and bituminous mixes, technical chalk, sorbent for desulfurization, aggregates, limestone for sale, limestone and lime fertilizers*.
  - Kujawy Wapno Sp. z o.o. w Bielawach (Kujawy Wapno Ltd. of Bielawy, a subsidiary of ZPW Trzuskawica S.A.), Bielawy, 88–192 Piechcin, tel. +48 52 5643400, fax +48 52 5643497, www.trzuskawica.pl — *burnt lime, milled burnt lime, hydrated lime, aggregates, limestone for sale, lime fertilizers*.

Other plants

- Kopalnia Wapienia Czatkowice Sp. z o.o. w Czatkowicach (Czatkowice Limestone Mine Ltd. of Czatkowice), 32–063 Krzeszowice, Czatkowice 248, tel. +48 12 2821020, fax +48 12 2821025, www.czatkowice.com.pl — *sorbent for desulfurization, aggregates, limestone for sale*.
- Nordkalk Sp. z o.o. w Krakowie (Nordkalk Ltd. of Kraków), 31–038 Kraków, ul. Starowiślna 13/15, tel. +48 12 4286580, fax +48 12 4295005, www.nordkalk.com — *aggregates, limestone for sale, ground calcium carbonate for bituminous mixes, sorbent for desulfurization, limestone fertilizers*.
- GiGa Sp. z o.o.(GiGa Ltd.), ul. J. Sobieskiego 43, 32–552 Płaza, tel. +48 32 6131205, fax +48 32 6131208 — *aggregates*.

- Labtar Sp. z o.o. w Tarnowie Opolskim (Labtar Ltd. of Tarnów Opolski), 46–050 Tarnów Opolski, ul. Św. Jacka 12, tel. +48 77 4644596, fax +48 77 4645660, www.labtar.pl — *ground calcium carbonate for coal mines, fodder chalk*.
- Zakłady Przetwórcze Surowców Chemicznych i Mineralnych Piotrowice Sp. z o.o. w Piotrowicach (Piotrowice Chemical & Mineral Commodities Processing Works Ltd. of Piotrowice), 27–630 Zawichost, tel. +48 15 8364142, fax +48 15 8364020, www.piotrowice.com.pl — *technical chalk*.
- Zakład Produkcyjno-Handlowy APG s.c. w Sokołowie (APG Production and Trade Plant Civil Co. of Sokołów), 28–305 Sobków, Sokołów Górny 73, tel./fax +48 41 3871193 — *technical chalk*.
- Zakład Przerobu Surowców Mineralnych Minerał Sp. z o.o. w Wałczu (Minerał Minerals Processing Plant Ltd. of Wałcz), 78–600 Wałcz, ul. Papieża Jana XXIII 3, tel. +48 67 2584001, fax +48 67 2584781 — *fodder chalk*.
- Kopalnia Wapienia Morawica w Morawicy (Morawica Limestone Mine of Morawica), 26–026 Morawica, tel. +48 41 3441401, fax +48 41 3114532, www.kwmorawica .kielce.pl — *aggregates, limestone for sale, limestone fertilizers*.
- Kieleckie Kopalnie Surowców Mineralnych S.A. w Kielcach (Mineral Mines of Kielce Joint Stock Co.), ul. Ściegiennego 5, 25–950 Kielce, tel. +48 41 3612711, fax +48 41 3613999, www.kksm.com.pl — *aggregates, limestone for sale, limestone fertilizers*.
- Kopalnie Odkrywkowe Surowców Drogowych w Kielcach (Road Materials Quarries of Kielce), ul. Ściegiennego 177, 25–116 Kielce, tel. +48 41 3614791, fax +48 41 3614863, www.kosd.kielce.pl — *aggregates, ground calcium carbonate for bituminous mixes and coal mines, limestone fertilizers*.
- Kopalnie Dolomitu S.A. w Sandomierzu (Dolomite Quarries Joint Stock Co. of Sandomierz), ul. Błonie 8, 27–600 Sandomierz, tel. +48 15 8323036, fax +48 15 8323037, www.kopalnie-dolomitu.pl — *aggregates, limestone fertilizers*.
- Spółdzielnia Pracy Surowce Mineralne w Kielcach (Surowce Mineralne Cooperative of Kielce), ul. Wspólna 5, 25–950 Kielce, tel./fax +48 41 3454823 — *aggregates, limestone fertilizers*.
- Przedsiębiorstwo Wydobycia i Obróbki Marmuru Marmur-Sławniowice (Marmur-Sławniowice Marble Mining and Working Enterprise), Sławniowice, 48–355 Burgrabice, tel. +48 77 4398018, fax +48 77 4398019, www.marmur-slawniowice.pl — *marble blocks and slabs, grits*.

LITHIUM

Overview

Lithium (**Li**) forms many minerals, the most important of which are ***amblygonite***, ***spodumene***, ***petalite***, ***lepidolite***, etc. They occur mainly in pegmatite-type and greisene-type deposits. Another important primary source of lithium is ***lake brine*** and ***lithium-bearing thermal water***, from which lithium is obtained in the form of ***carbonate***.

Lithium has broad and various applications. Currently, it is used primarily in the form of **carbonate** in the ceramics and glass-making industries, in primary aluminum metallurgy, and as auxiliary material for the manufacture of lubricants and greases, in the production of synthetic rubber, parts for television sets, etc.

Sources

There are no ***lithium*** or ***lithium-bearing*** ore deposits in Poland.

Production

Lithium commodities are not produced in Poland.

Trade

Domestic demand has been entirely covered by imports, mainly of ***lithium oxide*** and ***hydroxide*** and ***lithium carbonate*** (Tab. 1). The major suppliers have been Chile, Belgium, Germany, France, UK, the US, China, Russia, the Netherlands, and Switzerland. The balance of ***lithium commodities*** trade has been always negative (Tab. 2). In 2010 lower prices on international markets brought the slight improvement of the trade financial results, in spite of higher imports volume. In recent years the deficit deepened, mainly in the case of ***lithium carbonate***. The unit values of imported to Poland ***lithium commodities*** were higher than at US market (Tab. 3).

Tab. 1. Lithium statistics in Poland

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Year	2009	2010	2011	2012	2013
Lithium oxide and hydroxide CN 2825 20					
Imports	86	90	114	141	98
Exports	4	15	4	21	26
Consumption[a]	82	75	110	120	72

Lithium carbonate CN 2836 91					
Imports	156	185	176	177	173
Exports	30	31	31	32	22
Consumption[a]	126	154	145	145	151

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Value of lithium commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Lithium oxide and hydroxide CN 2825 20					
Exports	97	246	100	461	688
Imports	1,808	1,702	1,844	2,731	2,397
Balance	**-1,717**	**-1,456**	**-1,744**	**-2,270**	**-1,709**
Lithium carbonate CN 2836 91					
Exports	650	619	633	696	496
Imports	3,390	3,435	3,245	3,812	3,768
Balance	**-2,740**	**-2,816**	**-2,612**	**-3,116**	**-3,272**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit values of lithium commodities imports to Poland

Year	2009	2010	2011	2012	2013
Lithium oxide and hydroxide CN 2825 20					
PLN/kg	21.0	19.0	16.2	19.4	24.4
USD/kg	6.7	6.2	5.5	5.9	7.8
Lithium carbonate CN 2836 91					
PLN/kg	21.7	18.6	18.6	21.5	21.7
USD/kg	7.0	6.1	6.3	6.6	6.9

Source: ***The Central Statistical Office (GUS)***

Consumption

Imported ***lithium commodities*** are used by the glass-making industry, ceramics and electronics, but no detailed information on the consumption pattern is available.

MAGNESITE AND MAGNESIA

Overview

Magnesite ($MgCO_3$) occurs in two forms: crystalline and compact (cryptocrystalline). ***Crystalline magnesite*** is almost entirely used by the refractory industry in the form of **dead-burned magnesite** (crystalline species roasted at 1,450–1,600°C to obtain MgO) and **fused magnesite** (dead-burned magnesite fused at 3,000°C). These both types of magnesite are used in the civil construction industry, the glass-making industry, ceramics, and abrasives, in the form of **calcined magnesite** (calcined at 800–1,000°C). Magnesites are also a source of **magnesium compounds** used in other branches of industry, such as pharmaceuticals, paper, chemicals, plastics, etc. **Dead-burned**, **calcined**, and **fused magnesite**, produced from **natural magnesite**, can be replaced by higher purity grades of **synthetic magnesia** (MgO), obtained from ***seawater***, ***brines***, and ***dolomites***.

Sources

Compact magnesite deposits containing a considerable admixture of silica occur in the Lower Silesia. These deposits are connected with ***serpentinite*** massifs on both slopes of the **Sowie Góry Unit**: northern (the massifs of **Sobótka** and **Gogołów-Jordanów**) and southern (the massifs of **Szklary** and **Braszowice-Grochów**). There are 6 recognized deposits, with total resources of 14.4 Mt (as of 31 December 2013), of which 4.2 Mt are in **Braszowice**, the only extracted deposit.

Production

In the last several years, ***magnesite*** has been exploited exclusively by the **Magnezyty Grochów** in the **Konstanty Mine** (open-pit) from the **Braszowice** deposit. The low quality material is processed — by crushing, optical sorting and classification — into ***raw magnesite concentrate*** with 43–45% of MgO. Between 2009 and 2013 its production more than doubled, amounting to 97 kt in 2013 (Tab. 1). Magnesite concentrate has been used for the production of a few grades of ***milled magnesite*** (so-called ***R40 grade***) sold as intermediate raw material for the manufacture of multicomponent NPKMg fertilizers (20,000-30,000 tpy). ***Crushed raw magnesite concentrate*** manufactured in quantities 25,000–35,000 tpy, has been purchased by e.g. domestic chemical plants for the production of magnesium compounds (e.g. ***magnesium sulfate***). **Braszowice** plant has also utilized accompanying magnesite-serpentinite rock for the production of so-called ***milled magnesite R35*** and ***R30***. Their total production (R40, R35, and R30) amounted to 90,000–130,000 tpy (ca. 116,300 t in 2013). Since 2001 the **Magnezyty**

Grochów has started to produce ***active*** (***calcined***) ***magnesite*** containing 70–86% MgO. This production has not exceeded 50 tpy (Tab. 1).

Tab. 1. Magnesite and magnesia statistics in Poland

'000 t

Year	2009	2010	2011	2012	2013
Magnesite, raw CN 2519 10					
Production	47.0	63.0	75.0	84.0	97.0
Imports	4.8	3.2	1.9	1.5	0.6
Exports	0.5	0.1	0.1	0.1	0.1
Consumption[a]	51.3	66.1	76.8	85.4	97.5
Calcined, dead-burned and fused magnesite and magnesia CN 2519 90					
Production	0.0	0.0	0.0	0.0	0.0
Imports	81.4	116.4	140.0	116.3	100.2
Exports	0.2	0.9	0.5	3.3	5.9
Consumption[a]	81.1	115.5	139.5	113.0	94.3

Source: ***The Central Statistical Office (GUS), Mineral Resources Datafile, producer's data***

Trade

Trade in ***raw magnesite*** has been marginal, usually not exceeding 5,000 tpy (Tab. 1). It was imported almost entirely from Slovakia. Small amounts of raw magnesite have been also exported, primarily to the Czech Republic and Germany. The main imported products have been ***dead-burned***, ***fused***, and ***calcined magnesite*** obtained from magnesite, as well as ***dead-burned***, ***fused***, and ***calcined magnesia*** from ***seawater*** and ***brines*** (Tab. 2).

In terms of volume, ***dead-burned magnesite*** has been the main imported commodity. Its deliveries have been recently varied between 68,000 and 108,000 tpy due to volatile demand for magnesite refractories. Its main suppliers have been recently China, Brazil, and Slovakia, with minor supplies from Australia, Russia and others. Imports of ***dead-burned magnesia*** from ***seawater*** and ***brines*** in the last years fluctuated from 6 to 19 ktpy, partly due to competition of fused magnesia and irregular large purchases from the Netherlands (Tab. 2). ***Fused magnesite*** and ***magnesia*** were imported from China, Australia and Israel (5,000–6,000 tpy). ***Calcined magnesite*** and ***magnesia*** were primarily imported from Germany, Greece, France, and other European countries, in total amount of around 7,000 tpy, with a single increase to ca. 10,500 t in 2010. In this group, imports of so-called ***Mg-Cr*** and ***Mg-Al co-clinkers*** have been also reported from the United Kingdom and Austria (total of less than 1,000 tpy).

The trade balances of ***magnesite*** and ***magnesia*** have been consistently negative. It increased to the record level of almost 265 million PLN in 2011, with reduction to 165 million PLN in 2013 (Tab. 3).

Tab. 2. Polish imports of magnesite and magnesia, by country — CN 2519

'000 t

Year		2009	2010	2011	2012	2013
Imports		**86.2**	**119.6**	**141.9**	**117.8**	**100.8**
• ***raw magnesite***		***4.8***	***3.2***	***1.9***	***1.5***	***0.6***
• ***calcined magnesite and magnesia***		***6.6***[e]	***10.5***[e]	***7.2***[e]	***7.0***[e]	***6.5***[e]
• ***dead burned magnesite***		***68.5***[e]	***95.2***[e]	***107.7***[e]	***97.2***[e]	***75.5***[e]
• ***dead burned magnesia from seawater and brines***		***1.3***[e]	***4.7***[e]	***19.1***[e]	***6.1***[e]	***18.2***[e]
• ***fused magnesite and magnesia***		***5.0***[e]	***6.0***[e]	***6.0***[e]	***6.0***[e]	***6.0***[e]
Australia	d,f	5.6	8.7	17.9	16.7	0.7
Austria[1]	d	0.2	0.4	0.8	1.2	1.6
Brazil	d	22.7	26.0	14.7	13.8	11.3
China	d,f	24.4	34.5	44.9	34.7	27.7
France	c	0.5	0.5	1.4	1.0	0.1
Germany	c	2.1	6.7	3.3	1.1	1.1
Greece	c	1.3	1.9	1.3	1.4	2.9
Ireland	s	0.4	1.7	2.2	1.7	4.0
Israel	b,f	0.1	0.4	0.3	0.3	0.3
Netherlands	b	0.7	1.7	16.4	3.9	13.5
Russia	d	0.9	2.5	2.9	1.9	2.2
Saudi Arabia	d	-	-	-	-	1.1
Slovakia	d,r	24.5	30.8	33.5	36.4	30.0
Spain	c	0.1	0.2	0.1	0.6	2.5
United Kingdom[1]	s	0.1	0.2	0.2	0.2	0.4
Others	c	2.6	3.4	2.0	2.9	1.4

Legend: **b** — dead-burned magnesia from brine, **c** — calcined magnesite and magnesia, **d** — dead-burned from magnesite, **f** — fused magnesite and magnesia, **r** — raw magnesite, **s** — dead-burned from seawater

[1] almost entirely Mg-Cr and/or Mg-Al. co-clinkers

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Value of magnesite and magnesia trade in Poland — CN 2519

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	783	1,758	1,358	33,918	2,611
Imports	129,089	177,585	266,234	212,309	168,245
Balance	**-128,306**	**-175,827**	**-264,876**	**-178,391**	**-165,634**

Source: ***The Central Statistical Office (GUS)***

The average unit values of ***magnesite*** and ***magnesia*** (all grades) importation (in USD/t) increased significantly in the years 2008–2012 (Tab. 4), according to world tendencies. The average unit values for various grades were different: for ***calcined magnesite*** and

magnesia — 250–2,000 USD/t, ***dead-burned magnesite*** — 250–600 USD/t, ***dead-burned magnesia*** — 600–1,500 USD/t, ***fused grades*** — 600–1,500 USD/t, ***specialised magnesia grades*** — even over 2,000 USD/t.

Tab. 4. Average unit values of imports of thermally processed magnesite and magnesia to Poland — CN 2519 90

Year	2009	2010	2011	2012	2013
PLN/t	1,569.9	1,526.5	1,892.9	1,812.8	1,671.3
USD/t	512.9	508.3	646.7	553.3	531.3

Source: ***The Central Statistical Office (GUS)***

Consumption

Concentrates of ***crude magnesite*** have been currently used mainly for the production of fertilizers (over 50%, see: Production). Up to 45% has been consumed for the production of ***magnesium sulfate*** (suitable for water treatment) and ***other magnesium compounds*** in **Złotniki** plant. ***Active*** (***calcined***) ***magnesite***, produced in marginal amounts by the **Magnezyty Grochów** since 2001, has been applied for water and sewage treatment, as well as for abrasives and fertilizers manufacturing.

Imported ***dead-burned*** and ***fused magnesite***, and ***magnesia***, as well as ***co-clinkers***, have been entirely consumed in the manufacture of various grades of magnesite, magnesite-graphite, magnesite-chromite, and magnesite-spinel in refractory plants, namely: the **Ropczyce Magnesite Works**, and the **ArcelorMittal Refractories** of **Cracow**. Imported ***calcined magnesite*** and ***magnesia*** has been applied mainly in the production of ***magnesium compounds***, with the abrasives sector playing a minor role.

Companies involved in magnesite production in Poland as of December 2013

- Magnezyty Grochów S.A. w Grochowej (Magnezyty Grochów Joint Stock Co. of Grochowa), Grochowa 3, 57–257 Brzeźnica, tel./fax +48 74 8170907, www.magnezyty.com.pl — *raw magnesite concentrates, milled magnesite, active (calcined) magnesite*.

MAGNESIUM

Overview

Magnesium (**Mg**) can be recovered from ***seawater***, ***underground brines***, and ***lake brines***, as well as from ***magnesite*** and ***dolomite***, the resources of which are virtually unlimited and globally available. Seawater, with a magnesium content of 0.13% by weight, is an inexhaustible resource. **Magnesium** can be commercially produced by the electrolysis of ***magnesium chloride*** or thermal processing of ***dolomite***, which are very energy-consuming technologies. **Metallic magnesium** and its alloys are used in the automotive industry, and in aeronautics.

Sources

Deposits of ***dolomite*** are the only potential source of ***magnesium*** in Poland. Despite such deposits are common in Poland, they have not been utilized for the production of ***magnesium*** (see: **DOLOMITE**).

Production

Magnesium has not been produced in Poland despite in the 1950s the technology for ***metallic magnesium*** and ***magnesium oxide*** manufacturing was developed in the pilot scale in **Trzebinia Metallurgical Works**. However, the Central Statistical Office has reported some output of ***magnesium and magnesium products*** in Poland that amounted from 366 t in 2010 to 392 t in 2012 and only 48 t in 2013. The majority of these commodities have been probably ***high pressure die-castings*** (HPCD) made of magnesium at the plants of **Finnveden Metal Structures** in Bielsko Biała, **Euromag** and **Polmag** both in Kędzierzyn Koźle, all located in the south of Poland.

Trade

The entire demand for ***magnesium metal*** and ***magnesium alloys*** in Poland has been satisfied by imports. In recent years the volume of these deliveries has ranged from 3,600 to 6,400 tpy (Tab. 1). The large portion of these deliveries has come from China (60-65%), while the rest from Germany, Hungary, Netherlands and other European countries, in 2013 also from Australia (Tab. 2). Some quantities of ***magnesium scrap*** have been also exported. From 2009 to 2012 these sales have been gradually increasing, exceeding 1,000 tons in 2012, then slightly decreased in 2013. Most recently the major recipients of ***magnesium scrap*** have been Hungary and Austria. At the same time there were ***magnesium powder***, ***shavings***, ***fillings***, and ***granules*** deliveries recorded. In 2013 they originated mainly from Germany, China and Austria.

Tab. 1. Magnesium commodities statistics in Poland

t

Year	2009	2010	2011	2012	2013
Magnesium metal CN 8104 11, 19					
Imports	3,622	4,821	5,713	5,177	6,454
Exports	299	172	196	192	54
Consumption[a]	3,323	4,649	5,517	4,985	6,400
Mg-bearing scrap and wastes CN 8104 20					
Imports	–	0	0	0	0
Exports	782	889	961	1,044	980
Magnesium shavings, filings, and granules; powders CN 8104 30					
Imports	82	184	898	1,396	2,464
Exports	2	2	412	673	926

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Imports of magnesium metal to Poland, by country — CN 8104 11, 19

t Mg

Year	2009	2010	2011	2012	2013
Imports	**3,622**	**4,821**	**5,713**	**5,177**	**6,455**
Australia	–	–	–	–	10
Austria	353	285	452	194	–
China	1,771	2,378	2,607	3,393	3,890
Czech Republic	399	293	278	13	7
Denmark	–	2	–	–	4
Germany	373	669	785	362	1,405
Hungary	150	598	672	579	784
Israel	–	–	–	23	–
Netherlands	208	302	449	58	133
Russia	238	63	–	51	–
Serbia	–	–	92	24	–
Slovakia	–	–	96	–	36
Slovenia	–	–	45	–	–
Sweden	5	93	96	24	152
Switzerland	–	–	–	449	–
United Kingdom	118	136	140	8	31
Others	7	2	1	0	6

Source: ***The Central Statistical Office (GUS)***

The trade balances of ***magnesium commodities*** have been always negative, and followed the changes in importation volume and international prices fluctuations. In the last five years they ranged from 12 to 55 million PLN per annum (Tab. 3). The unit values of magnesium importation to Poland were consistent with tendencies on world metal markets, ranging in recent years between 3,400 and 3,600 USD/t (Tab. 4).

Tab. 3. Value of magnesium commodities trade in Poland — CN 8104 11, 19, 20, 30

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	6,772	6,653	15,563	27,967	53,805
Imports	40,548	52,199	70,499	75,507	71,301
Balance	**-33,776**	**-45,546**	**-54,936**	**-47,540**	**-12,496**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. The unit value of magnesium imports to Poland — CN 8104 11, 19

Year	2009	2010	2011	2012	2013
PLN/t	10,888	10,358	10,697	11,700	11,046
USD/t	3,514	3,442	3,647	3,592	3,517

Source: ***The Central Statistical Office (GUS)***

Consumption

In 2013 the demand for ***magnesium metal*** in Poland increased to 6,400 tpy (Tab. 1). The major traditional consumer used to be the aluminum industry that has utilised magnesium for the production of ***Al-Mg casting alloys***, i.e. the **Aluminum Konin Impexmetal** and the **Nowoczesne Produkty Aluminiowe Skawina (**both belonging to the **Impexmetal)**, as well as the **Kęty Group**. The other key consumers have recently become the **Euromag** in Kędzierzyn-Koźle operating the largest and the most modern foundry in Poland (a subsidiary of **Tar Heel Capital** Polish-American venture capital fund), **Finnveden Metal Structures** plant in Bielsko Biała (a division of Swedish **FinnvedenBulten Group**), and **Polmag** in Kędzierzyn Koźle (planning expansion and the construction of large factory in Olszowa). The principal assortments offered by these plants have been various ***Mg*** and ***Mg-Al casts***, primarily for the automotive industry, electronics, the army, etc. The dwindled magnesium consumption in 2009 was a consequence of reduced demand for castings in the automotive industry caused by economic downturn. In 2010-2013 the car sales revived, and magnesium consumption increased. Last year as the demand for cars diminished, magnesium consumption was consequently lower.

MANGANESE

Overview

The primary source of **manganese** (**Mn**) is **manganese ore** of different types. The most important are ***oxide*** and ***silicate manganese ore***, which form huge deposits, but only in a few places in the world. **Manganese** is essential to iron and steel production, due to its sulfur-fixing, deoxidizing, and alloying properties.

Sources

Poland has no ***manganese ore*** deposits, and there are no prospects for their discovery.

Production

Ferromanganese (HC) has been produced in blast furnace at the **STALMAG** in Ruda Śląska. The output decreased from 8.5 kt in 2008 to only 1.7 kt in 2009 as a result of the slowdown in the Polish steelmaking industry. In subsequent years, due to economic problems of the sole ferromanganese producer in Poland, further production decline to 800 tpy was recorded (Tab. 1). In the years 2009–2013 the production of ***ferrosilicomanganese*** (from electric furnaces of **Łaziska Smelter**) was drastically reduced due to economic problems of the producer: to 72 t, 112 t, 378 t, only 81 t and 99 t, respectively (Tab. 1). In fact, in 2012 **Łaziska Smelter** went into systemic bankruptcy, and in the last two years performed manufacturing services for **RE Alloys** in Łaziska Górne.

Tab. 1. Manganese commodities statistics in Poland

'000 t

Year	2009	2010	2011	2012	2013
Manganese ores and concentrates CN 2602					
Imports	2.3	3.5	3.1	4.2	4.5
Exports	0.0	–	0.0	0.0	0.0
Consumption[a]	2.3	3.5	3.1	4.2	4.5
Ferromanganese CN 7202 11–19					
Production	1.7	0.8	0.8	0.8	0.8
Imports	30.9	31.4	44.1	30.9	64.4
Exports	2.3	2.6	1.6	2.0	26.1
Consumption[a]	30.3	29.6	43.3	29.7	39.1

Ferrosilicomanganese CN 7202 30					
Production	0.0[r]	0.1	0.4	0.1	0.1
Imports	73.0	56.8	65.5	60.6	71.3
Exports	18.3	7.4	1.7	3.7	18.1
Consumption[a]	54.7[r]	49.5	64.2	57.0	53.3
Manganese metal [t] CN 8111 00 11					
Imports	356.3	1,522.6	391.7	734.9	971.1
Exports	4.0	39.3	22.6	96.4	93.2
Consumption[a]	352.3	1,483.3	369.1	638.5	877.9
Manganese dioxide [t] CN 2820 10					
Imports	1,480.5	1,491.2	1,607.0	1,377.4	1,828.3
Exports	74.5	119.0	195.2	169.8	144.4
Consumption[a]	1,406.0	1,372.2	1,411.8	1,207.6	1,683.9
Potassium permanganate [t] CN 2841 61					
Imports	451.2	413.7	451.8	374.3	318.8
Exports	203.9	151.7	193.6	126.2	137.3
Consumption[a]	247.3	262.0	258.2	248.1	181.5

Source: ***The Central Statistical Office (GUS)***

Trade

In the years 2009–2013 imports of ***ores*** and ***concentrates*** of ***manganese*** showed an increase from 2,300 to 4,500 tpy, following the development of Mn ferroalloys production. The main imports sources were Gabon, Ukraine (in 2012-2013), France, and also Singapore as a trader (Tab. 2).

Tab. 2. Polish imports of manganese ores and concentrates, by country — CN 2602

'000 t

Year	2009	2010	2011	2012	2013
Imports	**2.3**	**3.5**	**3.1**	**4.2**	**4.5**
Brazil	0.0	0.1	0.0	–	–
France	0.4	0.2	0.1	0.2	0.3
Gabon	0.3	1.3	1.0	0.7	1.0
Germany	–	0.1	0.3	0.1	0.1
India	–	0.1	0.0	–	0.1
Morocco	–	–	0.0	0.0	–
Netherlands	0.0	0.0	0.0	0.0	0.0
Singapore	1.5	1.6	1.5	1.6	1.5
Slovakia	–	–	0.0	–	–
Ukraine	–	–	–	1.6	1.5

Source: ***The Central Statistical Office (GUS)***

The decrease of ***ferromanganese*** production from blast furnace has caused the increase of its importation (Tab. 1). Moreover, in the years 2009–2013 exports of ***ferromanganese*** and ***ferrosilicomanganese*** exceeded the volume of domestic production (Tab. 1), which may be indicative of a weakness of domestic producers unable to meet the market requirements. ***Manganese metal*** and ***manganese dioxide*** have been available in Poland exclusively from imports. The main suppliers of ***manganese metal*** were: China (together with Hong-Kong in 2010), the Netherlands (especially in 2013), the Republic of South Africa, and Germany (Tab. 3). In 2009–2013 imports of ***manganese dioxide*** ranged from 1.4 to 1.8 ktpy (Tab. 4). The principal suppliers included: Spain, Germany and other European Union countries, the US, and China (Tab. 4). The main supplier of ***potassium permanganate*** in the years 2009–2013 was China, whereas deliveries from the US and other countries were of minor importance (Tab. 5).

Tab. 3. Polish imports of manganese metal, by country — CN 8111 00 11

t Mn

Year	2009	2010	2011	2012	2013
Imports	**356**	**1,523**	**392**	**735**	**971**
Belgium	18	59	14	–	–
China	180	947	53	239	382
France	2	–	–	3	2
Germany	11	13	94	93	50
Hong Kong	–	100	–	–	–
Luxembourg	–	–	15	3	–
Netherlands	72	290	72	211	419
Mexico	–	–	–	9	11
South Africa, Republic of	68	68	70	75	81
Spain	1	21	45	26	26
Ukraine	–	–	–	65	–
United Kingdom	4	25	29	10	–
USA	0	0	0	0	0

Source: ***The Central Statistical Office (GUS)***

In the years 2009–2013 the trade balances in ***manganese commodities*** had negative values (Tabs. 1, 6). In 2009 this value amounted to almost -284 million PLN, while in the years 2010–2011 the deficit deepened to a record of -429 million PLN. In 2012–2013, due to lower prices on international markets, the trade balance value improved to -328 million PLN (Tab. 6). The unit values of manganese commodities imports to Poland depend mostly on the volume of imports (Tabs. 6 and 1), particularly in the case of ores and concentrates.

Tab. 4. Polish imports of manganese dioxide, by country — CN 2820 10

t

Year	2009	2010	2011	2012	2013
Imports	**1,480**	**1,491**	**1,607**	**1,377**	**1,828**
Belgium	–	–	6	0	0
Brazil	66	–	–	–	–
China	30	13	29	21	128
Germany	15	33	0	0	0
Greece	–	–	20	30	30
India	50	–	–	75	25
Italy	9	12	4	21	8
Kazakhstan	2	–	–	–	–
Netherlands	24	10	–	1	–
Singapore	–	–	–	–	24
Spain	1,188	1,269	1,369	1,008	1,464
USA	96	154	179	221	149

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Polish imports of potassium permanganate, by country — CN 2841 61

t

Year	2009	2010	2011	2012	2013
Imports	**451**	**414**	**452**	**374**	**319**
China	433	408	343	334	262
Czech Republic	0	–	–	–	–
Germany	0	0	0	0	0
Hungary	6	–	–	–	–
India	0	–	0	–	–
Netherlands	0	0	–	0	–
Spain	–	0	–	–	–
USA	11	5	109	40	57

Source: ***The Central Statistical Office (GUS)***

Tab. 6. Value of manganese commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Manganese ore and concentrates CN 2602					
Exports	65	–	58	2	309
Imports	4,538	7,150	6,324	7,406	8,525
Balance	**-4,473**	**-7,150**	**-6,266**	**-7,404**	**-8,216**

Ferromanganese CN 7202 11–19					
Exports	13,324	15,104	10,987	10,921	112,689
Imports	113,329	139,644	182,235	114,850	226,595
Balance	**-100,005**	**-124,540**	**-171,248**	**-103,929**	**-113,906**
Ferrosilicomanganese CN 7202 30					
Exports	55,536	27,590	7,112	14,426	59,874
Imports	224,247	230,965	245,173	229,249	246,907
Balance	**-168,711**	**-203,375**	**-238,061**	**-214,823**	**-187,033**
Manganese metal CN 8111 00 11					
Exports	48	375	260	1,037	817
Imports	3,095	13,668	4,162	6,968	7,492
Balance	**-3,047**	**-13,293**	**-3,902**	**-5,931**	**-6,675**
Manganese dioxide CN 2820 10					
Exports	745	1,682	2,977	2,246	1,748
Imports	9,709	10,351	10,911	10,508	12,316
Balance	**-8,964**	**-8,669**	**-7,934**	**-8,262**	**-10,568**
Potassium permanganate CN 2841 61					
Exports	1,950	1,331	2,397	1,334	1,365
Imports	3,594	2,975	3,625	3,363	2,589
Balance	**-1,644**	**-1,644**	**-1,228**	**-2,029**	**-1,224**

Source: ***The Central Statistical Office (GUS)***

Consumption

Manganese ores and ***concentrates*** have been consumed in Poland for the production of ***blast-furnace ferromanganese*** at the **Pokój Steelworks**, and of ***ferrosilicomanganese*** in the electric furnaces at the **Łaziska Smelter** (Tab. 1). The relatively high demand for ***manganese dioxide*** has been a result of the stable consumption growth in the battery making industry (the main plant: **Philips Matsushita Battery Poland S.A.** in Gniezno), and the chemical industry. ***Potassium permanganate*** has been traditionally used in the chemical and pharmaceutical industries.

An increase in the consumption of ***manganese metal*** has been offset by lower consumption of the remaining manganese commodities. The metal has been mainly utilised in the non-ferrous metals industry as a constituent of aluminum, cobalt, magnesium, titanium, and ferronickel alloys, as well as in solders for aluminum and aluminum alloys, copper, bronze, and silver.

Companies involved in manganese commodities production in Poland, as of December 2013

- Huta Łaziska S.A. w Łaziskach Górnych (Łaziska Smelter Joint Stock Co. of Łaziska Górne), ul. Cieszyńska 23, 43–170 Łaziska Górne, tel. +48 32 2241500, fax +48 32 2241523, www.hlsili.pl — *ferrosilicomanganese from electric furnace.*
- STALMAG Sp. z o.o. w Rudzie Śląskiej (STALMAG Ltd. of Ruda Śląska) ul. Hutnicza 2, 41–709 Ruda Śląska, tel. +48 32 7712801, fax +48 32 7712800, www.stalmag.pl — *ferromanganese from blast furnace.*

MERCURY

Overview

Mercury (**Hg**) is a metal that has been known for over 4,000 years. It is recovered almost entirely from ***cinnabar*** and ***native mercury*** forming individual deposits. Recently, secondary mercury from recycling started to be important due to environmental reasons. Currently, **mercury** is consumed in the chlorine-caustic soda industry using mercury cell technology; for the production of discharge lamps laboratory instruments; in dentistry; and for the production of low melting alloys for fuses and thermometers. Due to the toxicity of mercury and the introduction of many substitutes, its economic value is diminishing.

Sources

There are no deposits of ***mercury ore*** in Poland. Some concentrations of mercury are observed in ***hard coal*** in the **Upper Silesian Coal Basin** and **Lower Silesian Coal Basin** (from 1 ppb to 997 ppb), in some deposits of ***natural gas***, and in ***copper ore*** deposits in the **Fore-Sudetic Monocline**.

Production

Mercury is not recovered from primary sources, even though considerable amounts are emitted into the atmosphere in the course of ***hard coal*** and ***lignite coal*** combustion and the smelting of ***copper ore*** concentrates. Considerable amounts of mercury can be recovered from wastes containing this element, i. e.: spent batteries, but mainly from spent discharge lamps – fluorescent lamps, mercury discharge lamps, sodium discharge lamps, metal halide lamps and ultraviolet lamps. The average mercury content in discharge lamps previously produced is 40 mg Hg/unit and the newest products, according to European Union law regulations, may contain no more than 5 mg Hg/unit. From 2002, all producers and importers, which sell discharge lamps, excluding compact fluorescent lamps, are obliged to achieve the proper levels of their recovery and recycling – 40% until 2007. If these levels would not have been achieved, producer is obliged to pay the product fee. In Poland, there are several companies which dispose of the technology of mercury recovery from spent discharge lamps, i. e.: **Philips Lighting Poland** in **Piła**, **MAYA** in **Warsaw**, **Abba-Ekomed** in **Toruń**, **Eko-Neutral-Elektron** in **Gorlice**, and **Utimer** in **Warsaw**. In 2007, for the first time, output of secondary ***mercury*** was recorded by Central Statistical Office and amounted to 675 kg. In 2008 it increased to 1,332 kg, while in the years 2009 and 2010 it decreased to 801 kg and 705 kg, respectively. In the years of 2011-2013 the output data of secondary mercury was not given by Central Statistical Office.

Trade

Domestic demand for ***mercury*** is satisfied mainly by variable imports which significantly increased in 2013 (Tab. 1). The main suppliers to Poland were the Western European countries, and in the years 2009-2013 predominant were deliveries from the Germany and Netherlands (Tab. 2). Exports in item **CN 2805 40** “Mercury” was especially reported in the years 2009-2011 (Tab. 1), with Belgium, the Netherlands and India as the main buyers. It is not clear, what kind of commodity was exported under this item, because it had very low unit values 25-37 PLN/kg (8-12 USD/kg), while unit value of mercury imports in these years amounted to 328-673 PLN/kg (Tab. 4). In 2011, for the first time, the unit value of mercury exports was higher than unit value of imports, what indicates, that the traded mercury had comparable quality. In 2011 receivers of mercury exports from Poland were India, China and the Netherlands. Trade balance in ***mercury*** in the years 2011-2013 has been constantly negative, changing between 3.0 and 4.7 million PLN/y. In 2010 huge exports volume has caused that its value had exceeded value of imports, so the value of trade balance in mercury, for the first time in recent years, was positive (Tab. 3).

Tab. 1. Mercury statistics in Poland — CN 2805 40

t Hg

Year	2009	2010	2011	2012	2013
Imports	11	5	40	13	32
Exports	47	106	7	–	–
Consumption[a]	–36	–101	33	13	32

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Polish imports of mercury, by country — CN 2805 40

t Hg

Year	2009	2010	2011	2012	2013
Imports	**11**	**5**	**40**	**13**	**32**
Germany	0	0	34	10	16
Netherlands	10	4	5	3	15
Others	1	1	1	0	1

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Value of mercury trade in Poland — CN 2805 40

‘000 PLN

Year	2009	2010	2011	2012	2013
Exports	1,204	3,957	1,094	–	–
Imports	6,010	3,228	5,665	3,002	4,760
Balance	**-4,806**	**+129**	**-4,571**	**–3,002**	**-4,760**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Unit values of mercury imports to Poland — CN 2805 40

Year	2009	2010	2011	2012	2013
PLN/kg	546	673	142	221	151
USD/kg	183	224	48	68	48

Source: ***The Central Statistical Office*** *(**GUS**)*

Consumption

Until 2006, the apparent consumption of ***mercury*** in Poland has been on the same level, like a volume of imports, while in the years 2006-2010 (Tab. 1) large volume of exports has caused that the mercury apparent consumption became negative. In the years 2011-2013 mercury trade became irregular, exports were reduced, so apparent consumption amounted to 33 t in 2011 and dropped to 13 t in 2012, then increasing to 32 t in 2013 (Tab. 1). However, real consumption of mercury is estimated at a few, no more than a dozen tpy. There are no data available on the structure of ***mercury*** consumption in Poland. It is probably applied in the chlorine-caustic soda industry using mercury cell technology, for the production of discharge lamps, laboratory instruments, as well as for the production of low-melting alloys for fuses and thermometers.

MICA

Overview

Mica is the common name for a large group of rock-forming minerals that have a layered or platy texture. The most commercially important micas are ***flogopite*** and ***muscovite*** due to large sheets (minimum several hundred cm^2) utilized in electronics and electrotechnology as insulators. Mica sheets are transparent to opaque, resilient, reflective, refractive, dielectric, chemically inert, insulating and hydrophilic. Small monomineral ***mica flakes*** are used mainly in the production of ***micanite*** and ***mica paper*** (electrical insulators); ***finescale mica***, and ***mica powder*** are used as fillers in many industries. In some countries **synthetic mica** is produced, mainly ***synthetic flogopite***.

Sources

There are no ***mica*** deposits in Poland of economic importance.

Production

Mica is not produced in Poland.

Trade

Domestic demand is entirely satisfied by imports, which considerably increased from the level of 1,100–1,200 tpy in the years 2009–2010 to 1,400–1,900 tpy in the following years (Tab. 1). ***Mica powder*** accounted for most of the supplies (above 90%), whereas ***mica flakes*** and occasionally ***mica wastes*** were delivered in smaller amounts. India was the most important mica supplier to Poland, providing up to 50% of imports, until 2009. Since then the volume of deliveries from this country significantly dropped and the majority of imported mica came from Germany (actually there is no mica production in Germany and the majority of this raw material originated from processing plant in Aspang in Austria). Another important supplier became France (Tab. 1). The trade balance has been consistently negative, despite some re-exports of mica powder to neighbouring countries. Recently, the annual trade deficit varied between 3.5 and 5.7 million PLN (Tab. 2).

The unit values of ***mica*** imports to Poland followed the fluctuations of mica international quotations. In the years 2009–2013 these values fluctuated between 990 and 1,360 USD/t depending on the share of cheaper mica from India (***mica powder*** 279-566 USD/t), as well as more expensive mica from Germany (***mica powder*** 572-832 USD/t) and France (***mica powder*** 731-2,993 USD/t) in imports structure (Tab. 3).

Tab. 1. Mica statistics in Poland — CN 2525

t

Year	2009	2010	2011	2012	2013
Imports	**1,189**	**1,147**	**1,908**	**1,473**	**1,729**
Austria	–	–	1	25	83
Belgium	3	1	–	46	95
China	6	20	11	37	23
Czech Republic	–	0	3	49	4
Denmark	4	1	1	1	1
France	89	200	377	192	286
Germany	358	575	1,255	919	905
India	530	180	124	122	96
Japan	6	3	9	6	10
Madagascar	20	–	–	–	–
Netherlands	65	71	43	12	76
Spain	19	0	50	33	70
United Kingdom	38	22	22	20	25
USA	19	2	3	3	5
Other	32	72	9	8	50
Exports	**12**[1]	**42**[2]	**21**[1,3,4]	**30**[1,3,4]	**20**[5]
Consumption[a]	**1,177**	**1,105**	**1,887**	**1,443**	**1,709**

[1] mica powder to Ukraine
[2] predominantly mica powder to Russia
[3] mica flakes to Belarus
[4] mica powder to Germany
[5] predominantly mica powder to the Czech Republic

Source: ***The Central Statistical Office (GUS),***

Tab. 2. Value of mica trade in Poland — CN 2525

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	129	263	271	156	92
Imports	3,686	4,775	5,967	5,806	5,821
Balance	**-3,557**	**-4,512**	**-5,696**	**-5,650**	**-5,729**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit values of mica imports to Poland — CN 2525

Year	2009	2010	2011	2012	2013
PLN/t	3,100	4,164	3,128	3,941	3,368
USD/t	991	1,360	1,066	1,208	1,072

Source: ***The Central Statistical Office (GUS)***

Consumption

The apparent consumption of mica in Poland ranged from ca. 1,105 tpy to 1,887 tpy in last five years (Tab. 1). ***Mica*** imported by **Solvadis Polska**, **Continental Trade**, **Izo-Erg**, **Mikanit**, **Franspol**, **Sinkoplex**, **Surtex**, and **Techmat**, has been utilized mainly in electrotechnology for the manufacturing of electroinsulating materials (***micanite***, ***mica-foil***, ***mica paper***, etc.) as well as in the production of building materials (as substitute of asbestos) and paints. In the future, growth of utilization of mica product in plastic and rubber industries is possible.

MINERAL WAXES

Overview

Ozokerite, once incorrectly called **"fossil wax",** is the product of the natural differentiation of ***petroleum***, containing considerable concentrations of saturated hydrocarbons, with admixtures of liquid and gaseous hydrocarbon constituents. Most ozokerite is processed into **ceresine**, which is used to make candles, wax paper, etc. **Mineral waxes**, which are extracted from peat, lignite, or sapropel coal (***peat wax***, ***Montana wax*** and ***sapropel wax***, respectively) by using organic solvents at a temperature below 100°C, finds similar applications.

Sources

There are no ***ozokerite*** deposits in Poland. However, there are some possibilities for the ***Montana wax*** production from ***lignite***, e.g. from **Turów** lignite deposit.

Production

There is no production of ***ozokerite***, as well as of ***peat wax***, ***Montana wax***, and ***sapropel wax*** in Poland.

Trade

In 2009-2010 Germany was the main supplier of ***raw Montana wax*** to Poland. In recent years, it has been imported from Italy and the Netherlands. Total imports of ***raw Montana wax*** and ***other mineral waxes*** to Poland that previously approached 100 tpy, since 2009 have dropped to only a few tons per year (Tab. 1). Processed mineral waxes have been also traded in amounts ranging from 100 to 200 tpy. Trade balances of ***raw Montana wax*** have been traditionally negative (Tab. 2), what has been influenced by its high unit values (Tab. 3).

Tab. 1. Crude ozokerite, Montana wax, and peat wax statistics in Poland — CN 2712 90 11

t

Year	2009	2010	2011	2012	2013
Imports = Consumption[a]	**3**	**3**	**0**	**6**	**4**
Germany	3	1	0	0	0
Netherlands	-	-	-	6	4
Italy	0	2	-	-	-

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Value of crude ozokerite, Montana wax, and peat wax trade in Poland — CN 2712 90 11

'000 PLN

Year	2009	2010	2011	2012	2013
Imports = **Balance**	**-50**	**-39**	**-1**	**-69**	**-48**

Source: ***The Central Statistical Office*** *(GUS)*

Tab. 3. Average unit values of crude ozokerite, Montana wax, and peat wax imports to Poland — CN 2712 90 11

Year	2009	2010	2011	2012	2013
PLN/t	15,514	13,389	11,019	12,325	13,338
USD/t	4,937	4,307	3,817	3,793	4,196

Source: ***The Central Statistical Office*** *(GUS)*

Consumption

Ozokerite and ***mineral waxes*** are mainly used to make candles, floor paste, wax paper, and insulating materials.

MOLYBDENUM

Overview

The basic carrier of **molybdenum** (**Mo**) is ***molybdenite*** (***MoS_2***), in practice the only primary source of this metal. Less than 1/3 of the world supply of molybdenite comes from individual deposits. The remainder is obtained primarily as a co-product from the processing of porphyry-type ***copper ores*** (approx. 2/3 of the supply), while small amounts are recovered from secondary sources (spent ***catalytic convertors***).

Molybdenum is a valuable additive in steel refining, used to produce stainless steel and cast steel, and also non-ferrous alloys. Molybdenum is used as a metallic matrix in alloys with copper, silver, and other metals, as an additive in alloys with tantalum, titanium, and vanadium, and for obtaining magnetically soft heat-resistant and high-temperature alloys (super alloys). It is also used as an alloy matrix in non-reactive solders for metal and ceramics.

Sources

Poland has one porphyry-type deposit of ***molybdenum ore*** with ***tungsten***, and ***copper***, located near **Myszków**. The resources of the deposit amounted to 550.8 Mt of ore containing 295,000 t ***Mo*** (as of 31 December 2013). The deposit has a form of stockwerk with sulfides-oxides veins, connected with granitoid magmatism of Variscian age. The deposit has not been developed.

Small amounts of molybdenum occur in the ***copper ore*** deposits of the **Fore-Sudetic Monocline**. The estimated resources amounted to 68,710 t of Mo, including 59,110 t of Mo in developed deposits (as of 31 December 2013).

Production

In 2013 the output of copper ores from the **KGHM Polska Miedź S.A.** mines contained 1,310 t of Mo. In the course of processing, approx. 44% of the Mo goes to ***copper concentrate*** (120–350 ppm of Mo). However, due to the lack of economically viable recovery methods, the molybdenum is left in smelter waste materials.

Trade

The entire demand for ***molybdenum commodities*** has been satisfied by very variable imports of ***concentrates***, ***molybdenum oxides*** and ***molybdenum powder*** from Western European countries, China, the Czech Republic, Hungary (Mo oxides), Thailand (in 2011), and from Vietnam (in 2013) (Tab. 1). The most important molybdenum commodity imported to Poland has been ***ferromolybdenum*** (Tab. 2). In recent years its imports decreased from 751 t in 2009 to 421 t in 2011 as a result of lower demand, but in the period 2012–2013 increased to 1,286 t. In the last five years the major suppliers were Western European countries, Chile, Republic of Korea, while deliveries from China, Russia, Iran, and Armenia were of minor importance (Tab. 2). Incidental exports of some molybdenum commodities have also been reported. Especially high volume of re-exports was recorded in 2010 for ***molybdenum ores*** and ***concentrates***, in 2011 for ***molybdenum powder*** and in 2013 for ***molybdenum metal*** (Tabs. 1 and 2). Moreover, since 2010 there have been recorded extremely high re-exports of ***ferromolybdenum***, a few times higher then imports, resulting in negative apparent consumption (Tab. 2). Exports were directed mainly to the Czech Republic, the Netherlands, Slovakia, Belgium, Ukraine, Germany, and Hungary. The recipients of ***molybdenum ores*** and ***concentrates*** from Poland were the following: in 2010 Germany, in 2011 - Turkey and France, in 2012 - Turkey, Estonia and Spain, and in 2013 – Ukraine and Spain. The re-exports of ***Mo oxides*** in 2009 were directed to the Netherlands, while in 2010 to the Czech Republic and Germany; in 2011 and in 2013 the sole recipient was the Czech Republic (Tab. 2). Moreover, in 2011 ***molybdenum powder*** was sold to Russia, while in the period 2012–2013 - to the Czech Republic.

Tab. 1. Molybdenum commodities statistics in Poland

t Mo

Year	2009	2010	2011	2012	2013
Molybdenum ores and concentrates[1] CN 2613					
Imports	**0.2**	**1.0**	**34.5**	**1.2**	**63.3**
China	–	–	0.0	–	–
France	0.2	1.0	1.3	1.2	1.6
Germany	–	–	2.7	–	–
Hong Kong	–	–	5.0	–	–
Italy	–	–	–	–	3.7
Japan	0.0	0.0	0.0	–	–
Netherlands	–	–	–	–	0.0
Thailand	–	–	20.0	–	–
Uzbekistan	–	–	5.5	–	–
Vietnam	–	–	–	–	58.0
Exports	–	**16.0**	**0.4**	**0.8**	**1.9**
Consumption[a]	**0.2**	**-15.0**	**34.1**	**0.4**	**61.4**
Molybdenum oxides CN 2825 70					
Imports	**82.8**	**209.0**	**196.4**	**240.9**	**195.2**
Belgium	–	–	–	–	0.1
China	–	–	–	–	0.4
Czech Republic	27.0	24.6	23.5	15.2	18.0
France	–	–	–	1.8	–

Germany	22.8	5.8	27.0	1.4	0.0
Hungary	4.0	88.0	51.6	42.5	30.8
Kirgistan	15.4	–	–	–	0.0
Latvia	1.7	–	–	–	–
Netherlands	6.0	77.7	80.0	162.0	140.0
Ukraine	6.0	12.9	14.3	12.5	5.8
USA	0.0	0.0	0.0	5.4	–
Exports	**1.5**	**12.0**	**7.0**	–	**4.0**
Czech Republic	–	2.5	7.0	–	4.0
Germany	–	9.5	–	–	–
Netherlands	1.5	–	–	–	–
Consumption[a]	**81.3**	**197.0**	**189.4**	**240.9**	**191.2**
Molybdenum metal CN 8102 94					
Imports	**1.0**	**2.9**	**0.0**	**0.2**	**0.2**
China	0.1	–	–	0.2	0.2
Germany	0.0	–	–	–	0.0
Spain	–	–	0.0	–	–
Uzbekistan	0.9	2.9	–	–	–
Exports	–	–	–	–	**28.0**
Czech Republic	–	–	–	–	1.0
Netherlands	–	–	–	–	27.0
Consumption[a]	**1.0**	**2.9**	**0.0**	**0.2**	**-27.8**
Molybdenum powder CN 8102 10					
Imports	**0.6**	**0.2**	**0.7**	**1.5**	**2.2**
Belgium	–	0.1	–	–	0.0
China	–	–	0.5	0.7	0.1
Czech Republic	–	–	–	–	0.0
Germany	0.1	0.0	0.1	0.5	1.9
Netherlands	–	0.0	–	–	0.1
United Kingdom	0.4	0.0	0.0	0.0	0.0
USA	0.0	0.0	0.0	0.3	0.0
Exports	–	–	**3.1**	**0.2**	**0.5**
Czech Republic	–	–	–	0.2	0.5
Russia	–	–	3.1	–	–
Consumption[a]	**0.6**	**0.2**	**-2.4**	**1.3**	**1.7**

[1] gross weight

Source: ***The Central Statistical Office** (GUS)*

Tab. 2. Ferromolybdenum statistics in Poland — CN 7202 70

t

Year	2009	2010	2011	2012	2013
Imports	**751**	**638**	**421**	**1,039**	**1,286**
Armenia	108	68	21	10	46
Austria	42	18	7	–	–
Belgium	195	187	136	157	475
Brazil	–	5	–	–	–
Chile	58	48	12	66	358
China	0	18	20	13	2
Czech Republic	4	–	–	4	–
France	2	3	1	3	–
Germany	22	28	13	25	42
India	2	1	9	3	33
Iran	5	7	5	2	16
Kazakhstan	8	–	–	24	–
Korea, Republic of	7	62	127	97	50
Laos	7	–	–	–	–
Lithuania	–	–	–	24	–
Luxembourg	–	–	4	–	–
Netherlands	9	41	47	525	190
Romania	–	2	–	1	8
Russia	232	47	1	50	30
Slovakia	2	–	–	–	1
Slovenia	–	4	–	–	–
Spain	–	8	–	–	–
Sweden	3	7	7	4	4
United Kingdom	33	84	11	30	31
USA	7	–	–	–	–
Uzbekistan	5	–	–	–	–
Exports	**212**	**1,547**	**3,412**	**3,151**	**3,797**
Consumption[a]	**539**	**-909**	**-2,991**	**-2,112**	**-2,511**

Source: ***The Central Statistical Office (GUS)***

In recent years the trade balance of ***molybdenum commodities*** has been negative, particularly for ***ferromolybdenum*** in 2009 (Tab. 3). Since 2010 high volume of re-exports of ***ferromolybdenum*** and in 2013 of ***molybdenum metal*** resulted in positive values of their trade balances (Tab. 3). The unit values of molybdenum commodities imports to Poland depended mostly on the volume of imports and market prices (Tab. 4).

Tab. 3. Value of molybdenum commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Molybdenum ores and concentrates CN 2613					
Exports	–	237	4	1	142
Imports	6	18	1,858	21	2,694
Balance	**-6**	**+219**	**-1,854**	**-20**	**-2,552**
Molybdenum oxides CN 2825 70					
Exports	44	928	513	–	235
Imports	2,888	9,976	11,630	12,124	8,210
Balance	**-2,844**	**-9,048**	**-11,117**	**-12,124**	**-7,975**
Molybdenum metal CN 8102 94					
Exports	–	–	–	–	1,398
Imports	154	322	0	48	123
Balance	**-154**	**-322**	**-0**	**-48**	**+1,275**
Molybdenum powder CN 8102 10					
Exports	–	–	1,285	46	91
Imports	218	83	151	472	553
Balance	**-218**	**-83**	**1,134**	**-426**	**-462**
Ferromolybdenum CN 7202 70					
Exports	15,488	113,650	277,461	239,610	230,008
Imports	43,288	49,991	31,271	68,501	73,886
Balance	**-27,800**	**+63,659**	**+246,190**	**+171,109**	**+156,122**

*Source: **The Central Statistical Office (GUS)***

Tab. 4. Unit values of molybdenum commodities imports to Poland

Year	2009	2010	2011	2012	2013
Molybdenum ores and concentrates CN 2613					
PLN/t	30,000	18,262	53,894	16,725	42,526
USD/t	10,299	5,808	17,854	5,159	13,403
Molybdenum oxides CN 2825 70					
PLN/t	34,876	47,735	59,213	50,336	12,061
USD/t	11,223	16,069	20,731	15,415	13,441
Molybdenum metal CN 8102 94					
PLN/t	149,701	112,890	182,000	246,964	484,310
USD/t	50,153	38,918	63,000	77,388	155,459

Molybdenum powder CN 8102 10					
PLN/t	363,333	404,390	220,675	312,458	253,239
USD/t	123,823	132,434	72,904	95,359	80,833
Ferromolybdenum CN 7202 70					
PLN/t	57,640	78,310	74,286	65,286	57,443
USD/t	18,667	26,134	25,454	20,185	18,219

Source: ***The Central Statistical Office (GUS)***

Consumption

The ***molybdenum powder*** and some amounts of ***molybdenum trioxide*** MoO_3 and ***metallic molybdenum*** have been consumed by the **Polam-Warszawa**, mainly for the production of thin wires, rods, and bar ends. In 2009, the output of ***molybdenum products*** amounted to 28,073 kg, while in the years 2010–2011 it decreased to 6,058 kg and 2,964 kg, respectively. In the last two years it reached 5,345 kg and 10,679 kg, respectively.

Natural molybdenite of high purity or its synthetic variety is utilized in the production of ***molybdenum greases***, whereas ***ferromolybdenum*** is used in the steel and cast iron industry for stainless steel, spring steel, superalloys, heat resistant elements, etc.

NICKEL

Overview

The principal sources of **nickel** (**Ni**) are deposits of ***latheritic*** and ***silicate ores*** (processed mainly into **ferronickel** and **nickel oxide**), as well as deposits of ***nickel-copper sulfide ores*** (processed into **nickel sulfide concentrates**, **nickel matte**, and **nickel metal**), and other types of ore, in which nickel occurs as an accompanying element. In addition, there are extensive deep-sea resources of nickel in manganese crusts and nodules covering large areas of the ocean floor.

The majority of the **primary nickel** production is utilized for stainless steel and alloy steel manufacturing. It is also applied in the production of nonferrous alloys and superalloys, e.g. with chromium, copper, iron, aluminum, boron, magnesium, silver or gold, and electroplating. The future prospects for nickel demand are connected with the production of electrical vehicles powered by advanced nickel-metal hybrid batteries (***NiMH***).

Sources

Deposits of ***nickel silicate ore*** have been recognized in Lower Silesia. There is an independent deposit of **Szklary**, extraction of which was halted in 1983. Its resources, i.e. 14.64 Mt of ore graded at 0.8% Ni, since then have remained unchanged. Nickel occurs as an accompanying element also in the ***magnesite*** **Grochów** deposit (of no economic value).

Since 2008, the Szklary deposit has been re-explored by Australian-based **Northern Mining Limited** (**NMI**) which entered into a heads of agreement with Polish copper giant **KGHM Polska Miedź**. The Szklary Nickel Project had an initial Inferred Resource to JORC reporting standards of 16.8 Mt with 0.6% Ni for 94,000 t contained nickel (including 3.2 Mt with 0.9% Ni). **NMI** believed that there is potential to increase the size of the Szklary resources through further study of the historic workings. Therefore the Szklary Nickel Project concessions and Mining Lease agreement were renewed for a further three years from 25 March 2013 to 25 March 2016.

Up to date, the principal sources of ***nickel*** in Poland have been deposits of ***copper ore*** in the **Fore-Sudetic Monocline**, where it accompanies copper. The average content of nickel in the ore has amounted to 50 ppm, while in the shale-type of ore it has ranged from 200 to 280 ppm (occasionally peaking up to 521 ppm). At year-end of 2013 the approximate nickel resources were 56,380 t, including around 40,170 t in deposits currently operated, i.e. **Lubin-Małomice**, **Rudna**, and **Głogów Głęboki Przemysłowy**.

Production

In 2013 the nickel content in copper ore run-off-mine was 570 tons. The principal nickel commodity has been ***nickel sulfate***, recovered as a byproduct of metallurgical processing of ***copper concentrate*** at the smelters operated by **KGHM Polska Miedź**, i.e. **Głogów I** and **II** — 2,000 t in 2013, and **Legnica** — over 7,000 t. The total output of ***nickel sulfate*** that ranged between 2,100 and 2,800 tpy in the years 2009-2013, showing a growing tendency (Tab. 1). In recent time the **KGHM Ecoren** — a division of the **KGHM Polska Miedź** — has developed a hydrometallurgical technology for the by-product nickel sulfate purification, with ***nickel hydroxide***, and possibly — ***cobalt sulfate***, ***copper*** and ***zinc*** — as the final products. According to official records of the **Central Statistical Office** (**GUS**), some small amounts of goods made of ***nickel and nickel alloys***, i.e. sheets, bars, sections, wire etc., have been also manufactured (recently in the range 6-11 tpy).

Tab. 1. Nickel commodities statistics in Poland

t

Year	2009	2010	2011	2012	2013
Nickel oxide sinter CN 7501 20					
Imports	1,611.4	0.2	7.3	0.4	11.4
Exports	1,552.1	–	–	–	–
Consumption[a]	59.3	0.2	7.3	0.4	11.4
Nickel metal CN 7502 10					
Imports	1,200.3	1,989.5	2,592.7	2,878.1	2,884.4
Exports	120.6	671.0	249.3	883.0	2,607.4
Consumption[a]	1,079.7	1,318.5	2,343.4	1,995.1	277.0
Nickel alloys CN 7502 20					
Production	9.0	NA	NA	NA	NA
Imports	181.5	1,463.0	67.3	232.0	261.8
Exports	0.0	1,206.8	0.3	0.1	0.4
Consumption[a]	181.5	256.2	67.0	231.9	261.4
Wastes and scraps of nickel metal and nickel alloys CN 7503 00					
Imports	3,068.7	862.9	608.6	320.5	443.9
Exports	1,183.8	1,250.4	747.1	687.6	311.2
Consumption[a]	1,884.9	-387.5	-138.5	-367.6	132.7
Nickel powder and flake CN 7504 00					
Imports	94.7	89.4	114.1	132.7	141.8
Exports	7.2	10.3	8.9	7.7	7.8
Consumption[a]	87.5	79.1	105.2	125.0	134.0

Nickel sulfate CN 2833 24					
Production	2,123.0	2,378.0	2,481.0	2,600.0	2,756.0
Imports	122.7	328.5	159.5	223.5	229.3
Exports	2,080.6	2,742.0	2,419.6	2,668.5	2,931.9
Consumption[a]	165.1	-35.5	220.9	155.0	53.4
Nickel chloride CN 2827 35					
Imports	41.3	92.4	99.3	90.4	110.2
Exports	15.1	53.1	57.4	59.9	55.4
Consumption[a]	26.2	39.3	41.9	30.5	54.8

Source: ***The Central Statistical Office (GUS)***

Trade

The majority of ***nickel commodities*** consumed domestically has been imported in quite large quantities (Tabs. 1–3). The prime example has been ***nickel metal*** (1,200–2,900 tpy). These deliveries have been basically sourced from Russia, Netherlands, Norway, the United Kingdom, the Czech Republic (in 2012), and – until 2011 – Germany (Tab. 2). ***Nickel metal*** and especially ***nickel alloys*** have been distributed in Poland by subsidiaries of foreign companies, e.g. **Bibus Metals** (the Swiss representative of the US-based **Special Metals Corporation**), **Italinox** (Germany), **Jacquet Metals** (French-based). Other nickel commodities, i.e. ***powder***, and ***compounds*** (***sulfate***, ***chloride***, Tab. 3), recently have been brought from Belgium, Germany, Austria, and France. The substantial importation of ***wastes and scrap of nickel metal*** was significantly reduced in the last two years. In 2013 the majority of these materials originated from Germany and Slovakia. The principal nickel commodity exported from Poland has been ***nickel sulfate***, manufactured by the **KGHM Polska Miedź.** Its main and most regular recipient was Germany, while in 2012 and 2013 Philippines emerged as the major foreign customer (Tab. 4). ***Nickel metal*** has been also exported in various quantities (120-2,600 tpy). The sales of ***nickel wastes*** and ***scrap***, predominantly to Germany, were reduced from around 1,200 tpy in 2009-2010 to ca. 300 t in last year. Poland has been a net importer of ***nickel*** commodities, therefore the overall trade balance has been negative (Tab. 5). The deficit in the trade of nickel commodities has been mitigated by revenues from ***nickel compounds*** exports, which in recent years have ranged between 23 and 29 million PLN with a declining tendency (Tab. 5). Positive balances in the trade of ***nickel waste*** and ***scrap***, which in 2009-2012 ranged from 49 to 3 million PLN, in 2013 turned negative. In recent years the unit cost of ***nickel metal*** importation decreased substantially, reflecting the downward trend of the LME nickel prices and unprecedented world crisis due to huge oversupply of this metal on the market (Tab. 6).

Tab. 2. Polish imports of nickel, by country — CN 7502 10

t Ni

Year	2009	2010	2011	2012	2013
Imports	**1,200**	**1,990**	**2,593**	**2,878**	**2,884**
Australia	12	–	–	–	–
Belgium	4	40	13	–	79
Brazil	25	10	14	21	23
Canada	103	2	12	95	60
Czech Republic	2	18	10	59	308
Estonia	–	24	–	–	–
Finland	19	7	14	5	6
France	22	30	3	9	41
Germany	320	323	810	642	33
Italy	59	125	77	36	9
Luxembourg	116	8	265	97	28
Netherlands	121	501	443	374	210
Norway	154	243	207	345	303
Russia	195	391	540	968	1,370
Slovenia	–	72	–	–	–
Spain	18	69	–	1	1
South Africa	–	6	–	–	17
Switzerland	–	–	21	–	–
United Kingdom	30	121	164	226	394
Zimbabwe	–	–	–	–	2

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Polish imports of nickel compounds[1], by country

t

Year	2009	2010	2011	2012	2013
Imports	**164**	**421**	**259**	**314**	**340**
Austria	79	142	3	22	73
Belgium	–	53	90	97	111
Czech Republic	–	39	–	–	–
Finland	–	2	13	35	23
France	26	40	24	19	51
Germany	50	81	57	73	36
Italy	9	64	67	68	30
Spain	–	–	–	–	16
Taiwan	–	–	1	–	–
United Kingdom	–	–	4	–	0

[1] nickel sulfate — **CN 2833 24**, nickel chloride — **CN 2827 35**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Polish exports of nickel sulfate, by country — CN 2833 24

t

Year	2009	2010	2011	2012	2013
Exports	**2,081**	**2,742**	**2,420**	**2,669**	**2,932**
Belarus	4	7	1	3	2
Belgium	47	527	1,223	373	574
Czech Republic	33	16	1	2	1
Estonia	–	–	–	–	1
Finland	1,716	1,350	–	1	1
Germany	276	400	763	945	831
Hungary	1	1	8	6	3
India	–	322	396	–	–
Lithuania	1	2	2	2	3
Netherlands	–	–	–	15	–
Philippines	–	–	–	1,253	1,453
Romania	–	1	–	–	–
Russia	2	28	–	5	8
Serbia	–	–	–	2	–
Slovakia	–	–	3	17	10
Slovenia	–	0	–	2	–
Ukraine	1	42	23	43	45
United States	–	46	–	–	–

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Value of nickel commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Nickel oxide sinter CN 7501 20					
Exports	77,302	0	0	0	0
Imports	81,022	15	64	96	41
Balance	**-3,720**	**-15**	**-64**	**-96**	**-41**
Nickel metal CN 7502 10					
Exports	5,338	46,945	17,114	52,188	118,368
Imports	54,099	121,734	170,698	170,622	139,663
Balance	**-48,761**	**-74,789**	**-153,584**	**-118,434**	**-21,295**
Nickel alloys CN 7502 20					
Exports	3	78,938	28	44	124
Imports	15,682	95,409	5,244	22,007	27,439
Balance	**-15,679**	**-16,471**	**-5,216**	**-21,963**	**-27,315**

Wastes and scraps of nickel metal and nickel alloys CN 7503 00					
Exports	52,226	65,346	26,644	9,437	3,451
Imports	30,798	15,866	18,403	6,379	7,277
Balance	**+21,428**	**+49,480**	**+8,241**	**+3,058**	**-3,826**
Nickel powder CN 7504 00					
Exports	690	936	845	677	704
Imports	7,673	9,902	14,103	16,578	16,126
Balance	**-6,983**	**-8,966**	**-13,258**	**-15,901**	**-15,422**
Nickel compounds CN 2833 24, 2827 35					
Exports	18,505	35,715	32,639	31,981	28,052
Imports	1,955	6,637	4,739	4,846	4,453
Balance	**+16,550**	**+29,078**	**+27,900**	**+27,135**	**+23,599**

Source: ***The Central Statistical Office (GUS)***

Tab. 6. The unit value of nickel imports to Poland — CN 7502 10

Year	2009	2010	2011	2012	2013
PLN/t	45,082	61,188	65,830	59,285	48,420
USD/t	14,694	20,337	22,533	18,115	15,420

Source: ***The Central Statistical Office (GUS)***

Consumption

Over the years 2009-2012 the domestic consumption of nickel metal ranged between 1,100 and 2,300 tpy, while in 2013 it dropped to just 280 tons. The reason was stainless steel manufacturing cutbacks and increased importation of this commodity to Poland. The domestic demand has been dominated by ***stainless*** and ***alloy steels***. Another important end-uses have included: the production of ***non-ferrous metals alloys*** (e.g.: ***copper-nickel*** and ***nickel-copper***), ***high temperature superalloys***, ***casting alloys***, ***electroplating***, as well as ***vegetable fat hardening***. The largest domestic consumer of nickel in various forms (including scrap of stainless steel and high-nickel alloys) has been the **Arcelor Mittal Poland Huta Warszawa** — the major producer of wide assortment of ***special steels*** (***stainless***, ***bearing***, ***tool***, ***spring***) and ***alloy steel Ni-Cr-Mo***. Relatively small amounts of ***nickel*** have been utilized for rolled products (a few dozen tons per year) at the **Non-Ferous Metals Mill Gliwice-Łabędy** of Gliwice (***strips*** and ***sheets*** made of ***high-nickel brass***), the **Dziedzice Metals Mill** of Czechowice-Dziedzice (***cupro-nickel*** and ***alpaca strips***, as well as ***disks*** made of ***Cu-Ni***, ***Cu-Al-Ni***, ***Cu-Ni-Zn alloys***), **Hutmen** of Wrocław (***strips*** and ***coin disks*** made of ***nickel brass***, ***alpaca***, ***cupronickel***, and ***aluminum bronze***, as well as ***nickeline pipes*** to ***heat exchangers***). Some small amounts of ***nickel metal*** and ***stainless steel scrap*** with min. 9% Ni have been utilized by the **Huta Stali Jakościowych S.A.** of Stalowa Wola – a member of the Polish **COGNOR Capital**

Group – for the production of various grades of steel (***structural***, ***tool***, ***stainless***, and ***heat-resisting***). The list of nickel consumers in Poland have also included: **Ferrostal Łabędy** of Gliwice, **ISD Huta Częstochowa** of Częstochowa, **Batory Steelworks** of Chorzów and **IMN Gliwice** of Gliwice (***strips***, ***wire*** — including ***resistance wire Ni-Cr***).

Companies involved in primary nickel production in Poland, as of December 2013

- KGHM Polska Miedź S.A. w Lubinie (KGHM Polska Miedź Joint Stock Co.), ul. Skłodowskiej-Curie 48, 59–301 Lubin, tel. +48 76 7478200, fax +48 76 7478500, www.kghm.pl — *nickel sulfate*.

NIOBIUM (COLUMBIUM)

Overview

The main sources of **niobium** (**Nb**), also called **columbium** (**Cb**), are ***pyrochlore concentrates*** produced from carbonatite deposits. Additionally, concentrates of ***niobite*** (***columbite***) and ***niobite-tantalite*** are obtained from deposits of placer or vein type. These concentrates are used to produce **niobium pentoxide**, the main commodity for **niobium metal** and high quality **ferroniobium**, whereas pyrochlore is used only for ferroniobium production. Secondary sources — scrap and niobium-bearing waste materials, including ***niobium-bearing tin slag*** — are of less importance.

Niobium is a highly-valued additive for special steels and superalloys, providing them with better strength and corrosion resistance. Due to its important applications in the aerospace industry, armaments, and energy, it is considered a strategic material.

Sources

There are no deposits of ***niobium minerals*** in Poland.

Production

There is no production of ***niobium minerals*** or ***niobium commodities*** in Poland.

Trade

Domestic demand for ***raw niobium***, ***niobium powders***, and ***niobium products*** has been covered by imports, ranging from 9 to 69 kgpy in recent years (Tab. 1). Although this trade is reported under a common CN position with ***rhenium***, the majority have been niobium goods. The most deliveries have been originated from China, the US, Germany, the United Kingdom and Switzerland. Until 2011 small and irregular re-exports have been reported. In 2008 their sole recipient of 6 kg was the United Kingdom, while in 2010 less than 1 kg was sold to Germany (Tab. 1). Since 2011 the total volume of reported exports has consisted of the sales of rhenium, production of which has started in **KGHM Polska Miedź S.A.** (see: **RHENIUM**).

The most important ***niobium commodity*** imported to Poland has been ***ferroniobium***. Variable levels of deliveries, not exceeding 400 tpy, mainly from Brazil, the Netherlands, Belgium, France, and Canada, have been reported in the last years (Tab. 1). There have been also recorded regular re-exports to Spain, the Netherlands, Germany, Ukraine, Czech Republic, and Slovakia.

The balance of ***niobium commodities*** trade has reflected the type and quality of material traded. In the years 2009–2010 it was negative. Since 2011, when exports of

Tab. 1. Niobium commodities statistics in Poland

Year	2009	2010	2011	2012	2013
Niobium and rhenium [kg] **CN 8112 92 31, 8112 99 30**					
Imports	38	34	69	9	49
Exports	–	0	64[1]	4,963[1]	3,031[1]
Consumption[a]	38	34	5	-4,934	-2,982
Ferroniobium CN 7202 93					
Imports	244	392	243	379	278
Exports	48	125	3	11	34
Consumption[a]	196	267	240	368	244

[1] *exports of rhenium*

Source: ***The Central Statistical Office (GUS)***

rhenium from Poland have been started, the trade balance has been permanently positive (Tab. 2). Trade balances of ***ferroniobium*** has been consistently negative (Tab. 2). Unfortunately, in 2010 following the increase in importation, the trade deficit deepened, in spite of record volume of exports. The unit values of niobium commodities imports to Poland have depended on imports volume and prices on international markets (Tab. 3).

Tab. 2. Value of trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Niobium and rhenium CN 8112 92 31, 8112 99 30					
Exports	–	0	54[1]	58,284[1]	34,209[1]
Imports	47	33	29	29	57
Balance	**-47**	**-33**	**+25**	**+58,255**	**+34,152**
Ferroniobium CN 7202 93					
Exports	2,712	7,661	287	977	2,548
Imports	17,637	28,724	17,982	27,326	21,800
Balance	**-14,925**	**-21,063**	**-17,695**	**-26,349**	**-19,252**

[1] *exports of rhenium*

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit values of niobium commodities imports to Poland

Year	2009	2010	2011	2012	2013
Niobium and rhenium CN 8112 92 31, 8112 99 30					
PLN/kg	1,237	978	421	3,225	1,168
USD/kg	383	331	142	978	374
Ferroniobium CN 7202 93					
PLN/t	72,283	73,332	73,958	72,182	78,525
USD/t	24,530	24,492	25,364	21,988	25,043

Source: ***The Central Statistical Office (GUS)***

Consumption

Niobium is consumed almost exclusively as ***ferroniobium*** by the steel industry for the production of stainless and heat-resisting steels, and other high-grade special steels.

NITROGEN

Overview

Nitrogen (**N**) is one of the basic elements critical for life on the Earth in its present forms. The **nitrogen compounds** used as **fertilizers** are commercially the most important. **Ammonia NH_3**, obtained from atmospheric nitrogen and hydrogen coming from natural gas, is the basic material for the production of **nitrogen fertilizers**. It is also one of the most important raw materials for all modern chemistry, including the crucial compound **nitric acid HNO_3**. Both these compounds are used in the production of synthetic fibers for the textile industry, plastics, explosives, and enormous number of chemicals. **Elemental nitrogen**, obtained from atmospheric air or from natural gases, is also widely used, mainly as a protective (inert) gas, or as liquid nitrogen for freezing food products, kriotherapeutic treatments, structural investigations carried out in low temperatures, etc.

Sources

Atmospheric air and nitrified natural gas are the sources of ***elemental nitrogen***. Atmospheric nitrogen and hydrogen from natural gas are the basis for ***ammonia*** production. Ammonia, in turn, is used to produce ***nitric acid***. The last two mentioned compounds, i.e. ammonia and nitric acid, are crucial for the production of ***nitrogen fertilizers***.

Production

Poland is an important producer of ***nitric acid***, ***ammonia***, and ***nitrogen fertilizers***, as well as ***elemental nitrogen*** and other nitrogen compounds.

Between 2009 and 2013 the domestic production of ***elemental nitrogen*** rose from around 1.0 billion m^3py to 1.6-2.0 billion m^3py (Tab. 1). In practice it satisfied the demand of the Polish industry. Supplementary imports decreased from 44.6 kt in 2009 to very few thousand tons in the last three rears. Simultaneously, the exportation of nitrogen were developed, reaching 101 kt in 2013. ***Nitrogen***, ***compressed*** and ***liquid***, has been obtained in commercial gas plants (see: **GASES, COMMERCIAL**), i.e. the **Puławy**, **Tarnów**, and **Kędzierzyn Nitrogen Plants**, as well as in the natural gas denitriding plant of **PGNiG S.A.** (**POGC**) in **Odolanów**. Mixtures of nitrogen and carbonic acid, hydrogen, phosphine, etc. have been also manufactured.

Ammonia has been produced in the **Puławy**, **Kędzierzyn**, **Anwil**, **Tarnów**, **Chorzów**, and the **Police Chemical Plant**. The total production was reduced by almost 20% in the years 2009-2010, with recovery to previous levels since 2011 (Tab. 2). These plants,

Tab. 1. Gaseous nitrogen statistics in Poland — CN 2804 30

'000 t

Year		2009	2010	2011	2012	2013
Production	**[Mm^3]**	1,047.2	984.5	2,021.4	1,596.2	1,605.5
Imports		44.6	16.2	2.0	0.8	2.1
Exports		28.7	52.8	63.4	79.7	101.0

Source: ***The Central Statistical Office (GUS)***

except for the **Police Chemical Plant**, have produced ***nitric acid*** from ammonia. In the last years its production stabilised at 2.3–2.5 Mtpy (Tab. 3).

Tab. 2. Anhydrous ammonia statistics in Poland — CN 2814

'000 t NH_3

Year	2009	2010	2011	2012	2013
Production	1,958.2	2,059.7	2,326.6	2,526.2	2,482.2
— *N content*	*1,697.4*	*1,700.8*	*1,917.6*	*2,026.1*	*2,118.7*
Imports	85.1	97.9	35.4	12.5	3.5
Exports	40.8	71.9	112.2	157.0	147.4
Consumption[a]	2,002.5	2,085.7	2,249.8	2,381.7	2,338.3

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Nitric acid statistics in Poland — CN 2808

'000 t HNO_3

Year	2009	2010	2011	2012	2013
Production	2,139.4	2,209.4	2,168.1	2,322.6	2,279.7
Imports	24.1	19.0	16.6	14.4	16.9
Exports	14.2	18.8	14.0	14.6	26.9
Consumption[a]	2,149.3	2,209.6	2,170.7	2,322.4	2,269.7

Source: ***The Central Statistical Office (GUS)***

Most of the ***ammonia*** and ***nitric acid*** has been utilised in the production of ***nitrogen*** and ***multicomponent fertilizers***. ***Nitrogen fertilizers*** have been offered mainly by the following Nitrogen Plants: **Puławy** (over 40% of the domestic production regarding nitrogen content), **Anwil**, **Kędzierzyn**, **Tarnów**, **Chorzów**, as well as **Police Chemical Plant**. In 2012 Puławy, Tarnów, Kędzierzyn and Police plants were consolidated into **Grupa Azoty** holding group. The proportions of particular fertilizers in the total production in 2013 were as follows: ***urea*** (46% N) — 23%, ***ammonium sulfate*** (21% N) — 11%, ***ammonium nitrate*** (34% N) — 24%, ***nitro-chalk*** (approx. 28% N) — 29%, ***solution of ammonium nitrate*** and ***urea*** (30% N) — 12%. The share of other fertilizers (ammonia water, lime saltpeter, etc.) was insignificant. ***Ammonium nitrate*** has been produced by all four large plants, ***urea*** and ***solution of ammonium nitrate*** - by **Puławy**, **Kędzierzyn**, and **Police**, ***nitro-chalk*** - by **Tarnów, Anwil,** and **Kędzierzyn,** ***ammonium sulfate*** - by **Puławy** and **Tarnów.**

The total domestic production of ***nitrogen fertilizers***, after notable reduction by over 10% to under 4.5 Mtpy in 2009 due to lower exports, since 2010 has recovered approaching 5.5 Mtpy, as a result of higher exports and growing domestic demand (Tab. 4).

Tab. 4. Nitrogen fertilizers statistics in Poland

'000 t

Year	2009	2010	2011	2012	2013
Nitrogen fertilizers CN 3102					
Production	**4,472.4**	**4,709.0**	**4,986.8**	**5,454.5**	**5,407.0**
— containing N	1,466.2	1,491.7	1,609.9	1,741.7	1,720.0
• *urea*	*873.4*	*794.7*	*1,046.1*	*1,207.2*	*1,220.8*
• *ammonium sulfate*	*582.5*	*646.3*	*676.4*	*674.7*	*609.3*
• *ammonium nitrate*	*1,348.4*	*1,322.5*	*1,323.9*	*1,389.4*	*1,272.3*
• *nitro-chalk*	*1,260.9*	*1,474.1*	*1,358.0*	*1,487.3*	*1,568.7*
• *lime saltpeter*	*13.5*	*13.4*	*11.9*	*19.2*	*19.6*
Imports	**699.7**	**620.1**	**740.8**	**813.3**	**768.0**
Exports	**1,202.2**	**1,745.6**	**1,695.2**	**1,854.7**	**1,721.7**
Consumption[a]	**3,969.9**	**3,582.5**	**4,032.4**	**4,413.7**	**4,453.3**
Multicomponent fertilizers CN 3105					
Production	**1,138.5**	**1,941.8**	**2,016.2**	**1,894.1**	**1,406.8**
— containing N	79.6	145.8	156.8	138.8	84.1

Source: ***The Central Statistical Office (GUS)***

Multicomponent fertilizers of type ***NP***, ***NPK***, ***NPKMg***, and the like, are also carriers of nitrogen. They have been produced mainly by the **Police**, as well as the **Fosfory Phosphatic Fertilizers Plant** of Gdańsk, **Siarkopol** of Tarnobrzeg, **Fosfan** of Szczecin, and numerous smaller manufacturers. Their total production collapsed in 2009, primarily in Police plant. In the subsequent three years, their production recovered to 1.9-2.0 Mtpy, but in 2013 it dropped again to 1.4 Mt (Tab. 4). The content of N_2 in multicomponent fertilizers amounted to ca. 84,100 t in 2013 (only 5% of total N_2 supply, the remaining 93% from nitrogen fertilizers).

Trade

Exports and imports in ***elemental nitrogen*** and ***nitric acid*** in general have not exceeded 100,000 tpy. ***Ammonia*** and ***nitrogen fertilizers*** have been exported from Poland in significant amounts. The ***ammonia*** exports have usually exceeded 100,000 tpy, but in the years 2009-2010 they were significantly lower. The main buyers have been the Czech Republic, Slovakia, Sweden, and Germany (Tab. 5). The importation of ***ammonia***, coming from Ukraine, Russia and Belarus, were quite high only in the years 2009-2010 (Tab. 2).

Tab. 5. Polish exports of ammonia, by country — CN 2814

'000 t

Year	2009	2010	2011	2012	2013
Exports	**40.8**	**71.9**	**112.2**	**157.0**	**147.4**
Czech Republic	24.9	36.2	83.1	80.1	27.6
Denmark	1.1	0.0	0.3	0.6	1.3
Finland	-	-	8.0	-	-
France	-	-	8.0	-	18.8
Germany	3.3	2.0	1.2	20.2	20.9
Netherlands	-	-	-	9.0	0.1
Norway	-	-	-	8.0	-
Portugal	-	-	-	-	3.0
Slovakia	5.5	26.2	5.1	15.0	14.1
Spain	-	-	-	-	11.6
Sweden	4.3	5.6	6.1	22.3	49.8
Others	1.7	1.9	0.4	1.8	0.2

Source: ***The Central Statistical Office (GUS)***

The most significant export commodities, i.e. ***nitrogen fertilizers***, have been sold in amount reaching usually 30–40% of the production volume, except for 2009 (Tab. 4). They have been sold not only in Europe, but also in Africa and America. In the last years they varied between 1.2 and 1.8 Mtpy, though in 2009 it was the lowest level over the decade (Tab. 6).

Tab. 6. Polish exports of nitrogen fertilizers, by country — CN 3102

'000 t

Year	2009	2010	2011	2012	2013
Exports	**1,202.2**	**1,745.6**	**1,695.2**	**1,854.7**	**1,721.7**
Argentina	–	5.0	10.0	–	49.2
Austria	18.7	12.6	11.7	35.0	27.0
Belarus	–	–	5.5	16.2	19.0
Belgium	37.3	110.5	80.3	17.5	7.0
Brazil	201.9	173.5	154.8	145.2	169.1
Cameroon	9.9	3.9	10.3	5.0	3.8
Canada	–	0.1	9.8	38.0	11.7
Czech Republic	131.4	96.6	127.1	142.3	185.2
Denmark	96.3	179.4	92.2	97.9	83.1
Estonia	–	–	6.9	20.8	14.2
France	107.6	71.2	151.1	217.4	154.2
Germany	258.1	526.9	539.3	452.5	400.5
Hungary	23.2	16.2	8.2	6.3	13.1
Ireland	3.2	51.4	18.2	2.7	5.8

Italy	11.0	11.9	22.0	22.2	13.7
Ivory Coast	2.1	7.8	–	0.0	12.6
Latvia	6.9	14.1	15.8	11.2	13.3
Lithuania	40.1	51.4	57.2	70.6	63.9
Netherlands	4.7	15.5	12.2	14.3	16.4
Peru	–	–	–	19.8	5.5
Portugal	7.9	12.2	0.5	3.7	3.9
Slovakia	49.3	77.5	75.2	82.1	119.2
Spain	29.1	5.2	1.6	8.1	5.8
Sweden	8.4	87.4	70.3	61.9	37.9
Turkey	41.5	1.4	11.1	19.7	1.4
United Kingdom	11.0	107.0	169.5	249.5	190.2
USA	0.0	–	0.4	2.8	39.4
Others	102.6	106.9	34.0	92.0	55.6

Source: ***The Central Statistical Office (GUS)***

The main purchasers have been Germany, the United Kingdom, the Czech Republic, Brazil, France, and Slovakia (Tab. 6). Among the exported commodities, ***solution of ammonium nitrate*** and ***urea***, ***nitro-chalk***, ***ammonium sulfate***, and ***urea*** have dominated, with minor sales of other grades. Significant amounts of fertilizers have been also imported to Poland — 700,000-800,000 tpy (Tab. 4), mainly from Germany, Russia, Lithuania, and the Czech Republic.

The trade balances of ***ammonia*** have been usually positive, only in the years 2009-2010 they turned negative due to a collapse of exportation (Tab. 7). The trade balance of ***nitrogen fertilizers*** has been positive and sometimes exceeded 1 billion PLN/y. Only in 2009, as a result of low exports volumes and lower prices, it was reduced to below 300 million PLN (Tab. 7, 8).

Tab. 7. Value of ammonia and nitrogen fertilizers trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Ammonia CN 2814					
Exports	47,699	77,959	164,797	251,936	218,402
Imports	82,546	107,115	51,283	19,282	6,662
Balance	**-34,847**	**-29,156**	**+113,514**	**+232,654**	**+211,740**
Nitrogen fertilizers CN 3102					
Exports	828,739	1,162,161	1,616,522	1,873,807	1,619,047
Imports	529,889	455,082	717,043	850,104	777,410
Balance	**+298,850**	**+707,079**	**+899,479**	**+1,023,703**	**+841,637**

Source: ***The Central Statistical Office (GUS)***

Tab. 8. Average unit values of ammonia and nitrogen fertilizers trade in Poland

Year	2009	2010	2011	2012	2013
Ammonia CN 2814					
Average exports unit values					
— PLN/t	1,168.2	1,084.4	1,468.3	1,604.5	1,481.9
— USD/t	366.9	358.7	488.8	490.9	473.8
Average imports unit values					
— PLN/t	970.5	1,094.5	1,448.3	1,541.8	1,918.4
— USD/t	314.4	361.1	503.1	484.6	607.7
Nitrogen fertilizers CN 3102					
Average exports unit values					
— PLN/t	689.3	665.8	953.6	1,010.3	940,4
— USD/t	215.4	221.7	325.1	308.5	299.6
Average imports unit values					
— PLN/t	757.3	733.9	968.0	1,045.2	1,012.2
— USD/t	233.9	247.5	327.0	318.9	324.3

Source: ***The Central Statistical Office (GUS)***

Consumption

Elemental nitrogen is used mainly as an inert protective gas in the chemical industry and electronics, as well as a cooling agent (liquid nitrogen). ***Ammonia*** is used primarily for the production of nitric acid and nitrogen fertilizers. ***Nitric acid*** is utilized predominantly for nitrogen fertilizers, but also for the production of many chemical compounds and explosives.

Nitrogen fertilizers are the most common fertilizers used in Polish agriculture. Domestic consumption has ranged between 3.6–4.4 Mtpy. The record levels of over 4.4 Mtpy were recorded in the last two years (Tab. 4).

Main companies involved in nitrogen and nitrogen compounds production in Poland as of December 2013

- Grupa Azoty Zakłady Azotowe Puławy S.A. w Puławach (Grupa Azoty Puławy Nitrogen Plants Joint Stock Co. of Puławy), Al. Tysiąclecia Państwa Polskiego 13, 24–110 Puławy, tel. +48 81 5652833, fax +48 81 5652856, www.zapulawy.pl — *elemental nitrogen, ammonia, nitric acid, nitrogen fertilizers* (*ammonium nitrate, urea, solution of ammonium nitrate and urea, ammonium sulfate*).
- Grupa Azoty S.A. Zakłady Azotowe w Tarnowie (Grupa Azoty Joint Stock Co. Nitrogen Plants in Tarnów), ul. Kwiatkowskiego 8, 33–101 Tarnów, tel. +48 14 6330781, fax +48 14 6330718, www.grupaazoty.com — *elemental nitrogen, ammonia, nitric acid, nitrogen fertilizers* (*nitro-chalk, ammonium nitrate, ammonium sulfate*).

- Grupa Azoty Zakłady Azotowe Kędzierzyn S.A. w Kędzierzynie-Koźlu (Grupa Azoty Kędzierzyn Nitrogen Plants Joint Stock Co. of Kędzierzyn-Koźle), 47–220 Kędzierzyn-Koźle, ul. Mostowa 30A, tel. +48 77 4812000, fax +48 77 4812999, www.grupaazoty.com — *elemental nitrogen, ammonia, nitric acid, nitrogen fertilizers* (*ammonium nitrate, nitro-chalk, solution of ammonium nitrate and urea, urea*).
- Anwil S.A. we Włocławku (Anwil Joint Stock Co. of Włocławek), ul. Toruńska 222, 87–805 Włocławek, tel. +48 54 2363091, fax +48 24 3677634, www.anwil.pl — *elemental nitrogen, ammonia, nitric acid, nitrogen fertilizers* (*ammonium nitrate, nitro-chalk*).
- Zakłady Azotowe Chorzów S.A. w Chorzowie (Chorzów Nitrogen Works Joint Stock Co. of Chorzów), ul. Narutowicza 15, 41–503 Chorzów, tel. +48 32 7362000, fax +48 32 7362037, www.azoty-adipol.pl — *ammonia, nitric acid, potassium and calcium nitrates*.
- Grupa Azoty Zakłady Chemiczne Police S.A. w Policach (Grupa Azoty Police Chemical Plant Joint Stock Co. of Police), ul. Kuźnicka 1, 72–010 Police, tel. +48 91 3171717, fax +48 91 3173603, www.grupaazoty.com — *ammonia, urea, multicomponent fertilizers*.
- Gdańskie Zakłady Nawozów Fosforowych "Fosfory" Sp. z o.o. w Gdańsku ("Fosfory" Phosphatic Fertilizers Plant Ltd. of Gdańsk), ul. Kujawska 2, 80–550 Gdańsk, tel. +48 58 3438376, fax +48 58 3038555, www.fosfory.pl — *multicomponent fertilizers*.
- Zakłady Chemiczne Siarkopol Tarnobrzeg Sp. z o.o. w Tarnobrzegu (Siarkopol Tarnobrzeg Chemical Plants Ltd. of Tarnobrzeg), ul. Chemiczna 3, 39–400 Tarnobrzeg, tel. +48 15 8565801, fax +48 15 8229797, www.zchsiarkopol.pl — *multicomponent fertilizers.*
- Fosfan S.A. w Szczecinie (Fosfan Joint Stock Co. of Szczecin), ul. Nad Odrą 44/65, 71–820 Szczecin, tel. +48 91 4538394, fax +48 91 4538490, www.fosfan.pl — *multicomponent fertilizers.*
- PGNiG S.A. Oddział w Odolanowie (Polish Oil and Gas Company Joint Stock Co., Odolanów Unit), ul. Krotoszyńska 148, 63–430 Odolanów, tel. +48 62 7364441, fax +48 62 7365989, www. Odolanow.pgnig.pl — *elemental nitrogen liquid*.

For other plants producing *elemental gaseous nitrogen*, see **GASES, COMMERCIAL**.

OIL, CRUDE

Overview

Crude oil, together with natural gas, hard and brown coal, and lignite, is a basic fuel for the world's energy economy. Natural deposits are the only source of **crude oil**. Preliminary processing, i.e. desalination and deemulgation, are needed to lower a water content below 1%. Some types of crude oil require further stabilization by the separation of volatile fractions — ***methane***, ***ethane***, ***propane***, and ***butane*** — which serve both as fuels and as important raw materials for the chemical industry, and are extracted mainly from natural gas. Preliminary **purified crude oil** is the first commercial product, which can be processed into various **petroleum products**, e.g. ***gasoline*** (***petrol***), ***diesel oil***, ***fuel oil***, ***kerosene***, and ***mazout***. These products are used directly or processed into further derivatives.

Currently, petroleum products are consumed mainly by the fuel and power industries (almost 90% of the total consumption). They are also used in the petrochemical industry to produce many **synthetic products** (***fibers***, ***rubber***, ***paints*** and ***lacquers***, ***detergents***, ***drugs***, ***chemicals***, etc.).

Sources

In the 21st century, only two relatively large deposits of ***crude oil*** — called **Lubiatów** and **Grotów** — were discovered in Poland (Lubiatów in 2004, Grotów in 2005), despite intensive exploration works conducted. The prospects for the discovery of significant new crude oil deposits on land are limited. The resources of 83 mostly small deposits recognized in the **Polish Lowland**, the **Carpathian Mountains**, and the **Carpathian Foredeep** were 19.54 Mt, including 7.45 Mt in the **BMB**, 5.09 Mt in the **Lubiatów**, 1.8 Mt in the **Grotów** and 1.31 Mt in the **Cychry** (as of 31 December 2013). Several dozen concessions for exploration of certain promising areas in the Polish Lowland and the Carpathian Foredeep have been granted.

On the **Baltic Sea Shelf** two crude oil and accompanying gas deposits have been recognized — **B3** (operated) and **B8** (under development). Resources of these deposits were 4.84 Mt, including 3.45 Mt in B8 (reserves recalculated in 2009), and 1.39 Mt in B3 (as of 31 December 2013). At present, exploration works have been conducted in the NE area of the Polish economic zone of the Baltic Sea. One of results has been the confirmation of a few potential structures.

In 2012, the Polish Geological Institute reported estimated resources of ***shale oil*** in Lower Paleozoic shales in the Bałtyk-Podlasie-Lublin Basin at max. 535 Mt, but most probably between 215-268 Mt. Moreover, prognostic resources of crude oil in conventional deposits were estimated at ca. 382 Mt (as of 31 December 2009).

Production

In 2013 the production of ***crude oil*** in Poland increased by ca. 41%, to 962 kt (Tab. 1). Offshore production on the Baltic shelf decreased by ca. 22%, and onshore production increased by ca. 66%. The total supply met ca. 4% of the domestic demand for crude oil, and constituted only 1% of the total domestic supply of primary energy in 2013.

Tab. 1. Crude oil statistics in Poland — CN 2709

'000 t

Year	2009	2010	2011	2012	2013
Production	687	687	617	680	962
— *offshore production*	*183*	*186*	*149*	*188*	*146*
— *onshore production*[1]	*504*	*501*	*468*	*492*	*816*
Imports	20,098	22,688	23,792	24,630	23,135
Exports	226	211	292	211	403
Change in stocks	134	325	-52	-52	-509[e]
Consumption[a]	20,425	22,839	24,169	25,151	24,203

Source: ***The Central Statistical Office (GUS),*** [(1)] ***POGC***

The deposits located in the **Polish Lowland** have supplied ca. 94% of the onshore oil output. These have been operated by the **Polish Oil and Gas Company** (**POGC**) — **Zielona Góra Unit**. **POGC — Sanok Unit**, has operated the deposits in the **Carpathians** (ca. 3% of the terrestrial production) and the **Carpathian Foredeep** (ca. 3%). In 2013 new **Lubiatów-Międzychód-Grotów – LMG** mine was commenced to extract **Lubiatów** and **Grotów** deposits. Total output of LMG mine amounted to 325 kt, including 304 kt from Lubiatów deposit. The onshore production rose up to 816 kt. According to the strategy of POGC, the onshore crude oil production should increase to ca. 1 Mtpy until 2015 owing to further development of **LMG** and **BMB** mines. The **B3** deposit in the **Baltic Sea Shelf** is operated by the **LOTOS Petrobaltic** (**LOTOS Capital Group**). It intends to expand production volume considerably, basing on **B3** and **B8** deposits, and maybe on other potential structures.

Trade

In the years 2010–2012 ***crude oil*** imports to Poland increased by 22%, to ca. 24.6 Mt, but in 2013 it was reduced by 6%. In 2013 ca. 98% of deliveries came from Russia and Norway, the rest - from the United Kingdom, Kazachstan, and Lithuania (Tab. 2). It should be mentioned that last year all the imports from Russia were realized through brokers from Cyprus, Bermudas, Virgin Islands, Germany, Switzerland, and the United Kingdom. All imported oil from Russia and Kazachstan has been delivered through the **Przyjaźń** pipeline to Płock (throughput 50 Mtpy). The rest has been delivered by sea. In 2013 ***crude oil*** exports rose to 0.4 Mt, and was directed mostly to Germany.

The trade balance in ***crude oil*** has been extremely negative (Tab. 3). In the years 2009–2012 the trade deficit deepened, exceeding 63 billion PLN in 2012. It was a result of rising world oil prices, as well as increase in importation. In 2013, as imports volumes and prices were reduced, it improved to ca. 56 billion PLN (Tab. 3, 4).

Tab. 2. Polish imports of crude oil, by country — CN 2709

'000 t

Year	2009	2010	2011	2012	2013
Imports	**20,098**	**22,688**	**23,792**	**24,630**	**23,135**
Algeria	424	–	–	–	–
Belarus	372	0	160	–	–
Colombia	–	97	–	–	–
Denmark	0	85	–	–	0
Iran	–	–	124	–	–
Iraq	–	–	–	120	–
Kazakhstan	7	–	0	0	105
Lithuania	–	–	–	–	45
Norway	275	1,142	1,336	716	756
Saudi Arabia	–	–	–	59	–
South Africa, Republic of	131	–	–	–	–
Russia	18,574	20,761	21,086	23,618	21,977
Tunisia	–	–	–	103	–
United Kingdom	163	0	158	0	247
Unknown country[e]	143	600	920	–	–
Others	9	3	8	14	5

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Value of crude oil trade in Poland — CN 2709

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	250,000[e]	340,000[e]	700,000[e]	566,690	1,049,732
Imports	26,092,513[e]	38,190,715[e]	54,939,232[e]	63,891,033	56,823,596
Balance	**-25,842,513[e]**	**-37,850,715[e]**	**-54,239,232[e]**	**-63,324,343**	**-55,773,864**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Average unit values of crude oil imports to Poland — CN 2709

Year	2009	2010	2011	2012	2013
PLN/t	1,298.3[e]	1,683.3[e]	2,309.1[e]	2,682.9	2,456.2
USD/t	422.7[e]	555.6[e]	786.2[e]	822.5	780.2

Source: ***The Central Statistical Office (GUS)***

Consumption

Crude oil's share in the structure of domestic primary energy consumption amounted to 23%. All crude oil is processed to ***petroleum products***: ***fuels*** — gasoline (petrol), diesel oil, fuel oil, liquefied petroleum gas, etc., and ***non-fuels***: asphalts, motor-oils, lubricants, paraffin, kerosene, solvents, etc. As in other developed countries, over 80% of the Polish demand for ***petroleum products*** has been met by domestic producers.

Crude oil is processed in 4 refineries, with a total capacity of ca. 27.25 Mtpy. The largest facilities are the **Płock Refinery** (capacity of 16.3 Mtpy) and the **Gdańsk Refinery** (10.5 Mtpy). Other smaller refineries, i.e. **Trzebinia** (0.36 Mtpy) and **Jedlicze** (0.09 Mtpy), supplement the production of basic fuels (i.e. gasoline, diesel oil, and fuel oil) with over 300 specialized petroleum products (so-called niche products).

The shortage of ***petroleum products*** on the domestic market, especially liquid and gas fuels, has been supplemented by imports. It is especially the case of ***diesel oil***. On the contrary, Poland has been the net exporter of ***fuel oil*** (Tab. 5).

Tab. 5. Principal petroleum products statistics in Poland

'000 t

Year	2009	2010	2011	2012	2013
Gasoline (petrol)					
Production	4,271	4,210	3,904	4,009	4,021
Imports	492	415	530	437	414
Exports	369	463	518	678	872
Consumption[a]	4,394	4,162	3,916	3,768	3,563
Diesel oil					
Production	8,901	9,742	10,652	10,854	10,840
Imports	2,227	2,355	1,942	1,419	941
Exports	128	43	127	337	624
Consumption[a]	11,000	12,054	12,467	11,936	11,157
Fuel oil					
Production	3,818	4,354	4,212	4,546	4,285
Imports	93	102	77	73	129
Exports	1,059	1,633	2,054	2,310	2,592
Consumption[a]	2,852	2,823	2,235	2,309	1,822

Source: ***The Central Statistical Office (GUS)***

As a result of long process of Polish oil industry restructurisation, significant changes in the organisation and ownership structure of this branch occurred. Currently, two main companies are involved in crude oil processing and oil products manufacturing in Poland. i.e. the **Polish Oil Company — PKN ORLEN** (with **Płock**, **Trzebinia**, and **Jedlicze** refineries) and **LOTOS Capital Group — GK Grupa LOTOS** (**Gdańsk** refinery, and **LOTOS Petrobaltic**).

Storage and pipeline transportation of crude oil through **Przyjaźń** pipeline (in the Polish part) and **Pomorski** pipeline (between Gdańsk and Płock), as well as pipeline transportation of petroleum products, has been managed by the **PERN Przyjaźń** (100% State Treasury property). In the area of trans-shipment, transportation and storage of crude oil and petroleum products, a few companies were established in Poland. **PPS Port Północny** has been engaged in trans-shipment of oil and oil products in the **Liquid Fuels Basis** (100% **Naftoport** – 67% PERN Capital Group) in the Północny Port in Gdańsk of capacities of 34 Mtpy. Petroleum products stores in the Poland have been managed by the **OLPP** (100% PERN Capital Group). Rail transportation has been realized by: **GATX**

Rail Poland (former DEC, owned by GATX Corp. of US), **Orlen KolTrans** (100% **PKN ORLEN**) and **LOTOS Kolej** (100% **LOTOS Group**), and others. Petroleum products from Płock refinery have been partly transported by pipelines to **OLPP** stores in Rejowiec, Nowa Wieś Wielka, Boronów, Koluszki, Emilianów, and Mościska, and to Underground Oil and Fuel Store PKN ORLEN in Góra. The remaining Płock refinery products, as well as products from other refineries, have been transported by rail tanks of Orlen, Lotos or GATX, as well as by car tanks. Petroleum fuels distribution has been provided by over 6,745 petrol stations. The largest part of them belongs to PKN ORLEN (ca. 1,778) and LOTOS Group (ca. 439). The rest has been owned by private domestic and international companies, such as: **British Petroleum** (ca. 461), **Shell** (ca. 378), **Statoil** (ca. 354), **Lukoil** (ca. 116, together with former stations of ConocoPhillips — Jet brand), **Neste** (ca. 106), and others.

Recycling

The only petroleum products which can be recycled are ***lubricants***, which are recycled in the course of purification, distillation, and refining at the **Jedlicze Refinery** of recycling capacity ca. 140 ktpy. The Jedlicze Refinery introduced a new recycling program of lubricants, with ca. 15 companies dealing with buying up of used lubricants, all over Poland.

Companies involved in crude oil production in Poland, as of December 2013

- Polskie Górnictwo Naftowe i Gazownictwo S.A. w Warszawie (Polish Oil and Gas Company Joint Stock Co. of Warsaw), ul. Krucza 6/14, 00–537 Warszawa, tel. +48 22 5835000, fax +48 22 6918273; www.pgnig.com.pl — *crude oil.*
- LOTOS Petrobaltic S.A. w Gdańsku (LOTOS Petrobaltic Joint Stock Co. of Gdańsk), ul. Stary Dwór 9, 80–958 Gdańsk, tel. +48 58 3013061–5, fax +48 58 3014311, www.lotos.pl — *crude oil.*

PEAT

Overview

Peat is a mineral of organic origin, usually formed in cold, anaerobic, and extremely moist conditions. In its natural state, it usually contains 86–95% water.

There are many classifications of **peat**, based on botanical, physical, mechanical, geomorphological, genetical, or mixed criteria. For economic purposes, however, only two types are important: **fuel peat** and **horticultural peat**, used in agriculture, gardening, pomiculture, and medicine, and also (to a small extent) in the chemical industry.

Only **peat products** for agriculture, pomiculture, gardening, etc. are traded commercially. Polish standards distinguish the following peat types: **gardening peat**, **peat substrate**, **mineral peat mixes**, and **agricultural peat**, offered in bales or bags.

Sources

There are over 50,000 known occurrences and deposits of ***peat*** in Poland (a surface area of approx. 1.2 million ha), the resources of which amount to 17,000 Mm^3. In 2013, only 279 of these — with resources of 80.21 Mm^3, including 30.97 Mm^3 of available reserves (as of 31 December 2013) — were listed in the **Mineral Resources Datafile**. Over 93% of the known deposits are in the northern and central parts of the country. Small deposits, the area of which does not exceed 100 ha, are the most common (over 90% of the total number of deposits).

Production

In comparison to peat resources, its production in Poland is very limited, partly due to environmental restrictions. In the years 2011–2013, 91 deposits were developed and 65 deposits were extracted. In 2013 mining output of ***raw peat*** amounted to 1,205,200 m^3 (Tab. 1). The production of the majority of peat mines has been around several thousand tpy, and only in a few of them it has exceeded 50 ktpy. The largest producers have been: **Wokas** of Łosice with 9 mines in Lubuskie, Lubelskie, Podlaskie, Mazowieckie and Warmińsko-Mazurskie voivodeships (the total output 200,000–250,000 m^3py), **Hollas** of Pasłęk with four mines in Warmińsko-Mazurskie and Pomorskie voivodeships (160,000–230,000 m^3py) and **Karaska Peat Plant** of Łomianki with two mines in Mazowieckie voivodeship (130,000–180,000 m^3py). The production of ***commercial peat*** has usually constituted 55–70% of the mining output (Tab. 1).

Trade

Agricultural and ***horticultural varieties of peat*** have been traditionally exported to various European countries. They have been much dispersed. In the years 2011–2013 the

Tab. 1. Statistics on peat and peat products in Poland — CN 2703

'000 t

Year		2009	2010	2011	2012	2013
Mining output	['000 m^3]	1,151.5	985.5	1,214.0	1,220.7	1,205.2
Production		620.0	671.6	746.0	758.8	817.8
Imports		164.4	211.7	204.9	183.9	149.7
Exports		51.7	44.4	34.9	41.7	39.2
Consumption[a]		732.7	838.9	916.0	901.0	928.3

Source: ***The Central Statistical Office (GUS)***

main customers were Italy, Germany, Ukraine, Belarus, and - recently United Kingdom, Lithuania and Latvia (Tab. 2). Simultaneously, imports of ***peat products*** have been continuously increasing from Latvia, Lithuania, Belarus, Germany, and Ukraine (Tab. 3).

Tab. 2. Polish exports of peat and peat products, by country — CN 2703

'000 t

Year	2009	2010	2011	2012	2013
Exports	**51.7**	**44.4**	**34.9**	**41.7**	**39.2**
Belarus	2.0	3.3	3.7	4.6	5.1
Croatia	1.6	0.1	0.1	0.1	0.0
Germany	1.5	1.8	5.6	5.9	9.5
Italy	37.1	29.2	15.0	13.4	11.7
Latvia	–	0.0	0.0	0.3	2.6
Lithuania	0.0	3.6	0.0	2.9	0.0
Malaysia	0.5	0.7	0.2	0.3	0.2
Moldova	0.1	0.2	0.2	0.5	0.6
Netherlands	–	1.1	4.4	0.0	0.0
Oman	0.1	0.1	0.1	0.1	0.1
Russia	0.2	0.0	0.0	0.5	0.4
Slovenia	3.4	1.1	0.0	–	–
Spain	0.1	–	–	–	–
Ukraine	5.0	2.8	5.3	3.3	7.2
United Kingdom	–	–	0.0	9.5	1.1
Others	0.1	0.4	0.3	0.3[r]	0.7

Source: ***The Central Statistical Office (GUS)***

The trade balances in ***peat*** and ***peat products*** have been negative. In recent years, this deficit has deepened (Tab. 4), mainly due to growth in importation. Until 2012 exports unit values have been higher than imports unit values, but in 2013 it changed (Tab. 5).

Consumption

Low and transient peats with a moisture content of 60–70% are used to produce ***agricultural peat***, ***peat compost***, and ***peat flower-pots***. Low, high, and transient peats

Tab. 3. Polish imports of peat and peat products, by country — CN 2703

'000 t

Year	2009	2010	2011	2012	2013
Imports	**164.4**	**211.7**	**204.9**	**183.9**	**149.7**
Belarus	42.3	73.1	56.1	41.2	15.1
Czech Republic	0.7	0.5	0.0	0.0	0.0
Denmark	0.1	0.2	–	0.2	1.1
Estonia	3.0	3.6	4.3	3.2	2.2
Finland	0.0	0.0	–	0.1	0.0
Germany	21.1	25.0	28.3	21.7	25.8
Italy	1.3	–	2.0	–	–
Latvia	51.3	51.0	35.9	51.7	54.5
Lithuania	35.8	42.4	36.5	58.2	44.1
Netherlands	0.3	1.3	0.4	0.1	0.1
Russia	2.4	2.1	1.6	2.2	2.8
Ukraine	5.9	12.4	39.6	5.3	1.5
United Kingdom	–	–	–	–	2.3
Others	0.2	0.1	0.2	0.0	0.2

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Value of peat and peat products trade in Poland — CN 2703

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	23,066	19,797	12,156	14,471	14,428
Imports	45,964	51,341	57,212	55,107	55,848
Balance	**-22,898**	**-31,544**	**-45,056**	**-40,636**	**-41,420**

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Average unit values of peat and peat products trade in Poland — CN 2703

Year	2009	2010	2011	2012	2013
Exports unit values					
PLN/t	446.1	445.7	348.2	347.1	367.7
USD/t	142.2	148.0	121.5	106.6	117.1
Imports unit values					
PLN/t	279.6	242.5	279.2	299.7	373.2
USD/t	89.8	80.7	96.1	91.8	118.7

Source: ***The Central Statistical Office (GUS)***

containing 40–50% of water are processed into ***horticultural peat***, ***peat substrate***, and ***mineral peat mixes***, sold in bales, bags, or bulk. Therapeutic peat grades should meet specific requirements, as they have been documented and exploited only for this purpose. They are used to make ***peat bath***, ***therapeutic paste***, ***dressings***, and ***therapeutic preparations***, including the ***Tołpa preparation*** used in the treatment of cancer.

Principal companies involved in peat production in Poland, as of December 2013

- Hollas Sp. z o.o. w Pasłęku (Hollas Ltd. of Pasłęk), ul. 3 Maja 30, 14–400 Pasłęk, tel. +48 55 2482000, fax +48 55 2482009, www.hollas.pl
- Wokas S.A. w Łosicach (Wokas Joint Stock Co. of Łosice), ul. Błonie 5A, 08–200 Łosice, tel./fax: +48 83 3590555, www.wokas.pl
- Torfex Sp. z o.o. w Niedrzwicy (Torfex Ltd. of Niedrzwica), Niedrzwica 25, 19–500 Gołdap, tel./fax +48 87 6153945, www.torfex.pl
- Zakład Torfowy Karaska w Łomiankach (Karaska Peat Plant of Łomianki), ul. Partyzantów 35, 05–092 Łomianki, tel./fax +48 22 7512269, www.karaska.pl
- Lasland Sp. z o.o. w Gródach (Lasland Ltd. of Gródy), Gródy, 72–342 Cerkwica, tel. +48 91 3867776
- Zakład Produkcji Torfowej Torf Sp. z o.o. (Torf Ltd. Peat Production Plant), Nowy Chwalim, 78–460 Barwice, tel./fax +48 94 3736383, www.torf.home.pl
- Bio-Produkty Sp. z o.o. Athena (Bio-Produkty Ltd. Athena), ul. Piramowicza 16A, 71–157 Szczecin, tel. +48 91 3860117, www.athena.com.pl
- Agromis S.C. Przedsiębiorstwo Wielobranżowe (Agromis Multitrade Company civil partnership), Łochowice 36, 86–065 Łochowo; tel. +48 52 3202935, fax +48 52 3202936, www.agromis.pl
- Atlas Planta S.C. (Atlas Planta civil partnership), ul. Przemysłowa 8, 85–758 Bydgoszcz; tel./fax +48 52 3421902, www.atlas-planta.pl

PERLITE

Overview

Perlite is rhiolithic volcanic glass, whose volume increases considerably (even fifteen times) when roasted at 800–1,100°C. In this way **expanded perlite** is obtained (with a volume density of 55–500 kg/m^3), useful primarily as insulating material and light aggregate, and also as absorbent and filtering material. In the majority of its applications it can be replaced with ***vermiculite***, ***pumice***, ***diatomite***, or related materials.

Sources

Perlite deposits do not occur in Poland.

Production

Raw perlite is not produced in Poland. The total production level of ***expanded perlite*** is impossible to assess, because — according to the Central Statistical Office classification — it is recorded together with other porous minerals in one **PKWiU** item **23.99.19.20**. It is possible however to estimate the production level based on the data obtained from domestic manufacturers - in recent years it could reach 350,000-450,000 m^3/y.

The largest supplier of ***expanded perlite***, which offers products for construction, filtration and agricultural, is **Perlipol** in **Belchatów**, which bases on the raw material imported mainly from Hungary and Slovakia. In the plant, which was opened in 2005, there are three production lines for expanding perlite in operation, with total capacities amounting to ca. 300,000 m^{3}py. Due to increasing supply for building perlite, which has made recently about 90% of total company's supply, its production grew to the level of 250,000-270,00 m^{3}py in 2011-2013; almost all (95%) was sold on the domestic market. Besides the construction grades, the company offers perlite for horticulture (about 9% in 2013) and filtration applications.

The second largest manufacturer and Polish pioneer in the production of expanded perlite is the **Zębiec Mining and Metal Works** of **Starachowice,** which imported expanded crude perlite from Hungary already since 1999. After modernization of the expanding installation and start of agroperlite manufacturing for horticultural applications, the company's production capacity rose to about 180,000 m^3/y, and production in 2011-2013 reached the level of 66,000–75,000 m^{3}py (i.e. ca. 6,600–7,700 tpy). Perlite is manufactured there in four grades of: **0** (max. bulk density of 120 g/m^3) and **I-III** (max. 100, 150, and 180 g/m^3). Almost 85% of its production is consumed in building applications, in smaller amounts in agiculture, horticulture and metallurgy as insulation filler.

Since 2007 the **PTH Certech** company in Niedomice near Tarnów has produced perlite for agriculture and horticulture application based on the raw perlite from the Lehotka deposit in central Slovakia. The production volume of the plant in recent years ranged from 3,200-4,000 m^3py, while the level of raw materials imports reached 326-420 tpy. In the same year, the production line of expanded perlite for construction application, with the installed capacity of ca. 50,000 m^3py, was constructed by **Piotrowice II** in Tarnobrzeg. The production based on Hungarian raw material ranging between 20,000 to 30,000 m^3 per year in 2011-2012 depending on consumer demand, slightly decreased to 18,000 m^3 in 2013. Small amounts were exported. In September 2012, the next modern plant of expanded perlite was opened in **Kazimierz Biskupi**, near Konin by **Perlit AF**, whose main shareholder is the Polish company **Atlas**. The plant uses the Hungarian raw material and it was launched with the participation of the Hungarian mining company capital. Its production reached 4,000 m^3 in the year of commissioning, but next year it achieved 70,000 m^3, whereas the target production capacity is about 80,000 m^3py. Perlite produced there is mainly used for building applications, not only for internal purposes of Atlas Group. ***Expanded perlite*** based on Hungarian raw materials is also produced in the plant of **Knauf Jaworzno III**. Almost all final products are used for the plant's internal dry plasters production, but in small amount they are also exported to another Knauf's plant in Riga.

Trade

Imports of perlite (non-porous) is reported in the common CN 253010 position with vermiculite and chlorite, but perlite dominates there. The importation of ***perlite*** has shown a strong growth in recent decade (Tab. 1). Development of domestic production of ***expanded perlite*** in **Zębiec**, **Perlipol**, **PTH Certech**, and **Piotrowice II**, as well as new opened **Perlit AF** were the main reasons of growth in imports, especially of ***raw perlite***. Additionally, another Polish company **Perlit-Polska**, which previously imported expanded perlite from the Czech Republic, Hungary and Slovakia, recently purchased an expanding plant in Novy Jicin in the Czech Republic. The production plant with capacity of 100,000 m^3py supplies expanded perlite mainly for construction (80%) and horticulture applications. A part of expanded perlite manufactured there is sold on Polish markets.

Tab. 1. Perlite statistics in Poland — CN 2530 10 10

t

Year	2009	2010	2011	2012	2013
Imports	**21,568**	**24,542**	**25,476**	**24,914**	**22,417**
Bulgaria	–	–	–	–	770
Belgium	13	–	–	–	273
China	–	82	96	22	22
Czech Republic	33	38	27	28	26
France	–	0	65	319	153
Germany	242	379	498	354	324
Hungary	13,256	13,141	16,979	20,663	16,838

Italy	24	24	–	–	21
Netherlands	14	8	–	9	11
Slovakia	7,901	10,723	7,667	3,237	3,541
Turkey	84	–	88	154	88
Uganda	–	–	–	–	100
United Kingdom	–	97	5	–	–
USA	–	1	22	30	95
Uzbekistan	–	–	–	20	107
Others	1	49	22	30	95
Exports	**56**	**78**	**204**	**188**	**377**
Consumption[a]	**21,512**	**24,464**	**25,272**	**24,726**	**22,040**

Source: ***The Central Statistical Office (GUS)***

In the last five years, imports of perlite rose to the level of 25,400 t in 2011, with small (2%) decrease in 2012, and much visible reduction (10%) in 2013 (Tab. 1). The majority of deliveries was coming from Hungary (75% of imports in 2013), for Zębiec, Knauf and Piotrowice II, and recently Perlit AF companies. Since 2010, the import from Slovakia has decreased significantly, and in 2013 its share in total imports accounted only 16% (Tab. 1). Some occasional re-exports of small amounts of perlite occurred (including ***expanded perlite***), as well as exports of this material from the plant of **Knauf Jaworzno III** and **Zębiec** to Lithuania and Belarus. The trade balance in ***perlite*** was always negative and in the last years it deepened as a result of the increasing importation volume, except for 2013, when exports increased more than twice compared to 2012 (Tab. 2).

Tab. 2. Value of perlite trade in Poland — CN 2530 10 10

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	163	138	289	295	1,221
Imports	6,156	7,288	7,518	8,078	8,898
Balance	**-5,993**	**-7,150**	**-7,229**	**-7,783**	**-7,677**

Source: ***The Central Statistical Office (GUS)***

The average unit values of perlite imports refers to all grades of raw material, crude and expanded. Recently, due to the commencement of expanded perlite in Poland they refers mainly to crude perlite. Since 2008 the importation unit values has shown significant rising tendency, with the exception of a slight decrease in 2011 (Tab. 3).

Tab. 3. The unit values of perlite imports to Poland — CN 2530 10 10

Year	2009	2010	2011	2012	2013
PLN/t	285	297	295	324	397
USD/t	92	98	101	99	126

Source: ***The Central Statistical Office (GUS)***

Consumption

The major market for ***expanded perlite*** in Poland is the construction industry — for thermal and acoustic insulation products, and lightweight component of gypsum plasters, in metallurgy — for insulation casting powders, and insulation refractories (perlite bricks), in the food industry — as a filter aid. At a limited scale it is also utilised as horticultural aggregate.

Companies involved in perlite production in Poland, as of December 2013

- P.P.H.U. Perlipol s.c., 97–400 Bełchatów, ul. Przemysłowa 4, tel. +48 44 6333398, fax. +48 44 6332408, www.perlipol.pl — *expanded perlite*.
- Zakłady Górniczo-Metalowe Zębiec S.A. w Zębcu (Zębiec Mining and Metal Works Joint Stock Company in Zębiec), 27–200 Starachowice, tel. +48 41 2747045, fax +48 41 2746177, www.zebiec.com.pl — *expanded perlite*.
- P.T.H. Certech, 33–132 Niedomice, ul. Fabryczna 36, tel./fax +48 14 6458703, www.certech.com.pl — *expanded perlite.*
- Zakład Surowców Chemicznych i Mineralnych Piotrowice II (Piotrowice II Chemical and Mineral Raw Materials Production Works Ltd.), 39–400 Tarnobrzeg, ul. Zakładowa 1, tel. +48 15 6415804, fax +48 15 6415805, www.piotrowice.com.pl — *expanded perlite.*
- Knauf Jaworzno III Sp. z o.o. (Knauf Jaworzno III Ltd.), 43–603 Jaworzno, ul. Promienna 51, tel. +48 32 7549 900, fax. +48 32 7549 902, www.knauf.pl — *expanded perlite.*
- Perlit AF Sp. z o.o. (Perlit AF Ltd.), 62-530 Kazimierz Biskupi, Kamienica 47, tel.+48 601 826 615, fax +48 63 241 22 74 — *expanded perlite*

PHOSPHATES

Overview

Phosphorus (**P**) and its compounds are obtained mainly from deposits of phosphate, apatite, and guano. The **apatite** deposits are richest in phosphorus; they contain ***fluoric apatite***, which is barely soluble in ground water and not absorbed by plants. Concentrates with 33–40% P_2O_5 are processed into phosphate fertilizers, which contain phosphate in an easily soluble and consumable form. **Phosphate** deposits are most common and occur widely around the world. They contain ***carbonate*** and ***hydroxilic apatite*** soluble in ground water and absorbed by plants. The concentrates contain 30–38% P_2O_5. In well-developed countries, animal bones are processed into bone meal, a high quality ***calcium-phosphate fertilizer***.

Sources

Deposits of ***phosphate concretion***, averaging 14% P_2O_5, were recognized in the NE part of the **Świętokrzyskie Mountains**. The resources of 10 deposits there amounted to 42.4 Mt of ***phosphates*** (7.35 Mt P_2O_5), including 10.77 Mt (1.47 Mt P_2O_5) in the formerly-mined deposits at **Annopol** (1924–1970) and **Chałupki** (1936–1956). These resources were determined on the basis of the economic criteria used in the 1950s. However, in the early 1980s, when the new criteria were introduced, the economic value of these deposits became negligible due to quality of phosphate rock and depth of deposits.

Production

Currently, there is no production of ***phosphates*** in Poland.

Trade

The demand for phosphorus-bearing raw materials has been satisfied entirely by imports (Tab. 1), consisting primarily of ***phosphate concentrates*** (32–33% P_2O_5), mainly from Algeria, Egypt, Morocco, Tunisia, Syria, and sometimes from other countries (Tab. 2). Crisis on the world fertilizers market, reported since the second half of 2008, has been also felt on the domestic market. In 2009 imports of calcium phosphates for the production of ***phosphates fertilizers and multicomponent fertilizers*** collapsed, to only 459 kt (Tab. 1). It has been the lowest level since the early 1970s. In 2010 domestic demand for fertilizers recovered, and as a consequence the importation of phosphates jumped to 1.3 Mt. In 2011 imports increased again to 1.4 Mt, while the last two years brought the reduction of deliveries, to 0.95 Mt in 2013. Small amounts of phosphates have been re-exported, mainly to the Czech Republic and Germany. Moreover, ***elementary***

phosphorus (yellow) has been imported at variable level of 9–25 ktpy (Tab. 5), almost exclusively from Kazakhstan.

Tab. 1. Natural calcium phosphates statistics in Poland — CN 2510

'000 t (gross weight)

Year	2009	2010	2011	2012	2013
Imports	459	1,302	1,438	1,238	949
Exports	0	0	0	0	1
Consumption[a]	459	1,302	1,438	1,238	948
— *P_2O_5 content*[e]	*149*	*423*	*467*	*402*	*308*

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Polish imports of natural calcium phosphates, by country — CN 2510

'000 t (gross weight)

Year	2009	2010	2011	2012	2013
Imports	**459**	**1,302**	**1,438**	**1,238**	**949**
Algeria	45	223	243	391	369
Egypt	–	6	173	336	141
France	0	–	–	7	–
Israel	31	14	45	80	74
Morocco	29	292	405	254	146
Netherlands	2	35	3	3	–
Senegal	–	–	–	–	88
Syria	162	321	292	67	107
Togo	–	–	116	75	23
Tunisia	189	410	160	25	–
Others	1	1	1	0	1

Source: ***The Central Statistical Office (GUS)***

The balance of ***natural calcium phosphates*** trade has been constantly negative. In 2009, due to collapse in importion and lower import unit values, negative trade balance was reduced to only 163 million PLN (Tab. 3). In 2010 unit values decreased, but due to imports growth the trade deficit rose to 412 million PLN. In 2011 and 2012 imports unit values increased what resulted in deepening of the deficit to almost 700 million PLN. In 2013, import unit values and import volumes declined, so the trade deficit was limited to 383 million PLN (Tab. 3, 4).

Tab. 3. Value of natural calcium phosphates trade in Poland — CN 2510

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	6	41	399	108	1,546
Imports	163,181	411,764	684,027	699,020	384,069
Balance	**-163,175**	**-411,723**	**-683,628**	**-698,912**	**-382,523**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Average unit values of natural calcium phosphates imported to Poland — CN 2510

Year	2009	2010	2011	2012	2013
PLN/t	355.6	316.3	475.7	564.7	405.0
USD/t	113.6	104.1	156.1	172.8	128.8

Source: ***The Central Statistical Office (GUS)***

Consumption

The consumption of imported ***phosphate*** has been determined by the demand from agriculture, as well as by the production capacities of the six domestic manufacturers of ***phosphate*** and ***multicomponent fertilizers***. Rapid growth of prices of all raw materials necessary for production of phosphate and multicomponent fertilizers, observed in 2008, resulted in drop of domestic agriculture demand for such fertilizers. This tendency was continued in 2009, in spite of the fact, that world ***calcium phosphates*** prices were distinctly lower than in 2008. As a result, in the years 2008–2009 sold production of ***phosphate fertilizers*** (over 99% to ***superphosphates***) decreased by 77%, while sales of ***multicomponent fertilizers*** by 68% (regarding P_2O_5 content). These facts influenced over 70% drop of demand and production of ***phosphoric acid*** (Tab. 5). In 2010 the situation in domestic agriculture improved, fertilizers prices were reduced, while food prices generally rose. As a result, demand for fertilizers rose, and imports of phosphates also increased. In the years 2010-2011 the production of ***phosphate fertilizers*** rose by 150% (in P_2O_5 content), ***multicomponent fertilizers*** - by 173% (in P_2O_5 content), and ***phosphoric acid*** - by 130%. In 2012–2013, the demand and production of ***phosphoric acid*** was reduced by 30-37%, the production of ***multicomponent fertilizers*** was reduced by 19%, while the output of ***phosphate fertilizers*** went down by 16%, though demand rose by 17%, with lower exports volume (Tab. 5). The only chemical plant processing ***elementary phosphorus*** into ***phosphoric acid*** and ***phosphorus compounds*** (mainly ***sodium tripolyphosphate***), has been the **Alwernia Chemical Plant**.

The processing of phosphates causes many ecological problems, due to ***phospho-gypsum*** waste material storage. These wastes, properly processed, could be a source of ***gypsum*** (see: **GYPSUM AND ANHYDRITE**). The phosphate and apatite imported to Poland contain some amounts of ***fluorine***, ***uranium***, and ***rare earth elements***, which should be recovered or neutralized; otherwise, they considerably contaminate the environment. In recent years some research works related to recovery of rare earth elements from phospho-gypsum and neutralisation of the remaining wastes have been carried on. Gases generated during the manufacturing of phosphoric acid and phosphate fertilizers contain fluorine, which is harmful to atmosphere. Up till now, installations for its recovery and the production of fluorine compounds were commenced only in three plants, i.e. **Siarkopol Tarnobrzeg Chemical Plant** producing ***cryolite*** (see: **FLUORITE**), **Luvena** (former **Luboń Chemical Works**) — ***hydrogen fluoride***, and **Police Chemical Works** — ***sodium fluosilicate***.

Tab. 5. Phosphorus commodities statistics in Poland

'000 t

Year		2009	2010	2011	2012	2013
Elementary phosphorus CN 2804 70						
Imports		9	13	15	15	25
Exports		2	2	1	0	4
Consumption[a]		7	11	14	15	21
Phosphoric acid CN 2809 20						
Production	*[P_2O_5]*	141	293	320	271	224
Imports		7	19	24	32	16
Exports		17	20	36	27	45
Consumption[a]		131	292	308	276	195
Phosphate fertilizers CN 3103						
Production, sold		50	104	115	110	97
— *P_2O_5 content*		*14*	*31*	*35*	*34*	*28*
Imports		10	16	3	3	5
Exports		17	49	48	33	20
Consumption[a]		43	71	70	80	82
Multicomponent fertilizers CN 3105						
Production, sold		1,189	1,746	1,849	1,722	1,500
— *P_2O_5 content*		*135*	*329*	*368*	*317*	*249*

Source: ***The Central Statistical Office (GUS)***

Main companies involved in phosphoric acid and phosphate fertilizers production in Poland, as of December 2013

- Grupa Azoty Zakłady Chemiczne Police S.A. (Grupa Azoty Police Chemical Plant Joint Stock Co. of Police), ul. Kuźnicka 1, 72–010 Police; tel. +48 91 3171717, fax +48 91 3173603; www.grupaazoty.pl — *phosphoric acid, multicomponent fertilizers NPS, NPKS, NPKMg, NPKMgS, NPKNaS, PK, PKMgS, NP.*
- Grupa Azoty GZNF Fosfory Sp. z o.o. Gdańsk Zakłady Nawozów Fosforowych (Grupa Azoty Fosfory Phosphate Fertilizers Plant Ltd. of Gdańsk), ul. Kujawska 2, 80–550 Gdańsk; tel./fax. +48 58 3438271, fax. +48 58 3438376; www.fosfory.pl — *phosphoric acid, superphosphates, multicomponent fertilizers PK, NPK.*
- Luvena S.A. (Luvena Joint Stock Co.), ul. Romana Maya 1, 62–030 Luboń; tel. +48 61 8900100, fax +48 61 8900400; www.luvena.pl — *multicomponent fertilizers NP, NPK.*
- Zakłady Chemiczne Siarkopol Tarnobrzeg Sp. z o.o. w Tarnobrzegu (Siarkopol Tarnobrzeg Chemical Plants Ltd. of Tarnobrzeg), ul. Zakładowa 50, 39–402 Tarnobrzeg 4, tel. +48 15 8555710, fax. +48 15 8229797, www.zchsiarkopol.pl — *superphosphates, NPK multicomponent fertilizers, synthetic cryolite.*

- Fosfan S.A. w Szczecinie (Fosfan Joint Stock Co. of Szczecin); ul. Nad Odrą 44/65, 71–820 Szczecin; tel. +48 91 4538394, fax +48 91 4538490; www.fosfan.com.pl — *superphosphates, NPK multicomponent fertilizers.*
- Alwernia S.A. (Alwernia Joint Stock Co.); ul. Karola Olszewskiego 25, 32–566 Alwernia; tel. +48 12 2589100, fax +48 12 2832188; www.alwernia.com.pl — *phosphoric acid, sodium tripolyphosphate, other phosphorus compounds.*

PLATINUM GROUP METALS

Overview

Platinum, along with **palladium**, **rhodium**, **iridium**, **ruthenium**, and **osmium**, belongs to a family of noble metals that form adjacent triads: ***light platinum metals*** (ruthenium, rhodium, palladium) 44-49, and ***heavy platinum metals*** (osmium, iridium, platinum) 76-78. For centuries, ***platinum*** obtained from placer deposits was used in jewellery, as well as for crucibles and sometimes for coinage. Since the beginning of the 20th century, industrial applications of **platinum** and other platinum group metals were developed, especially as chemical catalysts. In the last 30 years, rapid development of autocatalysts was reported, where a majority of these groups of metals is currently used.

The most of **platinum group metals** supply comes from primary sources, i.e. principally from the deposits of ***sulphide ores*** and ***Cu-Ni ores***. Concentrate of platinum group metals is obtained from ores, which is processed in multistage complicated process by a few refineries with a use of hydrometallurgical methods. Considerable and still increasing amounts of these metals are recovered from secondary sources, e.g. from **platinum-** and **palladium-bearing scrap** (e.g. spent catalysts).

Sources

In Poland, the only economic source of ***platinum group metals*** is the ***copper ore*** of the **Fore-Sudetic Monocline** deposits. ***Platinum group metals*** concentrations occur mainly in the bottom of the copper-bearing shale series, with the highest amounts in the western part of **Lubin** deposit and eastern part of **Polkowice** deposit (up to 1,000 ppm Pt-metals). ***Platinum group metals*** form their own minerals, or occur as admixtures in ***gold minerals***, or in non-metallic compounds.

The secondary sources of ***platinum group metals*** in Poland are: spent catalytic gauzes from nitrogen plants, as well as other scrap and wastes from plants, which produce platinum group metals-bearing products and compounds.

Production

In the course of ***copper ore*** processing at the **KGHM Polska Miedź**, ***platinum metals*** are collected in ***copper concentrates***, then transferred into the ***anode sludge*** which remains after the electrolytic refining of ***copper***. The ***anode sludge*** is processed at the **Precious Metals Plant** of the **Głogów Copper Smelter** (Boliden technology). The waste sludge after the electrolytic refining of ***silver*** and the precipitation of ***gold*** is processed into ***palladium-platinum sludge*** containing 22-36% Pt and 12-22% Pd. The level of sludge production stabilized at 90-100 kgpy. The Pt-Pd sludge is sold mainly to the **State Mint** of **Warsaw**, where ***platinum group metals*** are obtained by refining. Minor quantities are sold to the **POCH** of **Gliwice**. Sporadically, some amounts of sludge are also exported. ***Platinum*** is also recovered from waste solutions coming from the **Precious Metals Plant** in **Głogów** by some reduction method introduced in the **Non-ferrous Metals Institute**, **Legnica Branch**. ***Platinum concentrate*** with 30% Pt content is a product there.

Refined platinum group metals are manufactured in Poland mainly by the **Mennica-Metale Szlachetne** of **Warsaw** (daughter company of the **State Mint** of **Warsaw**). It uses both ***Pd-Pt sludge*** from KGHM, and ***platinum group metals scrap*** and ***wastes***. The latter ones are purchased from industrial users of products containing these metals (especially spent catalytic gauzes from nitrogen plants), as well as imported. ***Platinum*** production from sludge in the **Mennica-Metale Szlachetne** of **Warsaw** is estimated at 25-30 kgpy, while ***palladium production*** 15-20 kgpy. Probably production of ***platinum group metals*** (***platinum***, ***palladium***, ***rhodium***, etc.) from secondary sources is much higher. ***Refined platinum*** obtained from waste solutions, as well as ***refined platinum*** and ***palladium*** from scraps are manufactured by **Innovator Ltd.** of **Gliwice** (daughter company of the **Non-ferrous Metals Institute** of **Gliwice**), at the level of under 20 kgpy. Total domestic production of ***platinum group metals*** (***metals and powders***) recently varied between 50-300 kgpy, with significant decrease in 2013, coming mostly from scrap. However, official production data for 2011 - 7,569 kg - are ambiguous (Tab. 1).

The Mennica-Metale Szlachetne Ltd. of **Warsaw**, as well as the **POCH** of **Gliwice** and **Innovator** of **Gliwice** produce numerous ***platinum group metals compounds***, e.g. ***platinum chloride acid***, ***palladium chloride acid***, ***rhodium chloride acid***, ***compounds of the platinum***, and ***palladium chloride groups***, ***palladium***, ***platinum*** and ***rhodium nitrates***, ***palladium chloride***, ***rhodium sulphate***.

Trade

Trade of ***platinum group metals*** and their ***semiproducts*** are very variable, both in exports and in imports. The largest is the trade of ***platinum semiproducts*** and ***palladium semiproducts***. ***Metallic platinum group metals*** trade was very variable, sometimes above 100 kgpy or even 1,000 kgpy, and in 2011 even almost 100,000 kg (Tab. 1). Trade of other ***rhodium, iridium, osmium***, and ***ruthenium semiproducts*** is insignificant, commonly not exceeding a few kgpy. The official trade of ***platinum group metals*** and their ***semiproducts*** is reported almost entirely with Western and Central European countries - especially Germany and the United Kingdom, in 2012 also Slovakia. It is probable that some amounts of these metals come to Poland from Eastern Europe unofficially (smuggling).

Total trade balance of ***platinum group metals*** and their ***semiproducts*** was commonly negative, with total deficit of a few million PLN/y. However, in the years 2009-2011 it was exceptionally highly positive for semiproducts, while in 2011-2013 - for metals (Tab. 2). The average unit values of ***platinum group metals*** and their ***semiproducts*** trade are very variable as a result of fluctuations of this trade, so they are not presented.

Tab. 1. Platinum-group metals trade in Poland

kg

Year			2009	2010	2011	2012	2013
Platinum group metals — metal and powder							
	Production		**95**	**156**	**7,569**	**265**	**57**
	Imports		**45**	**37**	**41**	**675**	**51**
•	*Platinum*	**CN 7110 11**	*5*	*4*	*3*	*616*	*14*
•	*Palladium*	**CN 7110 21**	*37*	*28*	*33*	*48*	*37*
•	*Rhodium*	**CN 7110 31**	*3*	*5*	*3*	*10*	*0*
•	*Iridium, osmium and ruthenium*	**CN 7110 41**	*0*	*0*	*2*	*1*	*0*
	Germany		30	25	33	11	12
	Slovakia		–	–	–	580	–
	United Kingdom		5	5	3	42	27
	USA		1	0	3	42	0
	Others		9	7	2	0	0
	Exports		**12**	**810**	**97,438**	**753**	**156**
•	*Platinum*	**CN 7110 11**	*1*	*11*	*64,482*	753	90
•	*Palladium*	**CN 7110 21**	*1*	*796*	*32,948*	93	60
•	*Rhodium*	**CN 7110 31**	*10*	*3*	*8*	*3*	*6*
•	*Iridium, osmium and ruthenium*	**CN 7110 41**	*0*	–	–	–	–
	Czech Republic		–	25	45	510	3
	Germany		7	782	47	0	11
	United Kingdom		4	3	97,346	243	142
	Consumption[a]		**128**	**-617**	**-89,828**	**187**	**48**
Platinum group metals — semiproducts							
	Imports		**4,770**	**2,590**	**2,092**	**618**	**508**
•	*Platinum*	**CN 7110 19**	*2,173*	*720*	*782*	*433*	*262*
•	*Palladium*	**CN 7110 29**	*1,957*	*456*	*87*	*171*	*234*
•	*Rhodium*	**CN 7110 39**	*163*	*1,289*	*1,072*	*14*	*9*
•	*Iridium, osmium and ruthenium*	**CN 7110 49**	*477*	*125*	*151*	*0*	*3*
	Austria		–	–	213	5	–
	Czech Republic		5	7	19	10	14
	Denmark		34	19	12	6	0
	France		1,762	325	18	37	7
	Germany		2,563	439	528	329	167
	Ireland		–	–	752	18	4
	Italy		8	101	24	0	3
	Netherlands		1	–	2	2	70
	United Kingdom		385	1,682	518	199	158
	USA		3	6	4	8	81
	Others		9	11	2	4	4

	Exports		**29,575**	**282**	**1,112**	**301**	**1,155**
•	*Platinum*	**CN 7110 19**	*29,537*	*276*	*1,007*	*264*	*978*
•	*Palladium*	**CN 7110 29**	*37*	*4*	*100*	*37*	*153*
•	*Rhodium*	**CN 7110 39**	*1*	*2*	*5*	*0*	*24*
•	*Iridium, osmium and ruthenium*	**CN 7110 49**	–	–	*0*	*0*	*0*
	Czech Rep.		33	10	57	9	6
	Germany		112	250	965	165	159
	Italy		–	–	–	–	68
	Netherlands		45	18	–	29	85
	United Kingdom		29,350	2	8	0	832
	USA		–	–	80	97	–
	Others		1	2	2	1	3

Source: ***The Central Statistical Office*** (GUS)

Tab. 2. Value of platinum group metals trade in Poland

Year			2009	2010	2011	2012	2013
Platinum group metals — metal and powder							
	Exports		1,399	1,705	34,357	116,200	19,415
•	*Platinum*	**CN 7110 11**	*54*	*407*	*26,860*	*109,265*	*14,501*
•	*Palladium*	**CN 7110 21**	*3*	*591*	*5,682*	*6,250*	*4,353*
•	*Rhodium*	**CN 7110 31**	*1,339*	*707*	*1,815*	*685*	*561*
•	*Iridium, osmium and ruthenium*	**CN 7110 41**	*3*	–	–	–	–
	Imports		1,401	1,434	1,292	109,864	5,119
•	*Platinum*	**CN 7110 11**	*293*	*395*	*500*	*103,960*	*2,032*
•	*Palladium*	**CN 7110 21**	*604*	*467*	*330*	*4,557*	*3,057*
•	*Rhodium*	**CN 7110 31**	*489*	*545*	*460*	*1,287*	*29*
•	*Iridium, osmium and ruthenium*	**CN 7110 41**	*15*	*27*	*2*	*60*	*0,6*
	Balance		**-2**	**-271**	**+33,065**	**+6,336**	**+14,296**
Platinum group metals — semiproducts							
	Exports		35,799	43,200	173,527	43,906	55,060
•	*Platinum*	**CN 7110 19**	*34,754*	*42,838*	*166,132*	*41,452*	*43,428*
•	*Palladium*	**CN 7110 29**	*888*	*95*	*6,457*	*2,395*	*9,941*
•	*Rhodium*	**CN 7110 39**	*157*	*267*	*934*	*58*	*1,689*
•	*Iridium, osmium and rhutenium*	**CN 7110 49**	–	–	*4*	*1*	–
	Imports		21,143	32,486	28,318	50,015	53,511
•	*Platinum*	**CN 7110 19**	*14,240*	*22,678*	*21,350*	*37,225*	*39,920*
•	*Palladium*	**CN 7110 29**	*6,416*	*9,160*	*6,171*	*12,007*	*12,282*
•	*Rhodium*	**CN 7110 39**	*44*	*354*	*388*	*393*	*1,063*
•	*Iridium, osmium and rhutenium*	**CN 7110 49**	*443*	*294*	*409*	*390*	*245*
	Balance		**+14,656**	**+10,714**	**+145,209**	**-6,109**	**+1,549**

Source: ***The Central Statistical Office*** (GUS)

Consumption

The main uses of ***platinum group metals*** in Poland are industrial applications such as manufacture of: catalytic gauzes, liquid metals for chinaware and crystal decoration, glass fiber bushings, crucibles, electrodes and other laboratory apparatus, rolled and drawn products. All these products are manufactured by the **Mennica-Metale Szlachetne** of **Warsaw**, while ***chemical compounds*** also in the **POCH** of **Gliwice** and the **Innovator** of **Gliwice**.

Production of catalytic gauzes (***PtRh10***, ***PdAu20***, and ***PdAu10 alloys***) used by domestic nitrogen plants is currently the most important industrial application of ***platinum group metals*** in Poland. Liquid metals for decoration are sold to domestic chinaware and ceramic tiles plants, as well as to crystal glassworks. Glass fiber bushings (***PtRh10*** and ***PdRh20 alloys***) are sold to glass fibre plants. In the glass industry, special platinum-rhodium linings are used in some specialized glass furnaces. Production of crucibles, electrodes and other laboratory equipment with a use of ***PtIr2 alloy*** is very traditional use of platinum. Chemical compounds of platinum group metals, produced by the **Mennica-Metale Szlachetne** of **Warsaw**, as well as by the **POCH** of **Gliwice** find use as catalysts in various chemical processes. Rolled products (e.g. foil) and drawn products (e.g. wires) are manufactures from ***PtIr2***, ***PtRh10***, ***PtRh30***, ***PdIr10***, and ***AuPd20 alloys***. Rolled products are used in electronics (thermoelements, contacts), while thermocouple wires in laboratories. In recent years, production of autocatalysts was commenced in Poland. **Lindo-Gobex** of **Gorzów Wielkopolski** started to produce catalysts for some both domestic and foreign automotive plants, as well as spare parts in used cars. Total industrial consumption of ***platinum group metals*** in Poland amounts probably a few hundred kgpy.

Platinum and in minor amounts ***palladium*** have been used in jewellery for years. This is mostly ***platinum 950*** (with admixture of silver or copper), but also ***Au700Pt50Ag38Cu162*** and ***Pt250Au80Ag670 alloys***, as well as ***palladium 950*** (with admixture of silver or copper). For these purposes, mostly jewellery scraps are used, with some quantities of imported material. It is difficult to estimate the level of ***platinum*** and ***palladium*** consumption in Poland.

Companies involved in platinum group metals production in Poland, as of December 2013

- KGHM Polska Miedź S.A. w Lubinie (KGHM Polska Miedź Joint Stock Co. of Lubin); ul. Marii Skłodowskiej-Curie 48, 59-301 Lubin; tel. +48 76 8478200, fax +48 76 7478500, www.kghm.pl, *palladium-platinum sludge*.
- Mennica-Metale Szlachetne Sp. z o.o. w Warszawie (Mennica-Metale Szlachetne Ltd. of Warsaw), 00-958 Warszawa, ul. Pereca 21, tel. +48 22 6564101, fax +48 22 6564111, www.mennica-metale.com.pl, *platinum group metals and compounds*.
- Innovator Sp. z o.o. w Gliwicach (Innovator Ltd. of Gliwice), 44 101 Gliwice, ul. Sowińskiego 5, tel. +48 32 2380245, fax +48 32 2380202, www.innovator.com.pl, *platinum group metals and compounds*.
- POCH S.A. w Gliwicach (POCH Joint Stock Co. of Gliwice), 44-101 Gliwice, ul. Sowińskiego 11, tel. +48 32 2392000, fax +48 32 2392370, www.poch.com.pl, *platinum group metals compounds.*

POTASH

Overview

Potassium-magnesium chlorides and ***sulfates*** (rare, but of high value) are the main source of **potassium** and **potassium compounds**. Almost 90% of **potassium** and **potassium-magnesium salts** are extracted from natural deposits of ***chlorides*** or ***sulfates***, while the rest is obtained from deposits of ***potassium saltpeter*** KNO_3 and from ***brines of salty lakes*** and ***mineralized waters***. Potassium salts are used in their original state (rarely), or, after dressing and chemical processing, as mixed fertilizers, which are critical for the development of agriculture (95% of consumption). Other potassium compounds and **metallic potassium** are utilized to a lesser degree.

Sources

In Poland, deposits of ***K-Mg salts*** of the ***polyhalite type*** occur near Puck Bay north of Gdańsk. There are four recognized deposits (**Chłapowo**, **Mieroszyno**, **Swarzewo**, and **Zdrada**), the total resources of which amounted to 597 Mt of polyhalite (as of 31 December 2013), containing 7.7–13.7% K_2O (51 Mt K_2O). ***Chloride type K-Mg salts*** (***carnalite***) are known in the **Kłodawa** ***salt dome***. The raw material occurring there as an accompanying rock is ***kieserite carnalitite***, containing 8.5% K_2O and 8.1% MgO. Its resources amounted to 73 Mt (as of 31 December 2013) of ***carnalite salt*** (6 Mt K_2O).

Production

Kieserite carnalitite was extracted in the 1980s, as a byproduct of ***salt*** in the **Kłodawa** mine. It was used as a fertilizer and as salt for balneological curative treatment. Due to difficult mining conditions and low quality, it was irregularly extracted at the level of under 1,000 tpy (for the last time in 2000).

Trade

The demand for potassium commodities has been satisfied by imports of various grades of K and K-Mg salts, mainly ***potassium chloride*** (95% of the total in 2013) from Belarus, Russia, and Germany. ***Potassium sulphate*** came primarily from Germany, Belgium and Sweden (in 2013). In 2009 - due to collapse of demand for fertilizers in Poland - the level of imports dropped to ca. 0.2 Mt, while in 2010 it recovered to around 0.8 Mt, stabilizing at this level in the following three years (Tabs. 1, 2). Detailed information on the quality of imported ***chloride salts*** is not available, but it is known that these salts have included mainly ***dust*** and ***standard grades***, with low contents of useful components (mostly 40–60% K_2O). Minor amounts of ***potassium salts*** have been re-exported to Western Europe, only in 2009 re-exports constituted ca. 9% of imports (Tab. 1).

Tab. 1. Potash salt statistics in Poland — CN 3104

‘000 t (gross weight)

Year	2009	2010	2011	2012	2013
Production[1]	2.4	5.4	0.0	0.0	9.1
Imports	208.2	822.7	799.5	816.1	830.7
Exports	19.2	10.0	9.7	3.8	16.4
Consumption[a]	191.4	818.1	789.8	812.3	823.4

[1] only synthetic chloride and sulfate

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Polish imports of potash salt, by country — CN 3104

‘000 t (gross weight)

Year	2009	2010	2011	2012	2013
Imports	**208.2**	**822.7**	**799.5**	**816.1**	**830.7**
Belarus	107.1	8.0	7.4	5.6	3.5
Belgium	3.9	388.3	398.5	367.9	323.4
Germany	29.5	86.6	130.4	133.6	161.6
Israel	0.7	1.1	1.0	0.8	1.0
Lithuania	3.0	5.2	3.6	1.3	4.5
Russia	45.4	299.4	240.4	279.2	308.9
Spain	0.0	4.1	0.0	13.7	3.5
Sweden	–	–	–	0.0	6.2
United Kingdom	16.3	27.1	14.1	9.5	13.3
Others	2.3	2.9	4.1	4.5	4.8

Source: ***The Central Statistical Office (GUS)***

The balance of ***potash salts*** trade has been constantly negative. In 2009 imports unit values sharply rose, but due to imports volumes drop, deficit improved to -282 million PLN. In 2010 the situation reversed: unit values decreased by 30%, but due to imports rise, the deficit deepened to 862 million PLN. In the years 2011-2013, imports slightly rose, but the trade balance mostly depended on imported salts prices. In the years 2011–2012 imports unit values increased by over 31%, what resulted in deepening of the deficit to 1,132 million PLN, while in 2013 they decreased by 11%, with some improvement to -1,006 million PLN (Tab. 3, 4).

Tab. 3. Value of trade in potash salt in Poland — CN 3104

‘000 PLN

Year	2009	2010	2011	2012	2013
Exports	36,508	12,107	13,468	7,457	22,644
Imports	318,491	873,697	1,018,866	1,139,817	1,029,371
Balance	**-281,983**	**-861,590**	**-1,005,398**	**-1,132,360**	**-1,006,727**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Average unit values of potash salt imports to Poland — CN 3104

Year	2009	2010	2011	2012	2013
PLN/t	1,530.0	1,062.0	1,274.4	1,396.6	1,239.1
USD/t	513.8	355.6	434.8	426.0	394.0

Source: ***The Central Statistical Office (GUS)***

Consumption

The level of ***potash salts*** consumption in Poland is dependent on domestic agriculture demand. Due to high prices and worsening of economic situation of the domestic agriculture in 2009, demand for potash salts dropped by ca. 77%. Since 2010, due to lower unit values of potash salts imports and improvement of domestic agriculture the demand has recovered to ca. 800,000 tpy (Tab. 1).

It is estimated that for the production of ***multicomponent NPK fertilizers***, mainly at the **Police Chemical Plant**, has been usually consumed 60–70% of the total imports of potash salts (Tab. 5). The rest has been utilized directly as fertilizers, as well as in the chemical industry for the production of potassium compounds. Only in 2009 almost all imported potash salts (and maybe some stocks) were consumed for the manufacture of multicomponent fertilizers.

Tab. 5. Production of multicomponent fertilizers in Poland — CN 3105

'000 t

Year	2009	2010	2011	2012	2013
Multicomponent fertilizers	**1,138.5**	**1,941.8**	**2,016.2**	**1,894.1**	**1,619.5**
• *potash content (K_2O)*	*188.6*	*326.3*	*330.4*	*346.6*	*303.3*

Source: ***The Central Statistical Office (GUS)***

Irrespective of the level of demand, ***K*** and ***K-Mg chloride salts*** will need to be imported, because the Polish deposits of ***K-Mg salts*** are of the ***polyhalite type***, suitable only for the production of ***K*** and ***K-Mg sulfate***.

Companies involved in K-Mg salts production[1] in Poland as of December 2013

- Grupa Azoty Zakłady Chemiczne Police S.A. (Grupa Azoty Police Chemical Plant Joint Stock Co. of Police), ul. Kuźnicka 1, 72–010 Police; tel. +48 91 3171717, fax +48 91 3173603; www.grupaazoty.pl — *phosphoric acid, multicomponent fertilizers NPS, NPKS, NPKMg, NPKMgS, NPKNaS, PK, PKMgS, NP.*
- Grupa Azoty GZNF Fosfory Sp. z o.o. (Grupa Azoty Fosfory Phosphate Fertilizers Plant Ltd. of Gdańsk), ul. Kujawska 2, 80–550 Gdańsk; tel./fax. +48 58 3438271, fax. +48 58 3438376; www.fosfory.pl — *phosphoric acid, superphosphates, multicomponent fertilizers PK, NPK.*
- Luvena S.A. (Luvena Joint Stock Co.), ul. Romana Maya 1, 62–030 Luboń; tel. +48 61 8900100, fax +48 61 8900400; www.luvena.pl — *multicomponent fertilizers NP, NPK.*

[1] only production of multicomponent salts on the basis of imported potassium salts

- Zakłady Chemiczne Siarkopol Tarnobrzeg Sp. z o.o. w Tarnobrzegu (Siarkopol Tarnobrzeg Chemical Plants Ltd. of Tarnobrzeg), ul. Zakładowa 50, 39–402 Tarnobrzeg 4, tel. +48 15 8555710, fax. +48 15 8229797, www.zchsiarkopol.pl — *superphosphates, NPK multicomponent fertilizers, synthetic cryolite.*
- Fosfan S.A. w Szczecinie (Fosfan Joint Stock Co. of Szczecin); ul. Nad Odrą 44/65, 71–820 Szczecin; tel. +48 91 4538394, fax +48 91 4538490; www.fosfan.com.pl — *superphosphates, NPK multicomponent fertilizers.*

PUMICE AND RELATED MATERIALS

Overview

Pumice is very porous pyroclastic rock built of magmatic glaze. It occurs in many varieties, the finest of which are suitable for **cosmetic pumice** and **abrasive pumice stone**. Other pyroclastic rock types — compact **volcanic tuff** (called ***trass***, ***pozzolan***), **volcanic ash**, **lapilli**, and **scoria** — have a similar genesis and properties. These are widely used as active additives for cement, lime, and hydraulic binding materials, and also as natural light aggregates (e.g. ***tuffoporite***).

Sources

There are no ***pumice*** deposits in Poland. Nevertheless, large occurrences of ***tuff*** and ***volcanic ash*** are known in the Lower Silesia and in the vicinity of Krzeszowice near Cracow. The ***tuff*** deposit of ***Filipowice type*** has been recognized in **Kowalska Góra** near **Krzeszowice**, with resources estimated at 18.3 Mt (as of 31 December 2013). Moreover, another deposit containing 11.6 Mt of ***tuff*** and 21.6 Mt of ***melaphyre*** was recognized in **Włodzicka Góra** near **Nowa Ruda** (the Lower Silesia).

Production

There has been no ***pumice*** production in Poland. However, some its substitutes have been manufactured, i.e. synthetic ***quartz pumice*** (made from ***foam glass***) and ***polyurethane pumice*** used mainly in cosmetics. Moreover, foam glass is excellent insulator and material for filters. In the past in Poland was also produced so-called ***smelter pumice*** (***foam slag***) used as aggregate for lightweight concrete. According to the official statistics, the production of ***synthetic pumice*** taken together with ***tuff*** and other ***natural abrasive materials*** decreased from 41,300 tpy in 2009 to 37,900 tpy in 2013. The largest domestic producers of the synthetic pumice have been the following companies: **GL-PUMEKS, Pumice System,** and **MILMOR**.

Trade

Demand for natural ***pumice*** has been satisfied basically by importation and substitutes. The total volume of pumice supplies decreased considerably from 4,370 tpy in 2009 to 882 tpy in 2013 (Tab. 1). Until 2012 pumice has been imported primarily from Iceland. In 2013 the volume of these deliveries considerably dropped. Another prominent supplier has been Turkey, followed by the US. Some very small amounts of pumice have been re-exported to many countries, predominantly to the US. The balance of ***pumice*** trade has had positive value that grew from ca. 1.2 million PLN in 2009 up to 4.2 million

PLN in the years 2012–2013 (Tab. 2). Great surplus in pumice trade, in spite of the lack of domestic production is unclear, particularly regarding that only small part of annual supplies has been exported (ca. 2–18%). The very high unit values of exportation indicate that products from pumice or synthetic pumice were probably exported.

Tab. 1. Pumice statistics in Poland — CN 2513 10

t

Year	2009	2010	2011	2012	2013
Imports	**4,370**	**3,887**	**2,891**	**4,054**	**882**
Germany	8	9	13	8	17
Greece	86	23	2	–	–
Iceland	2,851	2,530	2,304	3,084	20
India	4	4	2	1	–
Italy	1	0	2	4	2
Turkey	1,217	1,090	388	706	615
USA	174	208	151	228	211
Others	29	23	29	23	17
Exports	**95**	**138**	**123**	**159**	**161**
Consumption[a]	**4,275**	**3,749**	**2,768**	**3,895**	**721**

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Value of pumice trade in Poland — CN 2513 10

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	3,748	4,946	3,998	6,332	5,328
Imports	2,528	2,090	1,782	2,139	1,165
Balance	**+1,220**	**+2,856**	**+2,216**	**+4,193**	**+4,163**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. The unit value of pumice imports to Poland — CN 2513 10

Year	2009	2010	2011	2012	2013
PLN/t	579	538	616	528	1,321
USD/t	184	174	213	163	420

Source: ***The Central Statistical Office (GUS)***

The average unit values of importation have followed the diversified prices of pumice grades purchased (Tab. 3). In the years 2009–2013 they ranged from 163 to 213 USD/t, mainly depending on the share of deliveries from Iceland (69–109 USD/t), Turkey (179–204 USD/t) and the US (620–818 USD/t).

Consumption

Imported ***pumice*** has been almost entirely consumed by the cosmetics and abrasive materials industries. On the domestic market also pumice for washing jeans clothes, for water filtration, and pumice powder for polishing denture have been available. ***Pumice aggregates*** imported from Iceland have been used for thermal insulation in heating systems. Domestically produced ***foam glass*** has been utilized for cosmetics, while ***smelter pumice*** (***foam slag***) from domestic smelters - as a light aggregate, e.g. for light concrete products. The ***tuff from Filipowice*** has been basically applied as the dimension stone, and in very small quantities — as poor quality light aggregate for the concrete manufacturing (***tuffoporite***) and for the production of dark bottle glass.

QUARTZ, QUARTZITE AND QUARTZ-SCHIST

Overview

Quartz, **quartzite** and **quartz-schist** are silica raw materials comprising quartz as a primary mineral. Depending on contents of SiO_2 and impurities (e.g. Fe_2O_3, Al_2O_3, TiO_2) they are used in the production of ***silicon metal*** and ***ferrosilicon*** (**quartz** and **quartzites**), ***siliceous refractory materials*** (**quartzite** and **quartz-schists**), and also in the ceramics, glass-making, and chemical industries (mainly **quartz**).

Quartz, the crystalline form of silica SiO_2, is one of the most widespread rock minerals. It is extracted primarily from various types of quartz veins. The unique form of the quartz is large crystals, known in Poland as **quartz crystal** or **mountain crystals**. Due to its piezoelectric properties, quartz crystal is one of the basic raw materials for the electronics. It is also used in the optics and production of jewellery. However, **synthetic quartz crystal** now predominates in the electronics, where it is known as **piezoelectric quartz**. This is obtained by using natural quartz crystal of lower grade (***lascas***) as crystallization nuclei for ***cultured quartz crystals*** in pressure reactors.

Quartzite is usually understood as thermally metamorphosed quartz rocks. However, the commercial term **industrial** (**refractory**) **quartzite** refers to all rocks rich in SiO_2 (>97%), suitable for the production of ***siliceous refractory materials*** and ***ferrosilicon***. The significance of the first application of quartzite is continually declining, due to the decreasing use of ***siliceous refractory materials***. On the other hand, ***ferrosilicon*** production has recently become the main use of industrial quartzite around the world, and in Poland as well. So, demand for quartzite is strictly dependent on demand for ferrosilicon used in steel production.

Quartz-schist is a rare metamorphic rock. **Quartz-schist** from Jegłowa deposit (Lower Silesia) for over 150 years has been utilized as natural refractory material, previously as shaped lining elements, but now as a powder for mortars and mixes.

Sources

Quartz crystal occurs in the fissures of granite massifs (e.g. in Strzegom) and in the ***quartz-schist*** deposit in **Jegłowa** (Lower Silesia). It is picked up by collectors and used for jewellery purposes.

Quartz of commercial importance occurs in veins in magmatic and metamorphic rocks in Lower Silesia. Currently, 7 deposits are recognized, with total reserves of 6,564,000 t (as of 31 December 2013). Three of them are developed, though currently abandoned (**Stanisław**, **Taczalin**, **Krasków**), two deposits were extracted irregularly in the past, and two have not been exploited so far. There are also prospects for discovery of new deposits with possible reserves of around 4 million t.

The deposits of ***industrial*** (***refractory***) ***quartzite*** known in Poland are of average or low overall quality, but of high refractoriness. They occur in the Świętokrzyskie Mountains, in the vicinity of Łagów (the **Góra Skała** and **Wojtkowa Góra I** and **II** deposits), and near Starachowice (the **Doły Biskupie-Godów** deposit). Their total reserves are 4,438,000 t. Moreover, partly suitable for the production of industrial quartzite are sandstone from another deposit recognised in these area — **Bukowa Góra,** classified into the group of crushed and dimension stones since 2008 (reserves of 12,331,000 t). There are also 14 abandoned deposits of ***high quality quartzite*** of the ***Bolesławiec type*** in Lower Silesia region, with the reserves of 2,442,000 t left (as of 31 December 2013).

The ***quartz-schist*** reserves in **Jegłowa** deposit near Strzelin amounted to 8,697,030 t (as of 31 December 2013).

Production

Domestic production of ***quartz*** and ***quartzite products*** increased from ca. 26,000 tpy to 95,000 tpy in the last five years (Tab. 1).

Quartz products were manufactured in the amounts of 5,000-6,000 tpy in the recent years. The ***quartz*** production reported by the Central Statistical Office concerned ***quartz flour***, manufactured by the **Strzeblowskie Kopalnie Surowców Mineralnych** on the basis of quartz sand from **Osiecznica Mine and Processing Plant**, situated in the **Bolesławiec Syncline.** The company delivers five grades of flours with the content of SiO_2 >99%, Al_2O_3 <1%, and <0.05% Fe_2O_3. Other producers of ***quartz flours,*** obtained by the milling of quartz sand from deposits in the **Tomaszów Syncline**, are **Grudzeń Las** and **Orbud**. The first company, providing a few thousand tpy of flours, processes the raw material derived from own mine. The offered products contain 98.5–99.1 %, SiO_2 and 0.06–0.1% Fe_2O_3. The larger capacity (ca. 1,000 t per month) has a processing plant belonging to **Orbud**, but the quality of the product is lower due to higher content of iron compounds. In the years 2009–2013 there was no mining output of vein quartz from any deposit in Poland (Tab. 1). The extraction of quartz in both **Taczalin** and **Stanisław** mines has been terminated by the **PeBeKa** of **Lubin** (KGHM Group) in 2005, whereas production in Krasków mine carried out by **PEZM Magma** was ceased three years later.

Raw quartzite materials are produced on the basis of ***quartzite sandstone*** from **Bukowa Góra** deposit. **Bukowa Góra Quartzite Mine and Processing Plant** in **Łączna**, operated since September 2009 by **PCC SE**[1], produces ***industrial quartzite*** in various grades (KpSi99, KpSi98 and KpSi97) and fractions (40-100 mm and 100-300 mm), as well as large amounts of ***quartzite crushed aggregates*** and ***quartzite sand*** (600–1,600 ktpy). The volume of production of industrial quartzite, which is dependent on condition of steel industry, increased from ca. 20,000 tpy in 2009 to 88,000 tpy in 2013 (Tab. 1). It was a result of the growth of the ferroalloys production in **Łaziska** smelter, as well as reported since 2010 exports to Slovakian ferrosilicon producer — **Oravske Ferozliatinarske Zavody**, in spite of growing imports of quartzite from Ukraine.

The producer of ***quartz-schist products*** was **Quartz System Kopalnie**, which exploited ***quartz-schist*** deposit in Jegłowa. The previous owner, **PPHU Kwarcyt Danuta Kwiatkowska,** sold the mine in October 2010. Since then, the output level considerably increased, from a few ktpy to 20–40 ktpy**.** The majority of the output was

[1] There was a change of the company's name into **PCC Silicium** in January 2011

Tab. 1. Quartz, quartzite and quartz-schist statistics in Poland — CN 2506

'000 t

Year		2009	2010	2011	2012	2013
Mining output		**637.5**	**1,223.4**	**1,654.4**	**1,085.2**	**1,040.0**
• *quartz*		–	–	–	–	–
• *quartzite*[1]		*634.0*	*1,221.0*	*1,614.0*	*1,057.0*	*1,015.0*
• *quartz-schist*		*3.5*	*2.4*	*40.4*	*28.2*	*25.0*
Production		**26.1**	**40.5**	**53.3**	**59.1**	**94.6**
• *quartz*		*5.0*	*5.6*	*6.1*	*5.3*	*5.8*
• *quartzite*		*20.4*	*34.2*	*46.5*	*53.2*	*88.3*
• *quartz-schist*		*0.7*	*0.7*	*0.7*	*0.6*	*0.5*[e]
Imports		**22.3**	**104.2**	**148.5**	**147.5**	**114.1**
• *quartz*		*8.0*	*8.4*	*3.8*	*3.3*	*3.0*
• *quartzite*		*14.3*	*95.8*	*144.7*	*144.2*	*111.1*
Belgium	q	0.2	0.2	0.4	0.3	0.4
Germany	q	1.5	1.8	2.0	2.7	2.0
Italy	q	0.8	0.1	0.0	0.3	0.4
Norway	q	5.1	6.0	1.4	–	–
Ukraine	qt	14.1	95.6	144.2	144.1	110.7
Others	q,qt	0.6	0.5	0.5	0.3	0.6
Exports		**0.1**	**7.7**	**41.8**	**34.6**	**43.3**
• *quartz*		*0.1*	*0.1*	*0.0*	*0.2*	*25.8*
• *quartzite*		–	*7.6*	41.7	*34.4*	*17.5*
Czech Republic	q	0.0	–	0.0	0.1	24.7
Slovakia	qt	–	7.6	41.7	34.4	14.3
Ukraine	q	–	0.0	0.0	0.0	3.1
Others	q,qt	0.1	0.1	0.1	0.1	1.2
Consumption[a]		**48.3**	**137.0**	**160.0**	**172.0**	**165.4**

Legend: **q** — quartz, **qt** — quartzite

[1] from Bukowa Góra deposit

Source: ***The Central Statistical Office (GUS), Mineral Deposits Datafile, producers' data***

utilized as split tiles, while production of ***silica mortars*** and ***mixes***, as well as ***foundry mix "kwarcoplast"*** consumed only ca. 500–700 tpy of raw material (Tab. 1).

Trade

The demand for the best quality ***quartz*** and ***quartzite*** grades is satisfied by imports. Level of supplies usually ranged from 100,000 tpy to 150,000 tpy, with the exception of 2009, when they amounted to ca. 20,000 tpy (Tab. 1). The deliveries of ***raw quartz material***, especially ***quartz flours,*** considerably decreased from ca. 8,000 tpy in 2009–2010 to ca. 3,000 tpy in the recent years. The decline was caused by cease of production of the ***quartz flours*** in the Norwegian plant in **Lillesand**[2] (**Sibelco Group**), which was the most important supplier of such commodities to Poland (Tab. 1). On the other hand, there was a slight growth of imports of the more expensive ***quartz flours*** from Germany. Moreover, smaller amounts of the ***raw quartz material*** came from Italy and Belgium (Tab. 1). Exports of ***quartz flours*** has not exceeded a few hundreds tpy, with the exception of 2013, when it considerably increased to nearly 26,000 t. Deliveries were directed almost exclusively to the Czech Republic. Due to the lack of refractory quartzite of the highest quality on the domestic market, some quantities (10,000–150,000 tpy) have been traditionally imported, predominantly from Ukraine (**Owrucz** mine). The majority of deliveries were used in ferrosilicon production, competing with domestic raw materials. Exports of ***industrial quartzite*** to Slovakia were reported in the amount of 7,000–42,000 tpy since 2010 (Tab. 1). ***Quartz-schist*** is not traded internationally.

The volume of trade of ***quartz crystal*** is difficult to determine, as there is no separate item for it in the Central Statistical Office statistics. Therefore, it is very probable that imported quartz crystal is included under the headings of ***piezoelectric quartz*** (**CN 7104 10**), ***quartzite*** (**CN 2506 20**) or ***quartz*** (**CN 2506 10**). The total amounts of deliveries range from a few hundred tpy to ca. 2 tpy. Supplies primarily of synthetic quartz crystal (***cultured***) came from China (12–968 kg/y), Germany (to 1546 kg/y), Japan (220–500 kg/y), the US (50–207 kg/y), Israel (100-869 kg/y) in the years 2011-2012 and Ethiopia (12 kg) in 2013.

The trade balance in ***quartz and quartzite products*** has been consistently negative and the total trade deficit ranged from 5 to 8 million PLN (Tab. 2). The unit values of ***quartz products*** (primarily ***quartz flours***) varied in a wide range from ca. 15 to over 800 USD/t, depending on grades. The unit values of ***quartz flours*** of German origin fluctuated between 172 USD/t in 2009 and 263 USD/t in 2013 (Tab. 3). The unit values of ***industrial quartzite*** imports from Ukraine ranged from 10 to 19 USD/t. The average unit values of ***industrial quartzite*** exports to Slovakia, reported since 2010, were considerably higher and reached 20–30 USD/t (Tab. 3). The unit values of ***piezoelectric quartz*** (***natural*** and ***synthetic***) imports from China, Germany, Japan, the US, and other countries were very high, changing in wide range from 14,000 to 366,000 USD/t.

Consumption

Total domestic consumption of ***quartz*** and ***quartzite products*** generally fluctuated between 137,000 and 180,000 tpy, with the exception of 2009 when it dropped to ca. 48,000 tpy (Tab. 1) The largest domestic consumer remains **Łaziska Smelter**, which strictly determines the level of demand. Consumption of quartz and quartzite products highly depends on competition from alternative raw materials of domestic and foreign origin (German and until 2011 Norwegian quartz flour, Ukrainian quartzite).

Quartz is utilized mainly in the form of the ***quartz flour***, which is a component for chinaware production, but being also utilized in glass (fibre and special glass), enamels, paints and varnishes, and in chemical industry. Owing to considerable decrease in the volume of domestic chinaware production demand for ***quartz flours*** dropped to below 10,000 tpy. The main component of the batch in the production of chinaware and

[2] The production of the **quartz flours,** on the basis on the quartz recovered in course of pegmatite flotation, has not been carried on since June 2011.

Tab. 2. Value of quartz and quartzite trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Quartz CN 2506 10					
Exports	182	101	113	61	1,211
Imports	4,953	3,528	3,062	3,149	3,174
Balance	**-4,771**	**-3,427**	**-2,949**	**-3,088**	**-1,963**
Quartzite CN 2506 20					
Exports	–	511	3,779	3,242	1,641
Imports	764	3,439	5,911	7,995	7,130
Balance	**-764**	**-3,439**	**-2,132**	**-4,753**	**-5,489**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. The average unit values of quartz and quartzite products trade in Poland

Year	2009	2010	2011	2012	2013
Quartz CN 2506 10					
Average imports unit values[1]					
— PLN/t	537.5	579.8	765.9	675.5	826.6
— USD/t	172.0	192.6	260.7	205.0	262.5
Average exports unit values					
— PLN/t	1,473.7	885.1	2,485.8	328.8	47.0
— USD/t	471.7	284.7	822.9	100.8	14.9
Quartzite CN 2506 20					
Average imports unit values[2]					
— PLN/t	31.1	31.9	42.6	53.7	58.5
— USD/t	11.2	10.4	14.2	16.4	18.6
Average exports unit values					
— PLN/t	–	67.4	90.5	94.2	93.8
— USD/t	–	22.8	30.2	28.6	29.8

[1] solely from Germany [2] solely from Ukraine

Source: ***The Central Statistical Office (GUS)***

electrical porcelain has been quartz flours derived from sand from Osiecznica mine as well as commodities imported from Germany and until 2011 from Norway. ***Quartz flour*** produced by the **Strzeblowskie Kopalnie Surowców Mineralnych** has been utilized as a component in ceramics, foundry, paint and varnish industries as well as in production of plasters, mortars, abrasives, and in many other applications. On the other hand, the important sector of consumption of the grades delivered by the Grudzeń Las has been frit added to glaze. A new application of quartz of significant growth potential is a production of reactive powder concretes as well as resin cement floor.

Industrial quartzite from Bukowa Góra and from Ukraine has been utilized in **Łaziska Smelter** in the production of ***ferrosilicon*** and other ***ferroalloys***. Recently, the demand for these commodities fluctuated between 100,000 and 150,000 tpy. The exception was the year 2009, when the plant was shut down for three months and the level of the consumption was considerably lower (ca. 20,000 t). The ***ferrosilicon*** has been utilized as the additive improving the quality of steel, therefore the demand for the industrial quartzite is a derivative of the condition of the steelmaking industry. Since 2012 the **Łaziska Smelter** has been in bankruptcy and the production of the ferroalloys in this plant has been carried out by the **Re Alloys**. The company, as the second in the world, launched the production of ***ferrosilicochrome,*** finding application in the aircraft industry and has further plans of expansion. The principal silica raw material utilized in the production of ***ferroalloys*** is quartzite from Ukraine, while the share of domestic quartzite does not exceed 40%.

Industrial quartzite has been also used in **Chrzanów Refractory Plant**[3] for the production of ***siliceous refractories*** (***shaped products***, ***mixes***, ***mortars***) applied for lining coke ovens, open-hearth furnaces, induction furnaces, glass-furnaces, etc. The decline in demand from some metallurgical plants (e.g. open-hearth furnace technology) has resulted in the collapse of siliceous refractories production, down by over 90% to only 3,000–31,000 tpy in the recent years. As a result, consumption of industrial quartzite for siliceous refractories production currently does not exceed a few thousands tpy, including primarily domestic quartzite from Bukowa Góra, and the smaller amounts of quartzite from Ukraine. The increase of demand for industrial quartzite is observed temporarily as a result of repairing of coke oven batteries. ***Industrial quartzite***, manufactured by the domestic producer are also utilised in electronics and renewable energy sector.

Quartz-schist mixes and ***mortars***, manufactured by **PPHU Kwarcyt Danuta Kwiatkowska** and afterwards by **Quartz System Kopalnie**, find application in a limited extend in the foundries.

Quartz crystal was used by the **Cemat 70 Electronic Materials Research and Development Center**[4], and until 2009 by **Thomson Displays** in **Piaseczno** (a manufacturer of TV kinescopes), among others.

Companies involved in quartz, quartzite and quartz-schist production in Poland, as of December 2013

- Strzeblowskie Kopalnie Surowców Mineralnych Sp. z o.o. w Sobótce (Strzeblów Mineral Mines Ltd. of Sobótka), 55–051 Sobótka, ul. Torowa 1, tel. +48 71 3904211, fax +48 71 3904224 www.sksm.pl — *quartz flours*.

[3] At the beginning of 2011 **Chrzanowskie Zakłady Materiałów Ogniotrwałych** were incorporated into **Mostostal Energomontaż** from Cracow. Both companies, belonging to **Ropczyce**, were sold to **Mostostal Rzeszów** in July 2011. Since then **Ropczyce** has been renting a plant in Chrzanów and has been carrying on production of aluminosiliceous and siliceous refractories in the newly formed division.

[4] The production in **Cemat 70** was terminated in December 2010, while in January 2011 it was resumed by newly formed **Cemat Ceramika**.

- Grudzeń Las Sp. z o.o. w Sławnie (Grudzeń-Las Ltd. of Sławno), 26–332 Sławno, tel./fax +48 44 7573234, www.grudzenlas.pl — *quartz flours.*
- PPU Orbud Sp. z o.o. in Łódź (Orbud Ltd. of Łódź), 91–228 Łódź, tel./fax +48 42 6589129, www.orbud.pl — *quartz flours.*
- Kopalnia i Zakład Wzbogacania Kwarcytu Bukowa Góra S.A. w Łącznej (Bukowa Góra Quartzite Mine and Processing Plant of Łączna), 26–140 Łączna, tel. +48 41 2548223, fax +48 41 2548330, www.bukowagora.com.pl — *industrial (refractory) quartzite, crushed quartzite aggregates*.
- Quartz System Kopalnie Sp. z o.o. w Jegłowej (Quartz System Kopalnie Ltd. of Jegłowa), 57-130 Przeworno, tel./fax. +48 74 810 23 26, www.quartzstone.pl — *quartz-schist powder, silica mortats, split tiles, garden stone*.

RARE EARTH ELEMENTS

Overview

The **rare earth elements** (**REE**), or **"lanthanides"** are a group of 14 chemically similar elements with atomic numbers between 57 (**lanthanum**) and 71 (**lutetium**), except for the synthetic element **promethium** (atomic number 61). Although not a lanthanide, **yttrium** (atomic number 39) is often included in the rare earth elements, because it invariably occurs along with them in nature, and has similar chemical properties (see: **YTTRIUM**). The **rare earth elements** and **yttrium** are essential constituents in more than 100 minerals; however, only a few of them occur in sufficient concentration to warrant their use as ore. ***Monazite*** from beach-sand deposits and ***bastnaesite*** from veins and disseminations in complexes of carbonate-silicate rocks are the principal mineral sources of rare earth elements. ***Apatite*** and multiple-oxide minerals, such as ***euxenite*** and ***loparite***, are also commercial sources. Recently it became mandatory to indicate the RE elements predominating in particular minerals by adding the appropriate abbreviation, e.g. ***monazite*** (***Ce***), ***monazite*** (***Nd***), ***fergussonite*** (***Y***), etc.

Due to their similar geochemical properties, the RE elements usually occur in the form of pleiads, with one of them predominant. A technology to separate them from **mischmetal** (a mixture of rare earth elements in metallic form) and obtain high purity compounds was developed after the Second World War.

The RE elements and their compounds are used in the most advanced branches of industry, e.g. for the production of special glass types, lasers, control rods in nuclear reactors, modern ceramic elements, ceramic glazes, superconductors, ferrites, and permanent magnets. They are also used as catalysts in many chemical and petrochemical processes, and in the production of luminophores, and also as additives for various types of alloys (e.g. **cerium**, **erbium**, **neodymium**, and **praseodymium** in metallic form).

Sources

RE minerals are known in Lower Silesia. In the vicinity of **Szklarska Poręba** lenses containing up to 0.5% REO occur, the resources of which amount to 305 t REO (anticipated resources of 1,500 t). Near **Bogatynia** there are ***phosphates of rare earth elements*** containing 1.55% REO (anticipated resources of 150 t). In both cases the rare earth minerals accompany thorium minerals.

On the other hand, there are huge stocks of secondary sources, e.g. ***phospho-gypsum*** after the processing of ***apatites*** imported from the **Chibiński massif** deposits (Kola peninsula, Russia). Dumps of phospho-gypsum at the **Wizów Chemical Plant** contain 8,280 t REE, in an average concentration of 0.69% REE, calculated for dry product (mainly ***yttrium***, ***europium***, and ***yttrium lanthanide***). These parameters are comparable to those which are specific for natural deposits of REE recognized elsewhere. Examinations and tests of phospho-gypsum from Wizów have proved that the recovery of these rare earths may be economically feasible. For several years now, as raw apatites have been replaced by concentrates free from significant admixtures of REE, the contents of these elements in the processing wastes currently generated are very low.

Production

Rare earth elements are not recovered in Poland from the existing sources, and Polish industry does not produce ***rare earth commodities***.

Trade

The total Polish demand for ***rare earth elements*** and their compounds is satisfied by imports (Tab. 1), mainly from China, Western European countries, and the US. In the period 2009–2013 structure of imports was dominated by cerium compounds and rare earth metals compounds (Tab. 1). The level of purchase has followed the demand of the electronics industry, where RE elements are used in many applications. In 2009 imports of ***rare earth commodities*** to Poland were lower by more than 70% in comparison to 2008 reflecting the lower demand from Polish economy. In 2010 domestic demand significantly increased and imports were more than three times greater, but in the next two years imports decreased again, by ca. 60% (Tab. 1). The trade balance (Tab. 2) of ***rare earth commodities*** has been consistently negative, depending on the imports volume, the quality of imported raw materials and the producers' price (Tabs. 1, 2). The same reasons were influencing the unit values of rare earth elements imports to Poland, especially for 2010 and 2011, when unstable deliveries from China – the world leading supplier – to international markets caused the sharp prices increase, and in 2013 when stabilized market conditions resulted in prices significant decrease (Tab. 3).

Tab. 1. Polish imports of rare earths, by country

t

Year	2009	2010	2011	2012	2013
Rare earth metals[1] CN 2805 30					
Imports	**2.4**	**7.9**	**0.0**	**1.7**	**27.0**
Austria	–	0.2	–	0.0	0.1
China	0.4	0.1	0.0	0.2	0.1
Czech Republic	–	–	–	0.9	2.1
France	–	–	–	–	24.2
Germany	1.5	6.1	0.0	0.0	0.1
Netherlands	–	0.4	–	–	–
Sweden	–	–	–	0.5	–
Spain	0.4	0.7	–	–	–
United Kingdom	0.0	0.4	0.0	0.0	0.3
USA	0.0	–	0.0	0.0	0.0

Rare earth metal compounds other than cerium compounds CN 2846 90					
Imports	**15.6**	**47.5**	**21.0**	**12.4**	**13.3**
Austria	3.0	2.0	0.0	0.0	0.0
Belgium	0.0	–	1.0	–	0.0
China	6.0	34.3	8.1	11.5	12.7
Czech Republic	–	0.0	0.0	0.0	–
Finland	–	–	7.0	–	–
France	0.4	0.3	0.5	0.0	0.0
Germany	0.1	0.0	2.6	0.2	0.1
Lithuania	0.5	–	1.0	–	–
Netherlands	5.5	7.2	0.5	0.0	0.0
Switzerland	–	–	0.0	0.0	0.0
Taiwan	0.0	–	0.0	0.0	0.2
Ukraine	–	–	0.3	–	0.0
United Kingdom	0.0	3.6	0.0	0.6	0.0
USA	0.0	0.0	0.0	0.0	0.2
Cerium compounds CN 2846 10					
Imports	**41.0**	**135.4**	**85.5**	**64.9**	**104.0**
Austria	3.2	3.8	2.0	4.1	2.8
Belgium	–	0.0	0.0	0.0	0.1
Bulgaria	–	–	0.5	0.3	0.2
China	11.3	99.4	39.2	35.9	79.0
Czech Republic	1.4	0.3	2.2	0.0	0.0
Denmark	–	–	–	0.9	0.1
France	9.4	10.3	0.8	5.3	4.6
Germany	6.7	8.0	8.3	14.9	12.1
Italy	–	–	2.0	–	–
Japan	–	–	–	–	0.1
Lithuania	–	5.0	3.0	0.0	0.0
Netherlands	–	–	8.0	0.0	0.6
Ukraine	–	–	17.3	–	–
United Kingdom	6.3	7.2	2.0	3.3	3.5
USA	2.7	1.3	0.1	0.2	0.2
Others	–	–	–	–	0.7

[1] together with scandium and yttrium

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Value of rare earth commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Rare earth metals[1] **CN 2805 30**					
Exports	–	16	0	14	14
Imports	106	157	71	117	310
Balance	**-106**	**-147**	**-71**	**-103**	**-296**
Rare earth metal compounds **other then cerium compounds** **CN 2846 90**					
Exports	17	881	16,541	1,111	545
Imports	1,004	7,122	6,449	4,461	2,369
Balance	**-987**	**-6,241**	**+10,092**	**-3,350**	**-1,824**
Cerium compounds **CN 2846 10**					
Exports	70	1,471	9,614	87	292
Imports	1,611	8,851	8,113	7,198	3,322
Balance	**-1,541**	**-7,380**	**+1,501**	**-7,111**	**-3,030**

[1] together with scandium and yttrium

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit values of rare earth commodities imports to Poland

Year	2009	2010	2011	2012	2013
Rare earth metals[1] **CN 2805 30**					
PLN/t	44,287	19,754	1,064,075	18,313	11,483
USD/t	14,516	6,645	359,478	5,570	3,629
Rare earth metal compounds **other then cerium compounds** **CN 2846 90**					
PLN/t	64,333	150,070	306,778	360,234	178,628
USD/t	21,209	49,750	104,387	110,252	56,535
Cerium compounds **CN 2846 10**					
PLN/t	39,296	65,380	96,168	110,898	31,958
USD/t	12,793	21,569	33,023	33,119	10,219

[1] together with scandium and yttrium

Source: ***The Central Statistical Office (GUS)***

Consumption

Rare earths elements in the form of oxides and other compounds are used in the glass-making industry, for optical instruments, in electronics, petrochemicals, ceramics, and for the production of special alloys. Their importance in modern technologies is increasing, beginning with the production of cast iron and continuing to advanced electronics. In spite of the very small amounts, the consumption of rare earth elements is important for the technical development of domestic industry.

RHENIUM

Overview

The main source of **rhenium** (**Re**) is ***molybdenite*** from porphyry deposits of Mo and Cu-Mo ores. Some concentrates contain up to 18.8 kg Re per ton of MoS_2. Rhenium can also be recovered in the form of **ammonium perrhenate** NH_4ReO_4 from ***dust*** generated in course of ***Cu*** and ***Zn-Pb concentrates*** metallurgical processing. **Rhenium metal** is obtained from **rhenium powder** by sintering at a temperature of 1,200°C.

Rhenium has been traditionally utilized in the petroleum industry as Pt-Re catalyst (to obtain high-octane hydrocarbons used in the production of lead-free gasoline), and in the production of high-temperature superalloys applied in jet engines, space rockets, and gas turbines.

The major commercial products containing rhenium are **ammonium perrhenate** (min. 69.2% Re), **rhenium metal**, and **metal powder** (99.99% Re).

Sources

Rhenium is an element associated with ***copper ore*** in the **Fore-Sudetic Monocline** deposits. Its content averages 0.6 ppm Re; however the richest in Re is the shale-type ore — 1.1 ppm, while in sandstone-type it approaches 0.4 ppm, and in limestone-type one — 0.5 ppm. In course of the ore beneficiation Re content is increasing to 5–20 ppm in copper concentrate. Total rhenium resources in copper ore deposits have not been estimated.

Production

Until 2010 the only rhenium commodity produced in Poland has been ***ammonium perrhenate*** (69.2% Re). Since the autumn of 2007 it has been recovered from acid waste water of copper extraction circuit by **KGHM Ecoren** at the **Hydrometallurgical Division** in the **Głogów II copper smelter**. At the end of 2009 the new plant for the ***ammonium perrhenate*** recovery from metallurgical sewage (up to 18,000 m^3 per year) was commissisioned in the **Głogów I smelter**. The production of crystalline ***ammonium perrhenate*** (99.99% NH_4ReO_4) has varied from 5 to 8.5 tpy. In April 2010 the new installation for ***ammonium perrhenate*** processing on pure ***rhenium metal*** (99.95% Re) was commissioned at the **Legnica Smelter**, within the area of the Legnica Technological Park - KGHM Letia. Current capacities of the **Rhenium Plant** has approached 6,000 tpy of Re. **Ecoren** has become the only metallic rhenium producer from own sources in Europe, and has ranked the fourth in the world, after **Chilean Molymet**, **Climax Molybdenum** of the USA and **Dzezkazganredmet** of Kazachstan. Most recently launching of the production of ***powdered rhenium super alloys with nickel and cobalt*** and ***spherical rhenium powder***, which are indispensible in modern aircraft and spacecraft construction, has been also planned. In 2013 the merger of **Ecoren** with **KGHM Metraco** was announced. **KGHM Metraco**, seated in Legnica, is a significant domestic supplier of salt for winter road maintenance and Poland's biggest scrap copper buyer. **Metraco** is going to expand its offer by adding products and services provided by divisions hitherto functioning within the structure of **Ecoren**.

Trade

Poland has exported ***ammonium perrhenate*** to the international market. Until 2013 the sales have been conducted by the **KGHM Ecoren** trade agency — **Traxys Belgium NV/S.A.** The group of recipients has included: the US (**Ultamet**, **Engelhard**), Japan (**Sumitomo Metal Mining**), the United Kingdom (**Rolls Royce**, **Johnson Matthey**), and Austria (**Plansee**). There are no individual data on volume and value of trade for ***rhenium commodities***. In the CN nomenclature they are listed together with niobium in a common position (see: **NIOBIUM**).

Consumption

The main consumer of ***ammonium perrhenate*** has been the petrochemical industry (for the production of catalysts), which utilises approximately 200 kg per annum NH_4ReO_4. Other rhenium commodities are probably not consumed in Poland.

Companies involved in rhenium commodities production in Poland as of December 2013

- KGHM Ecoren, ul. Rycerska 24, 59-220 Legnica, tel. +48 76 7468970, fax +48 76 7468971, www.ecoren.pl — *ammonium perrhenate, metallic rhenium, rhenium super alloys*

ROCK-SMELTING COMMODITIES

Overview

Rock-smelting commodities consist primarily of various types of ***basalt***, ***diabase***, ***amphibolite***, ***andesite***, etc. Two basic kinds of products are obtained through smelting of these rocks: **rock-casting commodities** and **rock wool** (the basic heat-insulation material). **Cast rock products**, particularly of ***basalt***, have high compression strength (490–590 MPa), similar to that of cast iron, and even better resistance to abrasion, and to atmospheric and chemical influences. **Rock wool** is produced by melting rocks at a temperature below 1,400°C, in furnaces similar to glass furnaces, with ***chromite*** added as crystallization nuclei, and then casting in steel or sand molds. Rock wool can be also made of industrial waste materials, such as ***foundry slag*** (**slag wool**).

Sources

Only some Lower Silesian ***basalts*** have been used for the production of rock-smelting commodities. ***Nepheline basalt*** (a basalt variety) from the **Mikołajowice** deposit is the best rock for the production of rock-casting commodities. The ***basalts*** from the **Bukowa Góra**, **Sulików**, and — in minor quantities — **Księginki I** and **Mikołajowice** deposits have been used in the production of ***rock wool***. Despite numerous advantageous properties, basalt is not an optimal raw material for the rock wool production, due to its high crystallization ability. Thus other rocks — ***diabase*** from the **Słupiec-Dębówka** deposit and ***gabbro*** from **Braszowice** deposit — have also begun to be used for this purpose, constituting ca. 50% of raw materials utilised in the production of rock wool.

Production

Cast basalt products have been manufactured at the **Basalt Melting Enterprise Ltd.** of Starachowice and **Kalenborn Delma** (previously: **Delma Bazalt**) of Strzegom. World leading producer of molten basalt products — German company **Kalenborn Kalprotect** — has had shares in both companies for a few years. Molten basalt is cast into molds for lining tiles, railway loading platforms, troughs and pipes for stowing pipelines, elbows, shaped elements, etc. The production of rock-casting commodities ranged from 8 to 10 ktpy in recent years (detailed information unavailable).

Rock wool (mainly made of basalt or diabase) has been produced by Danish company **Rockwool** in plants located in Cigacice and Małkinia, by Finnish company **Partek Paroc** (**Paroc Polska** subsidiary) in Trzemeszno, by Spanish **Uralita Group** (**URSA Polska** subsidiary) in Dąbrowa Górnicza, and by Austrian group **Isoroc** (**Isoroc Polska** subsidiary) in Nidzica. ***Glass wool*** has been manufactured only by **Saint Gobain**

Construction Products Polska in Gliwice. All these plants have been modernized and their production capacities have been expanded. Over the years 2009-2013 the output of rock wool rose by 40% to ca. 470 kt (Tab. 1).

Tab. 1. Rock wool statistics in Poland — CN 6806 10

'000 t

Year	2009	2010	2011	2012	2013
Production	334.1	395.9	449.0	451.2	469.5
Exports	120.6	163.5	194.8	185.0	212.0
Imports	17.6	33.6	35.6	33.4	43.5
Consumption[a]	231.1	266.0	289.8	299.6	301.0

Source: ***The Central Statistical Office (GUS)***

Trade

Since 2009 the volume of ***rock wool*** exported from Poland increased by 75%, to a record 212 kt in 2013 (Tab. 1). Their main recipients have been Germany, Ukraine, Belarus, Lithuania, Russia, Latvia, and Estonia. Imports in ***rock wool*** were a few times lower, in 2013 below 45 ktpy. The main suppliers have been Germany and the Czech Republic. The balance of ***rock wool*** trade has been positive in recent years (Tab. 2). Rock wool of the highest quality and most expensive, has been usually imported, while rock wool of standard quality has been exported, though this has recently changed (Tab. 3). Due to the increase in exports volume that in 2013 accounted for ca. 45% of the domestic production, positive trade balance rose up to almost 670 million PLN (Tab. 2).

Tab. 2. Value of rock wool trade in Poland — CN 6806 10

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	430,281	506,753	681,945	768,519	814,014
Imports	82,179	153,018	144,223	131,117	144,868
Balance	**+348,102**	**+353,735**	**+537,722**	**+637,402**	**+669,146**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Average unit values of rock wool trade in Poland — CN 6806 10

Year	2009	2010	2011	2012	2013
Average exports unit values					
PLN/t	3,567.2	3,098.9	3,501.3	4,153.4	3,839.4
USD/t	1,154.5	1,026.0	1,190.5	1,270.1	1,220.9
Average imports unit values					
PLN/t	4,674.3	4,557.4	4,053.5	3,931.1	3,327.4
USD/t	1,532.2	1,520.2	1,372.9	1,204.4	1,059.2

Source: ***The Central Statistical Office (GUS)***

Consumption

Rock-casting commodities are used mainly in underground hard coal and ore mines (in stowing pipelines), chemical plants (acid and wear resistant linings), municipal sewage systems, and bulk material reloading stations.

Rock wool is utilized primarily for the production of insulating plates, pipeline mats, and lagging; the density of the materials varies usually from 45 to 180 kg/m^3, and the thickness from 2 to 12 cm. Some of these products are hydrophobized. Small amounts of rock wool are added to bituminous pavement mixes and asbestos-cement products to replace asbestos. Special grades of rock wool are used as insulating refractory materials.

The per capita consumption of ***rock wool*** in Poland climbed from 6.1 kgpy in 2009 to almost 8.0 kgpy in 2013. It is worth mentioning that per capita consumption in Western Europe has amounted to 10–15 kgpy, and over 20 kgpy in Scandinavia. Continuous rise of energy prices on the domestic market, and stringent requirements regarding thermal insulation of new dwellings, enforcement of so-called "Thermo-modernization projects strengthening Act" in 1998, as well as the almost unlimited availability of domestic raw materials for the production of rock wool, should further stimulate the growth of the domestic rock wool consumption.

Principal companies involved in rock-smelting commodities production in Poland, as of 31 December 2013

- Kalenborn Bazalt Sp. z o.o. w Starachowicach (Kalenborn Bazalt Ltd. of Starachowice), ul. Piłsudskiego 68, 27–200 Starachowice, tel. +48 41 2745351, fax +48 41 2746150, www.kalenborn.com/pl — *cast basalt.*
- Kalenborn Delma Sp. z o.o. w Strzegomiu (Kalenborn Delma Ltd. of Strzegom), ul. Olszowa 60, 58–150 Strzegom, tel. +48 74 8555400, fax +48 74 8555401, www.kalenborn.com/pl — *cast basalt.*
- Rockwool Polska sp. z o.o w Cigacicach (Rockwool Polska Ltd. of Cigacice), ul. Kwiatowa 14, 66–131 Cigacice, tel. +48 68 3850250, fax +48 68 3850234, www.rockwool.pl — *rock wool.*
- Paroc Polska Sp. z o.o. w Trzemesznie (Paroc Polska Ltd. of Trzemeszno), ul. Gnieźnieńska 4, 62–240 Trzemeszno, tel. +48 61 4682190, fax +48 61 4682304, www.paroc.pl — *rock wool.*
- URSA Polska Sp. z o.o. w Dąbrowie Górniczej (URSA Polska Ltd. of Dąbrowa Górnicza), ul. Armii Krajowej 12, 42–520 Dąbrowa Górnicza, tel. +48 32 2680101, fax +48 32 2640791, www.ursa.pl — *rock wool.*
- Isoroc Polska Sp. z o.o. w Nidzicy (Izolacja Joint Stock Co. of Nidzica), ul. Leśna 30, 13–100 Nidzica, tel. +48 89 6250300, fax +48 89 6250302, www.isoroc.pl — *rock wool.*
- Saint Gobain Construction Products Polska Sp. z o.o. w Gliwicach (Saint Gobain Construction Products Polska Ltd. of Gliwice), ul. Okrężna 16, 44–100 Gliwice, tel. +48 32 3396300, fax +48 32 3396444, www.isover.pl — *glass wool.*

RUBIDIUM

Overview

In nature, **rubidium** (**Rb**) mainly occurs as dispersed element in lithium minerals (***lepidolite***), cesium minerals (***pollucite***), ***carnalite salts***, ***salty seawaters***, and ***geothermal waters***. It is recovered mainly from ***alcarb*** (waste remaining after the processing of ***lithium concentrates***), and as a by-product of cesium production from ***pollucite*** and ***brines***.

Metallic rubidium is used in the production of photocells, and **rubidium compounds** for the building of thermionic converters (heat-electricity converters) and in electronics. The introduction of **rubidium oxide** Rb_2O into glass considerably increases its hardness, but lowers its softening point. The high price of rubidium and its compounds is the primary factor limiting consumption, particularly when substitutes can be applied (mainly in the production of light-sensitive instruments): cesium, germanium, tellurium, selenium, silicon, and others.

Sources

There are no ***rubidium-bearing*** deposits in Poland.

Production

There is no ***rubidium*** production in Poland.

Trade

Domestic demand for ***rubidium*** has been satisfied by imports, mainly of highly processed products, but there are no data available.

Consumption

There are no data available on the structure of ***rubidium*** consumption in Poland.

SALT

Overview

Salt (**sodium chloride NaCl**) is one of the basic minerals, in use for 5,000 years. Bedded deposits and salt-domes of ***rock salt***, containing principally ***halite*** NaCl, are the main source of salt. It is also obtained from the evaporation of ***salty water***, ***sea water***, and ***natural*** or ***artificial brine***, as well as ***salty mine water***. For centuries, it has been consumed directly by both people and animals. Since the 19th century, sodium chloride has also been of fundamental importance in the production of ***calcined soda***, ***caustic soda***, and ***chlorine*** — the most widely applied inorganic compounds in modern industry.

Sources

Poland has large deposits of ***rock salt***, of total resources of 86,098 Mt (as of 31 December 2013). Only about 18.4% of the domestic resources has been in deposits currently operated. The most important are the deposits of the ***Zechstein formation***, which occur as ***salt-domes*** in the Kujawy region and the vicinity of Poznań (where the **Góra**, **Mogilno I**, **Mogilno II**, and **Kłodawa** deposits are extracted), or in bedded form in the **Pomerania** region (e.g. **Mechelinki** deposit, where **Underground Cavity Natural Gas Storage Kosakowo** started to be constructed) and in the **Fore-Sudetic Monocline** (extracted from **Sieroszowice** deposit and its part, recognized in 2013 – **Bądzów**, where salt is a co-product of ***copper ore***). The ***Miocene salt formation*** of the **Carpathian Foredeep** is of minor significance. There are also mines of only historical importance in **Wieliczka**, **Bochnia**, and **Kraków-Barycz**. The largest Miocene deposits are **Wojnicz** near Tarnów and **Rybnik-Żory-Orzesze** (Upper Silesia), but they are not intended for development.

Another source of NaCl is ***salty water*** from ***hard coal*** mines in the **Upper Silesian Coal Basin** and from the **Rudna copper ore** mine near Lubin. However, it has been utilized to a very small extent. Discharging of that water is damaging to environment and is only a burden on the mines' budgets.

Production

Until 2011 the production of ***rock salt*** has risen to 1.2 Mtpy, in 2012 it decreased to 0.8 Mt, while in 2013 increased again up to 1.3 Mt. On the contrary, until 2010 the output of ***salt brine*** has bee distinctly reduced, while in the following years it rose up to 2.7 Mtpy. As a result, the total salt production varied from 3.5 to around 4.1 Mt (Tab. 1). In the ***salt*** production structure, the share of ***rock salt*** increased to 32%, with ***brine*** constituting the rest.

Tab. 1. Salt statistics in Poland — CN 2501

'000 t NaCl

Year	2009	2010	2011	2012	2013
Total production	3,532.1	3,699.9	3,887.2	3,524.7	4,056.0
— *rock-salt*	*998.7*	*1,235.5*	*1,253.9*	*792.5*	*1,320.5*
— *brine*	*2,533.4*	*2,464.4*	*2,633.3*	2,732.2	2,735.5
Imports	483.3	887.1	1,043.4	454.9	906.8
Exports	510.5	565.3	521.6	396.0	625.7
Consumption[a]	3,504.9	4,021.7	4,409.0	3,583.6	4,337.1

Source: ***The Central Statistical Office (GUS)***

Domestic supply of ***salt*** in 98% originates from rock salt deposits. The other sources are: mine waters desalination in hard coal mines and closed historic salt mines, but also — in small amounts — salty water springs (e.g. Ciechocinek spa).

The production of ***rock salt*** has come mainly from **Kłodawa** underground salt mine, offering ***rock salt*** (97.5% NaCl) for industrial and human consumption, obtained in course of simple processing. This production, which amounted to 823 kt in 2010, in subsequent years was reduced, to 617 kt in 2013. Another rock salt producer has been the underground **Sieroszowice-Polkowice Copper Mine** operated by **KGHM Polska Miedź**, extracting salt from **Sieroszowice** deposit. In the years 2009–2013 this production was increasing, approaching 490 kt in 2013. Marginal amounts of ***rock salt*** for direct use have been also supplied by the underground **Wieliczka Salt Mine**.

Brine obtained by leaching of rock salt deposits has been the main primary source of salt in Poland. Its share in total domestic production has varied between 67 and 72%, while in 2012 it was 78%. The dominant producer — **Inowrocław Salt Mines Solino** (**GK PKN ORLEN** group) reduced the output from ca. 2.5 Mtpy to ca. 2.1 Mt in 2013. It has operated two well mines: **Mogilno I** and **Góra**. Moreover, in extracted salt cavities in Góra deposit, **Underground Storage of Oil and Fuels** (**USOF**) was finally formed. USOF will have total capacity of ca. 5 Mm^3 in 10 cavities. The exploitation of the **Mogilno II** deposit, carried out by **Polish Oil and Gas Company** of Warsaw through its subsidiary — **Investgas** (in July 2013 was taken over by **Operator of Storage System – OSS** owned by POGC), have been prepared cavities of **UCNGS Mogilno**. Their output has depended on intensity of such works, e.g. in the years 2011–2013 it was 750-870 ktpy salt in brine. In 2010 **Investgas** (since 2013 - OSS) started to leach **Mechelinki** deposit (north of Gdańsk) and launched the construction of **Underground Cavity Natural Gas Storage Kosakowo**. In 2013 there were 649 kt of salt in brine leached. However, it was not utilized in the industry, but directed to the Puck Bay of the Baltic Sea. Finally, this storage facility will consist of 10 caverns, each of capacity of 250 million m^3 of gas.

The **Wieliczka** and **Bochnia** salt deposits, in southern Poland near Cracow, were extracted for about 1,000 years, and now they are of only historical importance. In the oldest Polish shaft mines — **Wieliczka** and **Bochnia** — tourist and rehabilitation parts were delineated. In Wieliczka mine, for protection of museum part of mine, salty waters have been collected and up to 20,000 tpy of ***evaporated salt*** has been produced.

In addition to individual rock salt deposits, ***mineralized underground waters*** from hard coal mines in the **Upper Silesian Coal Basin** are also a source of sodium chloride. Their discharge into surface water is responsible for ecological disaster in the upper Vistula and upper Odra river valleys. The pilot plant **Dębieńsko Underground Water Desalination Plant** was constructed in 1975 to utilize salty water and produce ***evaporated salt*** (production capacity of 45 ktpy). In the years 1994–1995, the second **Dębieńsko II** plant (capacity 110 ktpy) was commenced. Since 1999, they have been included in **Dębieńsko Desalination Plant** (belonging to **Kompania Węglowa**), manufacturing 75–85 ktpy of ***evaporated salt***.

Evaporated salt has been produced from salt brine in saltplants. The largest evaporation plant has been Janikowo (**Soda Polska Ciech** — former **JZS Janikosoda**), delivering ca. 600 ktpy of ***evaporated vacuum salt*** with 99.8% NaCl. **Wieliczka** and **Dębieńsko** plants have been of minor importance. ***Precipitated salt*** has been recovered from post-production solutions in the plants, processing salt brine into chemical products other than evaporated salt. The largest installation of this type has been **Anwil Nitrogen Plants** (**ORLEN Group**) of Włocławek. The total supply of evaporated and precipitated salt amounted to 765 kt in 2013 (including 265 kt of edible salt).

Trade

Poland usually exported both ***rock salt*** and ***evaporated salt***. In the years 2009–2010, as a result of heavy winter, exports were above 0.6 Mtpy, with over 83% combined share of the Czech Republic, Germany and Slovakia (Tab. 2). In the years 2011–2012 exports decreased to ca. 0.4 Mtpy, while in 2013 foreign sales increased to ca. 0.64, with Slovakia among the main customers. Due to the same reasons, imports of salt from Ukraine and Belarus for road maintenance in 2009, and especially in 2010-2011 (from Belarus, Ukraine and Germany), rose to over 1,040 kt. In 2012, imports were reduced by over half, especially from Ukraine, but in 2013 they recovered to 907 kt (Tab. 3). Poland has been previously net exporter of salt, but since 2010 it - probably temporarily – has become a net salt importer.

Tab. 2. Polish exports of salt and pure sodium chloride, by country — CN 2501

'000t

Year	2009	2010	2011	2012	2013
Exports	**510**	**565**	**522**	**396**	**626**
Austria	7	13	4	2	2
Belgium	22	23	22	17	21
Czech Republic	235	236	218	156	268
Finland	3	5	4	1	2
France	9	8	6	5	3
Germany	142	174	189	94	171
Hungary	5	5	5	5	5
Latvia	2	2	2	3	3
Lithuania	7	9	10	10	10

Netherlands	2	1	1	0	0
Norway	1	1	1	1	1
Romania	3	3	1	1	1
Slovakia	54	63	38	78	114
Sweden	12	13	13	12	11
Others	6	9	8	11	14

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Polish imports of salt and pure sodium chloride, by country — CN 2501

'000t

Year	2009	2010	2011	2012	2013
Imports	**483**	**887**	**1,043**	**455**	**907**
Belarus	228	382	434	217	421
Czech Republic	1	1	0	1	5
Egypt	–	7	17	0	–
Germany	96	126	165	137	183
Slovakia	5	6	6	6	4
Ukraine	151	361	419	90	287
Others	2^r	4^r	2	4^r	5

Source: ***The Central Statistical Office (GUS)***

The balance of ***salt*** and ***pure sodium chloride*** trade has been usually positive, except for 2011. In 2011 high imports (two times higher than exports) resulted in a small trade deficit. In 2012 trade balance returned to positive value and amounted to over 31 million PLN, while in 2013 it decreased to 14 million PLN (Tab. 4). Positive trade balance resulted also from higher exports unit values in comparison to unit cost of importation (Tab. 5).

Tab. 4. Value of salt and pure sodium chloride trade in Poland — CN 2501

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	122,683	133,328	139,517	113,172	154,581
Imports	60,619	99,618	139,789	81,616	140,358
Balance	**+62,064**	**+33,710**	**-272**	**+31,556**	**+14,223**

Source: ***The Central Statistical Office (GUS)***

Consumption

The main consumers of ***salt brine*** are soda works and other chemical plants. In 2013 around 24% of salt brine was used for ***evaporated salt*** manufacture, ca. 62% for the production of ***calcined soda***, and the remaining 14% - other chemical compounds, including ***chlorine*** and ***caustic soda***.

Tab. 5. Average unit values of salt and pure sodium chloride trade in Poland — CN 2501

Year	2009	2010	2011	2012	2013
Imports unit values					
PLN/t	125.4	112.3	134.0	179.4	154.8
USD/t	40.8	37.7	45.2	55.1	49.4
Exports unit values					
PLN/t	240.3	235.8	267.5	285.8	247.1
USD/t	78.2	78.9	91.0	87.3	78.8

Source: ***The Central Statistical Office (GUS)***

The largest amounts of salt-brine are consumed by the **Soda Polska Ciech** in Janikowo soda plant (former **Janikosoda Soda Works**, ca. 1,500 ktpy of NaCl, used in the production of ***calcined soda*** and ***evaporated salt***), and in Inowrocław soda plant (former **Soda Mątwy Works**, ca. 900 ktpy of NaCl, mainly for the production of ***calcined soda***). Smaller amounts of salt-brine are consumed by the **Organika-Zachem Chemical Works** in Bydgoszcz (approx. 100 ktpy, used in the production of ***chlorine***, ***caustic soda***, and ***chemical compounds***) and other chemical plants.

Rock salt and ***evaporated salt*** are directly consumed mainly by humans and animals. In addition, significant amounts are used in the production of ***chlorine*** and ***caustic soda*** (**Anwil Nitrogen Plants** of Włocławek, **PCC Rokita** in Brzeg Dolny, **Nitrogen Works** in Tarnów). Other applications include plastics, refrigeration engineering, textiles, and agriculture, as well as the food industry and forestry. In the years 2010–2011, and in 2013, due to long and heavy winters in Poland, rock salt was used primarily for road maintenance.

Companies involved in salt production in Poland, as of December 2013

- Inowrocławskie Kopalnie Soli Solino S.A. (Solino Inowrocław Salt Mines Joint Stock Co. of Inowrocław), ul. Św. Ducha 26a, 88–100 Inowrocław, tel. +48 52 3545800, fax +48 52 3575837, www.solino.pl — *salt brine.*
- Polski Górnictwo Naftowe i Gazownictwo S.A. (Polish Oil and Gas Company Joint Stock Co. of Warsaw), ul. Krucza 6/14, 00–537 Warszawa, tel. +48 22 5835000, fax +48 22 5835856, www.pgnig.pl — *salt brine.*
- Kopalnia Soli Kłodawa S.A. (Kłodawa Salt Mine Joint Stock Co. of Kłodawa), Al. 1000-lecia 2, 62–650 Kłodawa, tel. +48 63 2733200, fax +48 63 2731560, www. sol-klodawa. com.pl — *rock salt.*
- Kopalnia Soli Wieliczka (Wieliczka Salt Mine of Wieliczka), Park Kingi 1, 32–020 Wieliczka, tel. +48 12 2787002, fax +48 12 2787110, www.kopalnia-pp.pl — *evaporated salt, rock salt.*
- KGHM Polska Miedź S.A. (KGHM Polska Miedź Joint Stock Co. of Lubin), ul. Marii Skłodowskiej-Curie 48, 59–301 Lubin, tel. +48 76 8481111, fax +48 76 8451527, www.kghm.pl — *rock salt.*
- Soda Polska Ciech Sp. z o.o. Zakład Janikosoda w Janikowie (Soda Polska Ciech Ltd. Janikosoda Works of Janikowo), ul. Przemysłowa 30, 88–160 Janikowo, tel. +48 52 3544100, fax +48 52 3544333, www.janikosoda.pl — *evaporated salt.*

- Anwil Zakłady Azotowe S.A. we Włocławku (Anwil Nitrogen Plants Joint Stock Co. of Włocławek), ul. Toruńska 222, 87–805 Włocławek, tel. +48 54 2363091, fax +48 54 2369786, www.anwil.com.pl — *precipitated salt.*
- Zakład Odsalania Dębieńsko Sp. z o.o. (Dębieńsko Desalination Plant Ltd.), ul. Młyńska 24, 44–230 Czerwionka-Leszczyny, tel. +48 32 4270280, fax +48 32 4312420, www.odsalanie.com.pl — *evaporated salt.*

SAND FOR LIME-SAND PRODUCTS AND CELLULAR CONCRETE

Overview

Quartz sand used for the production of ***lime-sand construction materials*** and ***cellular concrete*** is generally of ordinary or low quality, with 80–90% SiO_2, 5–10% clayey minerals, and 5–15% content of grains 2–4 mm. This group of quartz sand is sometimes included into the wide group of **industrial sand**. However, in other classifications, group of **industrial sand** does not include sand for ***lime-sand construction materials*** and ***cellular concrete***, as well as ***filling sand*** (see: **SAND, FILLING**) and ***construction sand*** classified as an ***aggregate*** (see: **AGGREGATES, MINERAL**).

Sources

Deposits of Quaternary ***quartz sand*** suitable for the production of ***lime-sand brick*** are of common occurrence in all 16 voivodeships. The largest are documented in northern and central Poland, especially in the Mazowieckie, Lubelskie, Zachodniopomorskie, Kujawsko-Pomorskie, and Łódzkie voivodeships. Deposits in the southern part of the country are smaller and of minor importance. Of the 105 recognized deposits, with reserves of 269 Mt (as of 31 December 2013), 29 are currently under operation, but 6 of them periodically.

Deposits of Quaternary ***quartz sand for cellular concrete*** are also common in Poland. Out of a total of 59 deposits, containing almost 144 Mt, 14 are in operation, but one of them periodically. The largest deposits are in central Poland, especially in the Lubelskie, Łódzkie, Kujawsko-Pomorskie, Wielkopolskie, and Mazowieckie voivodeships. Deposits in northern Poland are of minor importance, whereas deposits in southern Poland are marginal.

Production

Quartz sand for lime-sand products has been extracted at 27 pits in 12 voivodeships, but 7 of them have been operated periodically, therefore in 2013 in fact the mine output was recorded only in 20 mines. Production volumes are dependent on the demand from local markets, but commonly do not exceed 50,000 m^3py in a single mine. In the last year the highest level of output was recorded in following mines: **Barcin-Piechcin-Pakość** (72,000 m^3) in Kujawsko-Pomorskie voivodeship, and **Iława II** (57,000 m^3) in Warmińsko-Mazurskie voivodeship (Tab. 1). In 2013 in almost all the mines decline in mining output was recorded, what was reflected in the scale of the country. Additionally mining output from **Teodory** deposit in Łódzkie voivodeship was temporarily halted. All deposits are exploited for the needs of the local ***lime-sand materials*** plants. The financial and economic crisis initiated in 2008 resulted in lower production of the lime-sand products (Tab. 3), as well as decrease of output of sand for their manufacturing, by more than 32% in 2009 in almost all mines (Tab. 1). In the following two years, most of them managed to restore the level of output, so that the total mining production amounted to 780,000 m^3 in 2011. The year 2012, especially its second half brought another decline in demand for lime-sand products and fall of output of sand for their manufacturing to the level of 731,000 m^3 (Tab. 2). In 2013 this decline was even deeper and production reached the level of 520,000 m^3 - the lowest in the analyzed period of five years, in connection with the lack of economic recovery in the construction industry, especially in the first half of the year.

Tab. 1. Output of sand for lime-sand products

'000 m^3

Year	2009	2010	2011	2012	2013
Mining output	**560**	**615**	**780**	**731**	**519**
Kujawsko-Pomorskie	40	66	100	122	119
Lubelskie	27	15	17	16	15
Łódzkie	32	36	44	59	-
Małopolskie	56	43	56	49	50
Mazowieckie	137	151	153	133	88
Opolskie	25	26	34	24	15
Podkarpackie	15	7	20	20	12
Podlaskie	3	9	24	10	11
Pomorskie	32	16	48	42	24
Świętokrzyskie	42	34	33	36	22
Warmińsko-Mazurskie	20	120	111	101	84
Wielkopolskie	120	87	123	115	76
Zachodniopomorskie	11	5	16	4	3

Source: ***Mineral Resources Datafile***

The lime-sand plants, which operate pits of such sand, are autonomous enterprises or are subordinated to larger enterprises, e.g. **Niemce Building Materials Enterprise**, manufacturing both lime-sand products and cellular concrete blocks. The autonomous enterprises are — among others — in **Żytkowice**, **Silikaty-Trąbki** (Szczecin), in **Białystok (P.P.H. Silikaty-Białystok**), **MEGOLA** in **Hedwiżyn**, **Silikaty Szlachta or SIL-PRO Silicate Blocks** in Godzikowice in the Lower Silesia. As a result of the consolidation and ownership changes some plants created multi-plants enterprises such as: **Xella Poland** or **Silikaty Group.** Xella Poland located with office registered in Poznań produces silicate products under the trade name **Silka** now in six plants: Michałów - Reginów, Iława, Pasym, Trzciniec, Żabinko and Wincentów near Radom and also produces cellular concrete products in plants in: Ostrołęka, Sieradz, Milicz, Piła and Powodowo. The **Silikaty Group** delivering today about 30% of the domestic supply of sand-lime products, consolidated seven plants in Kruki near Ostrołęka, Pisz, Przysieczyn, Ludynia, Leżajsk, Klucze and Jedlanka.

Quartz sand for cellular concrete was extracted at 13 pits in 8 voivodeships in 2013 (Tab. 2). Production volumes depend upon the demand from local markets, but commonly do not exceed 50,000 m^3py in a single mine. In 2013, the highest level of output was recorded in following mines: **Studzienice** (116,000 m^3) in Pomorskie voivodeship, **Tuchorza** (30,000 m^3) in Wielkopolskie voivodeship, and **Lidzbark Welski** (47,000 m^3) in Warmińsko-Mazurskie voivodeship (Tab. 2). All deposits are exploited for the needs of the local cellular concrete production plants, being their owners. Some of these plants use also sand from other sources, i.e. ***construction sand*** of appropriate quality. At present, 23 cellular concrete plants utilize ***quartz sand***, whereas the remaining 7 — ***fly ash*** from power plants (see also: **CONCRETE AND CONCRETE PRODUCTS**). In 2012, the **Association of White Wall Materials Producers White masonry work** was created, associating most of manufacturers of cellular concrete and sand-lime products (including Xella and Silikaty Group).

Tab. 2. Mining output of sand for cellular concrete production

'000 m^3

Year	2009	2010	2011	2012	2013
Mining output	**322**	**397**	**414**	**355**	**334**
Dolnośląskie	21	24	23	23	21
Lubelskie	66	15	44	33	34
Łódzkie	21	31	25	19	20
Mazowieckie	47	46	34	19	6
Pomorskie	82	119	140	94	117
Świętokrzyskie	–	–	4	14	16
Warmińsko-Mazurskie	42	62	74	69	61
Wielkopolskie	43	70	69	85	60

Source: ***Mineral Resources Datafile***

Tab. 3. Production of lime-sand products in Poland

'000 m^3

Year	2009	2010	2011	2012	2013
Lime-sand wall elements	**915.9**	**942.2**	**1,375.9**	**1,208.1**	**1,098.9**
• *including* lime-sand brick	437.9	487.8	615.7	579.5	544.1

Source: ***The Central Statistical Office (GUS)***

The total mining output of ***quartz sand for cellular concrete*** was ranging between 320,000–400,000 tpy, except for 2011, when this level was exceeded, and reached 414,000 t (Tab. 2). However, for the production of cellular concrete good quality raw materials from deposits of construction sand and fly ashes were also utilised instead of such sand.

Trade

Quartz sand for lime-sand products, as well as ***for cellular concrete*** is used entirely for the needs of local lime-sand products and cellular concrete products plants.

Consumption

Lime-sand products produced in autoclaves are made of ***quartz sand***, ***milled lime***, and ***water*** (90% sand, 7% lime, 3% water). They have been widely used in building construction, being cheaper than conventional ceramic building materials. Many types of ***lime-sand products*** are produced, such as ***bricks***, ***tiles***, ***blocks***, ***channels***, etc. Their production significantly weakened by the crisis in 2009 to the level of 915,000 m^3, was managed to rebuild in the coming years, so that in 2011 reached almost 1.4 Mm^3. However, in the next years, production levels began to decrease again to less than 1.1 Mm^3 in 2013. In the structure of production the share of lime-sand brick increased, in the total production of silicate from 45% in 2011 to almost 50 % in 2013 (Tab. 3). The lime-sand products make only 9% of building wall elements in domestic market, where the largest share have cellular concrete products (43% share in market in 2011) and "red ceramics" products (34%).

Quartz sand for cellular concrete is used entirely for cellular concrete production. The competition from substitutes (especially cellular concrete made of ***dust*** and ***fly ash*** from power plants and thermal-electric power stations) were the main reasons for weak demand for cellular concrete products based on quartz sand.

Companies involved in lime-sand products and cellular concrete production, as of December 2013

- Xella Polska Sp. z o.o. w Warszawie (Xella Polska Ltd. of Warsaw), ul. Pilichowiecka 9/11, 02–175 Warszawa, tel. +48 22 5732000, fax +48 22 5732070, www.xella.pl — *lime-sand products*, *cellular concrete products.*
- Zakład Wapienno-Piaskowy Silikaty S.A. (Silikaty Lime-Sand Plant Joint Stock Co.), Teodory, 98–100 Łask, tel. +48 43 6752651, fax +48 43 6752028, www.silikaty-teodory.pl — *lime-sand products*.
- Zakłady Silikatowe Żytkowice S.A. (Żytkowice Lime-Sand Works Joint Stock Co.), Żytkowice, 26–930 Garbatka Letnisko, tel. +48 48 6210065, fax +48 48 6210649, www.silikaty-zytkowice.com.pl — *lime-sand products*.
- Silikaty-Trąbki sp. z o.o. (Silikaty-Trąbki Ltd.), Plac Batorego 3, 70–207 Szczecin, tel. +48 91 4345085, fax. +48 91 4346166, www.silikaty-trabki.pl — *lime-sand products.*
- Zakład Wapienno-Piaskowy Bełżec Sp. z o.o., (Lime-Sand Plant Bełżec Ltd.), 22–670 Bełżec, ul. Wąska 121 tel. +48 84 6652450, fax. +48 84 6652338, www.zwp-belzec.pl — *lime-sand products.*
- Przedsiębiorstwo Produkcji Materiałów Budowlanych Niemce S.A. (Production of Building Materials Enterprise of Niemce Joint Stock Co.), 21–025 Niemce k. Lublina, ul. Ceramiczna 6, tel. +48 81 7564400, fax. +48 81 7561627, www.ppmb-niemce.com.pl — *lime-sand products*, *cellular concrete products.*
- Silikaty Ostrołęka Sp. z o.o. (Silikaty Ostrołęka Ltd.), Grabowo, 07–400 Ostrołęka, tel./fax +48 29 7602908, www.grupasilikaty.pl — *lime-sand products*.

- Przedsiębiorstwo Produkcyjno-Handlowe Silikaty-Białystok Sp. z o.o. (Silikaty-Białystok Production and Trade Enterprise Ltd.), ul. Wysockiego 164, 11–167 Białystok, tel./fax +48 85 6751576, www.silikaty.com.pl — *lime-sand products*.
- Zakład Produkcji Silikatów Ludynia Sp. z o.o. (Silikaty Production Plant Ltd. of Ludynia), 29–105 Krasocin, tel./fax. +48 41 3917021 — *lime-sand products*
- Grupa Prefabet S.A. (Grupa Prefabet Joint Stock Co.), 26–900 Kozienice, tel. +48 48 6142807, fax +48 48 6143789, www.grupa-prefabet.pl — *cellular concrete products*.
- Solbet Sp. z o.o. (Solbet Ltd.), ul. Toruńska 71, 86–050 Solec Kujawski, tel. +48 52 3874100, fax +48 52 3872209, www.solbet.pl — *cellular concrete products*.
- Bruk-bet Sp. z o.o. (Bruk-bet Ltd.), Nieciecza 199, 33-240 Żabno, tel. +48 14 6377778, fax +48 14 6377784, www.bruk-bet.pl — *cellular concrete products*
- SIL-PRO Bloczki Silikatowe Sp. z o.o., (Sil-Pro Silicate Bloks Ltd.) Godzikowice 50 M, 55-200 Oława, tel. +48 71 7215050, fax.: +48 71 7215051, www.sil-pro.pl — *lime-sand products*

SAND, FILLING

Overview

Filling sand, i.e. **quartz sand** used for underground mines filling, has usually ordinary or even low quality. It should demonstrate the following parameters: max. 10–20% content of undersize grains (50 mm), below 0.5% of organic matter, max. 5–15% compressibility at the pressure of 15 MPa, min. 0.0004–0.007 cm/s water-permeability. Due to the high transportation costs and low unit price of filling sand, they are extracted within max. 50 km from underground mines, where they are used.

Sources

Poland is abundant in ***filling sand*** deposits, the majority of which usually occur in the vicinity (within 50 km) of underground mines of coal, copper, and zinc-lead ores. There are 34 deposits recognized (including 30 deposit in Upper Silesia region). Their total reserves amount to 2,471 Mt (as of 31 December 2013), of which less than 18% are in the 8 developed deposits, where one Bór (Wschód) has been exploited temporarily since 2013. The largest deposits are located along the eastern edge of the Upper Silesia Coal Basin, including the operated deposits at **Szczakowa-Pustynia Błędowska**. Another important area is the western edge of the Upper Silesia Coal Basin (which supplies sand for the Rybnik Coal District), including the **Kotlarnia** region as the most significant. Three deposits for copper ore mining purposes are recognized in Lubin area, including **Obora** operated deposit.

Production

Filling sand is predominantly mined in the eastern and western parts of the **Upper Silesia Coal Basin** (for the needs of coal mines) and near **Lubin** (for copper mines). Over 60-65% of the total production comes from the eastern part of the Upper Silesia Coal Basin (Tab. 1). The largest supplier (above 50% of domestic production volume) of ***Class I filling sand*** is the **DB Schenker Rail Polska**, which exploits deposits in the area of **Szczakowa**, **Pustynia Błędowska**, and **Siersza** on the border of Śląskie and Małopolskie voivodeships. The main consumers of sand from Szczakowa are coal mines in the Upper Silesia, the ZGH Bolesław Zn-Pb ore mine, and Wieliczka Salt Mine. Besides filling sand, the company also offers building sand, as well as foundry sand, but latter ones are marginal part of the **DB Schenker Rail** production as compared to amount of filling sand sales (3.5–5.4 Mtpy). The filling sands production has declined, due to decreasing demand of the coal mines and development of assortments for building applications (total 1.65 Mt in 2010).

The second significant producer of filling sand in the eastern part of the Upper Silesia Coal Basin is **CTL Logistic**, which exploits **Bór Wschód** and **Bór Zachód** deposits, close to coal mines in the Sosnowiec region, and delivers ***Classes I***, ***II***, and ***III filling sand***.

Tab. 1. Mining output of filling sand in Poland

'000 m^3

Year	2009	2010	2011	2012	2013
Total mining output	**5,928**	**5,090**	**4,405**	**3,762**	**3,649**
Dolnośląskie	1,594	1,331	1,097	871	920
Opolskie	777	550	482	340	468
Małopolskie	2,721	2,541	2,314	1,878	1,878
Śląskie	836	668	512	673	384

Source: ***Mineral Resources Datafile***

On the western edge of the Upper Silesia Coal Basin there is the **Kotlarnia Sand Pit** in Pyskowice, which exploits deposits in the **Kotlarnia** area, which mining output since 2004 has been fully utilized as construction aggregates.

In the Lower Silesia, only one filling sand deposit — **Obora** — has been extracted by **KGHM Polska Miedź** for years. The mining output of company ranging ca. 1.1–1.5 Mm^3py after significant reduction to 870,000 m^3 in 2012, was slightly restored to the level of 920,000 m^3 in 2013. Almost 95% of filling sand is consumed in copper mines in the Lubin area, whereas 5% is sold for individual consumer for engineering construction works.

The level of filling sands extraction, despite the partial sale for building applications, has systematically declined year by year and reached 3.6 Mm^3 in 2013, mainly because of decreasing tendency of their use for filling of mine excavations. Since 2009, as a result of the PKWiU classification changes filling sands are recorded under the item 08.12.11.90 "Natural sands". Since 2011, due to the unavailability of data, it is also difficult to estimate the size of their domestic supply based on the information from the largest suppliers, i.e. DB Schenker and Sand Pit Obora. Until 2010 it could be achieved with 5.5-6.0 Mm^3py.

The change of PKWiU classification resulted in problems with fixing the average unit values of ***filling sand*** production. It is only possible to present the average unit values for natural sand, which since 2011 has remained at a level more than 11 PLN/t (Tab. 2).

Tab. 2. The average unit values of filling sand production in Poland — PKWiU 08121190[1]

Year	2009	2010	2011	2012	2013
PLN/t	10.9	10.0	11.2	11.5	11.2
USD/t	3.5	3.3	3.8	3.5	3.5

[1] average unit value of natural sand registered in item **PKWiU** 08121190— **Other natural sand**

Source: ***The Central Statistical Office (GUS)***

Trade

Filling sand is used entirely for the needs of the local underground mines. It is not traded internationally.

Consumption

The consumption of filling sand (used for filling of the mining excavations) was sharply reduced in recent years due to decrease of their consumption in coal mines in the Upper Silesian Coal Basin, and since 2010 in the copper mines too. There are a few reasons of such situation: growing use of other stowing materials (mining waste, flotation tailings, slag and granulated ash used as an additive for filling sand); reduction in hard coal output; decreasing share of expensive stowing methods in the Upper Silesia coal mines.

As a result of filling sand sales, its producers were obliged to commence production of other assortments of sand: construction sand, sand for building chemistry (dry mortars). It is well observed in Upper Silesian filling sand mines.

Principal companies involved in filling sand production in Poland, as of December 2013

- DB Schenker Rail Polska S.A. (DB Schenker Rail Polska Joint Stock Co.), ul. Bukowa 12, 43–602 Jaworzno, tel. +48 32 7584 801, fax 48 32 7584 706, www.rail.dbschenker.pl — *Class I filling sand.*
- KGHM Polska Miedź S.A. Zakład Górniczy Piaskownia Obora (KGHM Polska Miedź Joint Stock Co., Obora Sand Pit), ul. Polkowicka 52, 59–305 Rudna, tel. +48 76 8430311, fax +48 76 8430390, www.kghm.pl — *Class I filling sand.*
- CTL Logistic Sp. z o.o. w Sosnowcu (CTL Logistic Ltd. of Sosnowiec), ul. Długa 90, 41–208 Sosnowiec, tel. +48 32 2990111, fax +48 32 2990113, www.ctl.pl — *Class I-III filling sand, building sand.*

SAND, GLASS

Overview

Glass sand is virtually monomineral ***quartz sand***, rich in SiO_2. This is the basic commodity for the glass industry; it should contain over 95% SiO_2, and very small amounts of coloring oxides, such as TiO_2 (0.2–0.02%) and Fe_2O_3 (1.0–0.006%), as well as other components, e.g. Al_2O_3 (3.5–0.15%), or CaO (1.5–0.1%). In Poland, glass sand is graded, depending on the impurities content, as grades **Sp** and **1** to **6**. In respect to grain size distribution, which is critical for the melting process, it is divided into **special** and **basic varieties**, **A** and **B**.

Sources

Over 80% of the reserves of ***glass sand and sandstone*** deposits are in the Cretaceous formations of the **Tomaszów Syncline** (Łódzkie voivodeship), where there are 10 proven deposits (including four currently operated), containing 504.5 Mt of sands suitable for ***sand*** production of ***Classes 3***, ***4***, and ***5***. The second important area where Tertiary deposits of the best quality ***sand*** are recognized (81.3 Mt) is the vicinity of **Bolesławiec** (Dolnośląskie voivodeship), suitable even for producing ***sand*** of ***Classes 1***, and ***2***. There are 8 deposits, including only one under operation.

Smaller deposits are found in the Mazowieckie, Wielkopolskie, Świętokrzyskie, and Zachodniopomorskie voivodeships, marginal deposits — in the Lubelskie, Lubuskie, Podkarpackie, and Pomorskie voivodeships. The total reserves of the 34 recognized deposits of ***glass sand*** amount to 626.5 Mt, including 202.3 Mt in 7 deposits under operation. Nevertheless, in 2013 mining output came only from 4 of them. Prospects for the discovery of new deposits are primarily in the Tomaszów and Bolesławiec Synclines.

Production

Glass sand is mined and produced in three large plants. The largest producer is recently the **Biała Góra Mineral Mines** in Smardzewice near Tomaszów Mazowiecki, since 2007 in the structure of German company **Quarzwerke GmbH**. In 2013 the exploitation was carried only from two deposits: **Biała Góra II — Wschód**, and **Unewel — Zachód — Nowy,** but previously under operation were also the **Biała Góra I — Wschód** and **Unewel — Zachód** deposits. Due to introduction of modernised processing, the company is able to produce glass sand of ***Class 3*** and ***2***, and rarely ***Class 1a***. The mining output after reduction to 729,000 t in 2009, increased in the next years to the record level of 930,000 t in 2011, and was significantly reduced to ca. 850,000 tpy in 2012-2013. Glass sand production in this plant makes currently 81–84% of its total production. The rest of sand is used for production of other industrial sand grades, mainly foundry sand (see: **SAND, INDUSTRIAL**).

Tab. 1. Mining output of glass sand in Poland

'000 t

Year	2009	2010	2011	2012	2013
Output, total	**1,793**	**1,995**	**2,290**	**2,149**	**2,114**
Dolnośląskie	624	695	789	797	777
Łódzkie	1,126	1,235	1,451	1,323	1,337
Mazowieckie	16	17	5	-	-
Wielkopolskie	27	48	45	29	-

Source: ***Mineral Resources Datafile***

The second important manufacturer is the **Osiecznica Glass Sand Pit & Processing Plant** (Dolnośląskie voivodeship), also in structure of **Quarzwerke GmbH**. Output from the **Osiecznica II** deposit, washed and purified in vanners, spirals and electro-magnetic separators, is processed into the best quality ***glass sand*** (***Classes 1–3***), offered in bulk or bags, or into ***sand for ceramics***, ***chemical industry***, ***construction chemistry***, etc. (small amounts). The waste material after processing is used to produce fine- and coarse-grained ***sand for construction and ceramics materials***, ***sand and gravel for filtration***, and ***raw kaolin*** for further processing (see: **KAOLIN**). The level of minig output after significant reduction to 624,000 t in 2009, has indicated increasing trend in the following years, reaching almost 800,000 t in 2012 and almost 780,000 t in 2013 (Tab. 1). The level of glass sand production in this period amounted to 630,000-720,000 tpy. Besides domestic customers, ***Classes 1*** and ***1a*** of ***glass sand*** from **Osiecznica** are also exported.

Grudzeń-Las Ltd.— a part of the **Atlas** company, has been the third producer of glass sand in Poland in recent years. It recovers ***Class 3*** and ***4 of glass sand*** (with predominance of the latter) in neighbouring processing plants from mining output of the **Grudzeń Las** deposit, recognized as ***foundry sand*** deposit, and of the **Piaskownica-Zajączków** deposit recognized as ***glass sand*** deposit. The total production of glass sand from both mines, has increased year by year, and reached 666,000 t in 2011, but in 2012 it has been reduced about 18% to less than 550,000 t. However, in 2013 the production exceeded the record level of 900,000 t.

The output from the remaining two active glass sand mines, i.e. **Wyszków-Skuszew**, and **Ujście Noteckie II,** was consumed directly by neighboring glass-works, i.e. **Ardagh Glass Wyszków S.A.** and **Ardagh Glass Ujście S.A**., but their exploitation was stopped respectively in 2012 and 2013 (Tab. 1). The quality of the glass sand in these deposits is rather low, but it meets the requirements of container glass producers.

Glass sand is also obtained as a by-product during the processing of ***kaolin*** from the **Maria III** deposit near Bolesławiec, operated by the **Surmin-Kaolin Mineral Mines Co.** of **Nowogrodziec**. Recently about 75,000-87,000 tpy of glass sand, mainly ***Class 3***, are produced there, but its amount was significantly reduced to 67,000 t in 2013.

The mining output of ***glass sand*** after reduction to the level of 1.8 Mt in 2009, mainly due to decrease of demand for raw materials for manufacturing construction glass and glass containers, as a consequence of the crisis (Tabs. 1, 2), began to revive in the next years, crossing the level of 2 Mtpy. The increase in exploitation and production began to be observed in 2010, but its maximum level was recorded in 2011 - almost 2.3 Mt in the case of mining output, and over 2.5 Mt in the case of production. The production volume reported by the Central Statistical Office in 2009-2012, however, should be adjusted in relation to the actual level (an average of about 300,000-350,000 tpy), due to the double production reported by one of glass sand producers, which recorded wet sand and dry sand manufactured based on it. Despite this adjustment, the level of production in some years exceeds the level of mining output, due to the fact that glass sand is also produced from the foundry sands deposits (especially from the Grudzeń Las mine), and from the kaolinite-rich sandstone deposit by KSM Surmin-Kaolin S.A.

Modernization investments undertaken in the processing plants in the last years contributed to increase of yield of the higher quality sand, so that production of ***Class 1–3*** (mostly from **Osiecznica** plant, **Biała Góra** and partly from **Grudzeń-Las** plants) could make above 70% of total domestic production. The share of ***Class 4*** (from **Biała Góra** and **Grudzeń-Las** plants) was about 20–30%.

Tab. 2. Glass sand statistics in Poland — CN 2505 10

‘000 t

Year	2009	2010	2011	2012	2013
Production	2,110.1	2,457.5	2,569.9	2,354.4	2,343.0
Production*	1,800.2	2,110.5	2,282.2	2,211.5	2,354.0
Exports	156.0	205.3	231.3	209.5	169.4
Imports	7.9	6.9	12.1	19.2	25.5
Consumption[a]	1,962.0	2,259.1	2,350.7	2,164.1	2,199.1

** The Central Statistical Office data corrected for overdeclared production of TKSM Biała Góra*

*Source: **The Central Statistical Office (GUS)**.*

The average unit values of ***glass sand*** production in Poland in recent years remained in the range of 32-35 PLN/t, except of the crisis year of 2009 as well as the year 2013, when they dropped to 27 PLN/t (Tab. 3). Prices of the best quality classes were over 100 PLN/t. The average unit value of exports has lasted on this level, or even higher in recent years (Tab. 3).

Tab. 3. Average unit values of glass sand production and trade in Poland — CN 2505 10

Year	2009	2010	2011	2012	2013
Production unit values					
PLN/t	30.0	34.8	32.8	34.8	27.1
USD/t	9.6	11.6	11.1	10.7	8.6
Exports unit values					
PLN/t	94.4	104.2	110.8	108.2	131.5
USD/t	30.5	34.5	37.9	33.0	41.7
Imports unit values					
PLN/t	695.6	668.3	627.5	538.7	783.6
USD/t	221.0	220.4	213.7	164.6	153.6

*Source: **The Central Statistical Office (GUS)***

Trade

Exports of glass sand makes 8-9% of domestic production, and after a period of stabilization at the level of 205,000-230,000 tpy fell sharply to less than 170,000 t in 2013 (Tab. 2). It is usually limited to the best quality grades, especially of ***Classes 1*** and ***1a***, what was confirmed by the high average exports unit values (Tab. 3). The main foreign customers in recent years have been: the Czech Republic (34–44% of exports), Lithuania (18% in 2013), Germany (23%), and Slovakia (15%).

Glass sand imports are much lower, ranging recently between 7,000 and 25,000 tpy. 30-50% commonly came from Germany, but in 2012 and 2013 imports from Czech Republic rose to almost 57% and 46% of supply respectively. Different grades of glass sand are imported, so their average unit values varies from 212–261 PLN/t for Czech sand to 599–749 PLN/t for German sand, whereas the average value was 538 PLN/t in 2012 and 784 PLN/t in 2013 (Tab. 3). Some amounts of other industrial sand, e.g. sand for hydraulic fracturing, can also be included in this CN item. Due to significant growth in sand exports, the balance of trade has shown a positive value, decreasing in the last two years (Tab. 3 and 4).

Tab. 4. Value of glass sand trade in Poland — CN 2505 10

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	14,734	21,391	25,623	22,654	22,272
Imports	5,499	4,678	7,569	10,326	12,346
Balance	**+9,235**	**+16,713**	**+18,054**	**+12,328**	**+9,926**

Source: ***The Central Statistical Office (GUS)***

Consumption

Glass sand is used to produce various types of ***glass*** and ***glass products***. The purest grades, ***Class Sp*** and ***Class 1***, containing less than 0.03% coloring oxides (TiO_2+Fe_2O_3), are consumed by the optical industry to produce ***optical glass*** (***spectacle lenses***), e.g. at the **Jelenia Góra Optical Works**, and laboratory glassware made of ***transparent silica glass***. Sand of ***Class 1*** (rarely ***2***) is applied for the production of ***lead crystal glass***. ***Class 3*** sand is used mainly for the production of ***glass tableware***, whereas ***Class 3*** and ***4 sand for window glass*** and other ***architectural glass***. The lowest classes of sand are used for the production of ***containers*** and ***glass insulators***.

Glassworks in Poland are highly differentiated in terms of size, technological level, production assortments and ownership structure. There are more than 100 glassworks or enterprises deal in the processing of glass of different sizes. The largest ones are flat ***float*** glassworks with capacities of over 200,000–300,000 tpy each, the smallest are glass tableware factories delivering less than 2,000 tpy. The total supply of glass is growing systematically, mainly due to the development of flat glass and containers - two of the most dynamically developing branches of the glass industry (Tab. 5). After a decline in production recorded in 2009, when in the consequences of the crisis glass tableware industry has suffered the most significantly as well as technical glass industry, the following years starting in 2010 resulted in a gradual increase in the supply of glass and its products to more than 2.6 Mtpy in the years 2012-2013. The structure of glass industry in Poland, as in Europe, is dominated by glass containers (52-53% of total supply), and flat glass not further worked (37-38%), which have more than 80% is further processed. Taking into account the production of the processed products (for construction and automotive glass), manufactured based on the "primary" sheets of flat glass, glass production and its products exceeded 3.5 Mtpy in last two years. Less importance in total glass production have ***glass tableware***, which accounts for ca. 3% (tableware, fancy glass products, mirrors), and ***technical glass***, which makes recently 2-3% (laboratory, lighting, electrotechnical glass products), and a wide range of products based on glass fiber about 3-4%.

Tab. 5. Glass statistics in Poland — CN 7002–7019

'000 t

Year		2009	2010	2011	2012	2013
Production *		**2,160.2**	**2,377.5**	**2,478.6**	**2,651.5**	**2,656.3**
Flat glass not further worked	**CN 7003–7008**	768.7	876.3	946.8	992.2	987.1
in which float flat glass	*CN 7005*	*718.0*	*819.6*	*903.3*	*957.0*	*962.1*
Technical glass	**CN 7002,7011,7014–7018**	59.0	59.7	55.2	63.8	61.3
Glass tableware	**CN 7009,7012,7013**	63.2	72.4	80.3	90.6	91.0
Glass containers	**CN 7010**	1,202.2	1,280.9	1,305.4	1,421.7	1,408.6
Fiberglass	**CN 7019**	67.1	88.2	90.9	83.2	108.3
Exports *		**550.7**	**738.5**	**768.5**	**795.3**	**788.0**
Flat glass, not further worked	**CN 7003–7008**	219.2	338.6	345.1	363.3	325.6
in which float flat glass	*CN 7005*	*185.3*	*329.6*	*335.2*	*354.3*	*315.3*
Technical glass	**CN 7002,7011,7014–7018**	21.2	22.8	28.2	28.8	31.3
Glass tableware	**CN 7009,7012,7013**	114.4	124.3	127.8	140.4	136.5
Glass containers	**CN 7010**	166.2	214.0	224.8	226.5	259.1
Fiberglass	**CN 7019**	29.7	38.8	42.6	36.3	35.5
Imports *		607.2	726.1	788.3	**716.4**	**691.3**
Flat glass, not further worked	**CN 7003–7008**	276.6	353.8	345.3	277.5	280.2
in which float flat glass	*CN 7005*	*266.1*	*344.0*	*334.4*	*272.0*	*274.4*
Technical glass	**CN 7002,7011,7014–7018**	21.1	24.1	21.7	18.7	21.9
Glass tableware	**CN 7009,7012,7013**	66.1	72.1	83.4	87.2	94.1
Glass containers	**CN 7010**	164.8	174.9	233.1	236.9	202.3
Fiberglass	**CN 7019**	78.6	101.2	104.8	96.1	92.8

Consumption^{p}*	2,216.7	2,365.1	2,498.4	2,572.6	2,559.6
Flat glass	826.1	891.5	947.0	906.4	941.7
in which float flat glass	*798.8*	*834.0*	*902.5*	*874.7*	*921.2*
Technical glass	59.0	61.0	48.7	53.7	51.9
Glass tableware	14.9	20.1	35.9	37.4	48.6
Glass containers	1,200.8	1,241.8	1,313.7	1,432.1	1,351.8
Fiberglass	116.0	150.6	153.1	143.0	165.6

** without flat further processing*

Source: ***The Central Statistical Office (GUS)***

Total production of glass containers, showing dynamic growth trend during the analyzed period, was slightly reduced in 2013, but keeping the level of over 1.4 Mt (Tab 5). The largest producers are:

- **Owens-Illinois Polska S.A.** (40% share of the sales in the glass containers sector) with two glassworks: **Jarosław** (after the expansion the biggest glass work of O-I in the world with 4 glass furnaces and capacity 1,200 tpd) and **Antoninek**;
- **Ardagh Glass plc** with three operations in **Ujście**, **Gostyń**, and **Wyszków** (ca. 20% share of the sales in the glass containers sector);
- **Warta Glass Ltd. Group**, with total production above 10%, with glassworks **HS Sieraków S.A.** - leader in the alcohol bottles producer with production of 1 million pieces per day, and **HS Jedlice S.A.** - the third producer in Poland;
- **Polampack S.A. Glasswork Orzesze** (ca. 7% share of the sales in the glass containers sector), with production capacity 240 t per day.

The other, smaller manufacturers have specialized in the production of some types of glass containers. The largest of them is the **Stolzle Częstochowa Joint Stock Co.** specialized in the pharmaceutical bottles production (ca. 110 tpd with the planned expansion to more than 200 tpd in 2013). Among the smaller producers there are: **HS Czechy Joint Stock Co.** and **Hainz Glas Działdowo Ltd.** manufacturing mainly bottles for cosmetics, **HS Sława Kielce**, **HS Vitrosilicon** in **Pobiedziska**, **HS Wymiarki, Feniks Glassworks** in **Piotrków Trybunalski** and **Kama-Vitrum** in **Wołczyn,** as well as **Glassworks TUR** in **Szubin** producing a bottle of sophisticated shape.

The similar fluctuations were observed, in case of flat glass, not further worked. It grew systematically, reaching in 2012 the level of almost 1 Mt (Tab. 5). Some limitation recorded in 2013 concerned to drawn flat glass and rolled glass, which is a margin of flat glass production (recently only 2-3%, Tab. 5). As a result of significant foreign investments in this sector, the share of ***float glass*** in the total flat glass production has already exceeded 98%, with the disappearing the production of glass by traditional methods. More than 85% of flat glass is subject to further processing, in 80-85% for construction, and 15-20% for the automotive industry. Four float glass glassworks currently dominate this sector: **Pilkington Sandoglass** in **Sandomierz** — a company of the British glass concern **Pilkington plc**, **Polfloat Saint Gobain** in **Dąbrowa Górnicza-Strzemieszyce** of the French concern **Saint Gobain**, **Guardian Industries Poland** in **Częstochowa**, a part of the American company **Guardian,** and the youngest on the market - **Euroglas** in Ujazd near Łódź of Swiss-German company **Euroglas**.

The others producers of flat glass in Poland, but of descending importance, was **91-Plus Glass Szczakowa** in Jaworzno, the only one in Europe producer decreasing amount of drawn glass with using traditional ***pittsburgh*** method (in 2011 the glass work was liquidated), and **Glaspol Jaroszowiec Saint Gobain** supplying flat ornamental glass and reinforced glass (produced by continuous rolling), **Gloss World Ltd.** in Wałbrzych (producing patterened rolled glass), or **Anex-Glas** (former **Kara** Glassworks) in Piotrków Trybunalski.

In the case ***glass tableware***, after decline in production in 2009, due to the difficult economic situation of many glassworks and significant competition of cheaper products imported from Asian countries, mainly from China and Indonesia, from 2010, it is possible to observe a gradual increase to over 90,000 tpy in 2012-2013 (Tab. 5). The structure of glass tableware is dominated by the production of glass made from soda glass (84% of supply). The major producers of this type of glass are two glassworks: **Krosno** specialized in ***hand-made tableware***, automatically formed ***sodium tableware***, ***glass fiber*** (the only producer) and ***technical glass,*** and **Irena** delivering ***crystal glass*** and automatically formed ***sodium tableware***. Other producers include: **Violetta** in **Stronie Śląskie**, and **Sudety Crystal Works** in **Szczytna**, in the case of ***lead crystal glass***; **HSG Tarnów** and **Szczakowa** for automatically formed ***sodium tableware***; **HSG Tadeusz Wrześniak** in **Tarnów**, and **HSG Rozalia** of **Radomsko** and others for hand-made ***tableware***.

The relatively small production of technical glass, is subject of quite frequent changes within the limits of 55,000-64,000 tpy (Tab. 5). The major producers of this branch are glassworks manufactured the special types of glass products: **Termisil Glassworks Wołomin — *heat-resistant glass***, **Biaglass** of **Białystok — *lighting glass***. There are also some companies manufacturing special types of glass, e.g. **Philips Lighting Poland** of Piła — light bulb production (operating by 2009, one of only two such plants in Europe); or **Saint-Gobain Isover Polska Ltd**. in Gliwice supplying glass wool. Different types of technical glass are also produced by **Vitrosilicon** in **Żary** and **Iłowa** (water glass, vitreous sodium and potassium silicates and glass blocks), and **Quimicer Poland** in Opoczno specialized in frits production. Another plant in this sector are **Jeleniogórskie Optical Plants** specialized currently in production of spectacle lenses, as well as a range of fine glassware manufacturers across the country.

In the case of glass fiber, production levels after a dramatic 50% reduction in 2009, mainly as a result of installation modernization the glassworks **Krosglass SA** and strong competition from low-cost imports from China, began to gradually rebuild to over 108,000 t in 2013 (Tab. 5). Production of glass fiber in the form of glass mats, rovings and fabrics are widely used in the production of components of boats and yachts, pipes, tanks, fire protection systems, vehicle components, and to reinforce plastics, vehicle body parts, brake pad, showers, bathtubs , window profiles, etc.

Significant amounts of glass products, especially ***flat glass***, ***glass containers***, and ***glass tableware*** are the subject of international trade. The structure of exports and imports, is dominated by the raw float glass, accounting for over 41-45% of foreign sales, and 38-43 % of supply. Its customers were the countries nearest neighborhood such as: Lithuania, Germany, Slovakia, Ukraine, the Czech Republic and Belarus, in the case of glass tableware, and glass containers (with smaller dimensions) they are sent besides of

Germany, to the more distant countries: France, the United Kingdom, the Netherlands, Italy Denmark, USA and many others.

The foreign sales of flat glass not further worked after the period of rapid grow noticed since 2009, reaching almost 363,000 t in 2012, has been reduced by over 10% in 2013, which accounted for over 33 % of domestic production. Equally dynamic growth of exports was recorded in case of glass containers, which in 2013 reached almost 260,000 t, ie about 18% of domestic production of tableware glass. In case of ***tableware glass*** its exports significantly exceeded the level of domestic production, what indicates the re-export of cheaper products imported from Asian countries, mainly from China and Indonesia (due to a significant level of imports in amout of around 66,000-94,000 tpy). In addition, the external trade purposes are also a large amount of processed flat glass (for construction and automotive applications). The level of its exports exceeds 230,000-278,000 tpy, while the import ranged 116,000-140,000 tpy. Trade in these highly processed products significantly affects the value of the balance of the glass. The inclusion of this group into the trade balance resulted in a highly positive value of trade balance amounting to 720-1,300 milion PLN/y in the last two years, but removal of these group from the balance gave a negative trade balance of glass in 2008-2011 (Tab. 6), of the order from - 100 to - 200 million PLN. Since 2012, the balance has shown a surplus value, due to a significant reduction in the import of "raw" flat glass, with a further increase of exports of processed products. In the analyzed period, only tableware glass showed the positive value of the trade balance, as well as the glass containers and "raw" flat glass. Permanently negative is the balance of technical glass and fiber glass (Tab. 6).

Tab. 6. Glass products trade balance in Poland — CN 7002–7019

million PLN

Year		2009	2010	2011	2012	2013
Exports, total		**1,912.7**	**2,179.8**	**2,591.0**	**2,795.5**	**2,801.2**
Flat glass*	**CN 7003–7005**	273.4	406.5	532.9	520.6	477.1
in which float flat glass	*CN 7005*	*210.3*	*386.0*	*507.7*	*493.1*	*452.4*
Technical glass	**CN 7002,7011,7014–7018**	99.8	95.0	105.2	101.1	107.9
Glass tableware	**CN 7009,7012,7013**	906.1	955.8	1,080.4	1,165.9	1,145.5
Glass containers	**CN 7010**	411.2	476.6	572.3	679.9	779.0
Fiberglass	**CN 7019**	222.2	245.9	300.2	328.0	291.7
Imports, total		**2,033.6**	**2,392.3**	**2,798.3**	**2,589.5**	**2,550.0**
Flat glass*	**CN 7003–7005**	479.4	554.2	582.0	493.4	530.3
in which float flat glass	*CN 7005*	*449.7*	*531.9*	*561.7*	*474.7*	*510.9*
Technical glass	**CN 7002,7011,7014–7018**	167.9	200.7	223.4	159.6	166.1
Glass tableware	**CN 7009,7012,7013**	426.9	515.5	537.6	542.7	573.7
Glass containers	**CN 7010**	456.7	491.3	628.0	636.0	629.0
Fiberglass	**CN 7019**	502.7	630.6	827.3	757.8	650.9

Balance, total		**-120.9**	**-212.5**	**-207.3**	**+206.0**	**+251.2**
Flat glass*	**CN 7003–7008**	–206.0	–147.7	–49.1	+27.2	–53.2
in which float flat glass	*CN 7005*	*–239.0*	*–145.9*	*–54.0*	*+17.4*	*–58.5*
Technical glass	**CN 7002,7011,7014–7018**	–68.1	–105.7	–118.2	–58.5	–58.2
Glass tableware	**CN 7009,7012,7013**	+479.2	+440.3	+542.8	+623.2	+571.8
Glass containers	**CN 7010**	–45.5	–14.7	–55.7	+43.9	+150.0
Fiberglass	**CN 7019**	–280.5	–384.7	–527.1	–429.8	–359.2

* *Flat glass, not further worked*

Source: ***The Central Statistical Office*** *(**GUS**)*

Companies involved in glass sand production in Poland as of December 2013

- Kopalnia i Zakład Przeróbczy Piasków Szklarskich Osiecznica Sp. z o.o. (Osiecznica Glass Sand Pit & Processing Plant Ltd.), ul. Piaskowa 7, 59–724 Osiecznica, tel. +48 75 7340044, fax +48 75 7312219, www.osiecznica.com.pl — *glass sand of Classes 1–3.*
- Tomaszowskie Kopalnie Surowców Mineralnych Biała Góra Sp. z o.o. w Smardzewicach (Biała Góra Minerals Mines Ltd. of Tomaszów in Smardzewice), 97–200 Tomaszów Mazowiecki, P.O. Box 73, tel. +48 44 7261801, fax +48 44 7245760, www.piasek.com.pl — *glass sand of Classes 2–4.*
- Grudzeń Las Sp. z o.o. w Unewelu (Grudzeń-Las Ltd. of Unewel), 26–345 Unewel, tel./fax +48 44 7573234, www.grudzenlas.pl — *glass sand of Class 3–4.*
- Kopalnie Surowców Mineralnych Surmin-Kaolin S.A. w Nowogrodźcu (Surmin-Kaolin Mineral Mines Joint Stock Co. of Nowogrodziec), ul. Kaolinowa 35, 59–730 Nowogrodziec, tel. +48 75 7316515, www.surmin-kaolin.com.pl — *glass sand mainly of Class 3, kaolin for ceramic and non-ceramic applications.*

SAND, INDUSTRIAL

Overview

Sand is a loose sedimentary rock, consisting of mineral grains mostly of 0.01 to 2.0 mm size. The most common is **quartz sand**, composed of round quartz grains formed in various geological conditions. Depending on its quality, sand has many applications. The best grades are applied in the glass and ceramics industry (see: **SAND, GLASS**). Sand of somewhat worse quality (min. 93–95% SiO_2) is used for foundries, construction chemistry, water filtering, construction sandblasting, cement durability testing, hydraulic fracturing in oil & gas industry. All these grades belong to the category of **industrial sand**. Ordinary sand (80–90% SiO_2) is utilized for the production of ***lime-sand bricks*** and ***cellular concrete*** (see: **SAND FOR LIME-SAND PRODUCTS AND CELLULAR CONCRETE**), as a filling material in mining (see: **SAND, FILLING**), and in building construction as ***construction sand***, which is commonly classified as an ***aggregate*** (see: **AGGREGATES**).

Sources

The deposits of ***foundry sand*** are the main source for the production of different grades of ***industrial sand***. The largest deposits of ***foundry sand*** are in the Cretaceous formations of the **Tomaszów Syncline** (Łódzkie voivodeship). There are 8 proven deposits, containing 123.2 Mt of sand (approx. 39% of domestic reserves), two of which were exploited in the last year. In the **Częstochowa** area (Śląskie voivodeship) there are over 45 relatively small deposits, with total reserves of 53.7 Mt. Most of them have been abandoned. Six deposits, containing 31.3 Mt, are recognized in the Opolskie voivodeship, but no of them is exploited now. There are single deposits recognized in Dolnośląskie (**Czerwona Woda**, **Krzeszówek**), Małopolskie voivodeships (**Szczakowa**) and smaller and undeveloped in the Lubelskie, Mazowieckie, Podkarpackie, Pomorskie, Świętokrzyskie, Wielkopolskie, and Zachodniopomorskie voivodeships. The total reserves of 74 recognized deposits of ***foundry sand*** amount to 294.5 Mt, of which 33.5 Mt in four exploited deposits (as of 31 December 2013).

Various grades of ***industrial sand*** are also recovered from worse parts of ***glass sand*** deposits, as well as from some deposits of ***natural sand & gravel aggregates***, ***sand for lime-sand products*** and ***for cellular concrete***.

Production

A few companies, which extract ***foundry sand*** deposits, are simultaneously the main producers of ***industrial sand***. The vicinity of Tomaszów Mazowiecki in the Łódzkie voivodeship (central Poland) is the most important region of their activity (above 79% of ***industrial sand*** domestic production, Tab. 1). Two large producers are active there — **Biała Góra Tomaszów Mineral Mines Ltd.** and **Grudzeń Las Ltd.**, as well as smaller one — **Badger Mining Poland Ltd.**

Tab. 1. Mining output from foundry sand deposits in Poland

'000 t

Year	2009	2010	2011	2012	2013
Mining output	**1,074**	**1,053**	**1,474**	**1,206**	**1,302**
Dolnośląskie	41	13	35	19	–
Łódzkie	799	788	1,210	949	1,035
Małopolskie	185	220	222	218	240
Śląskie	48	31	7	20	27

Source: ***Mineral Resources Datafile***

Recently the largest supplier of industrial sand in the Tomaszów region is **Grudzeń Las Ltd.** extracting the **Grudzeń-Las** deposit (recognized as ***foundry sand*** deposit), and **Piaskownica-Zajączków** deposit (recognized as ***glass sand*** deposit). The total output from both deposits after significant reduction to less then 1.3 Mt in 2012, in the nest year grew to a record level of more than 1.5 Mt (the similar volume was recorded in 2011). The total supply of all the sand manufacturing in the company, with the exception of 2009, marked by the crisis, exceeded 1.1 Mtpy, with the record of 2011 (ca. 1.5 Mt) and of 2013 (1.6 Mt). The company's portfolio is dominated by glass sands making 44% of the supply, and over 54% in 2013. Foundry sands makes in recent years about 30% of production and over 90% are derived from the Grudzeń Las deposit. Complementing the company's production is sand for construction chemistry and ceramics industry, derived predominantly from the Piaskownica-Zajączków field. Their production in the years 2012-2013 reached 290,000-300,000 tpy. Majority of them are used by owner of the company — **Atlas** of **Łódź** — for manufacturing various ***construction chemistry*** products (dry mixes, mortars, adhesives, etc.), while a part is sold to other companies with similar production profile (e.g. Mapei). Also ***filtration sand and gravel*** offering by company, despite water treatment application, found purchasers in the construction industry for the production of dry mixes and structural plasters. Their production in 2013 reached almost 60,000 t.

The second suppliers among manufacturers of industrial sand in the Tomaszów region is the **Biała Góra Minerals Mine Ltd.** of **Tomaszów** in **Smardzewice**. The company was in 2007 purchased by German company **Quarzwerke GmbH**. In 2013 the company extracted two deposits of glass sand only: **Biała Góra II — Wschód**, and **Unewel — Zachód — Nowy.** The combined volume of mining output ranged between 780,000–850,000 tpy, but in 2011-2012 it was close to 1 Mtpy. Almost all output comes from parts of deposits recognized for ***glass sand*** production. It is also used primarily for the production of ***glass sand*** (see: **SAND, GLASS**). The production of ***foundry sand*** in this company, contains in recent years in the range of 85,000-100,000 tpy. The total company sand production (combined with glass sand, sand for construction chemistry and ceramic industry, sand for construction sandblasting, standardized sand for testing of cement durability, filtration sand and gravel) exceed the level of 0.9-1.0 Mtpy with huge predominance of glass sand (80-82% of the total supply of the company).

The third producer in this region — **Badger Mining Poland Ltd.** — commenced its production in 1997 on the basis of **Ludwików** foundry sand deposit. Despite the ***foundry sand*** (mainly ***1K***) the company also offers ***sand for construction chemistry***, ***filtration sand***, ***sand for construction sandblasting***, ***sand for hydraulic fracturing in oil & gas industry***, etc. The production has been reduced to 20,000 tpy recently (Tab. 1).

The most important foundry sand supplier outside of Tomaszów Mazowiecki area is the company **DB Schenker Rail Polska S.A.**, which delivers ***1K*** and ***2K foundry sand*** from the **Szczakowa** deposit. Their production after the reduction to about 200,000 t in 2009, increased to 350,000 t in 2010 and probably remained at a same level in the following years, judging by a similar level of output. However this quantity is only a part of company activity, compared to huge amount of filling sand and construction sand produced there (total production above 5 Mt in 2010). Foundry sand from DB Schenker Rail Polska was sold both on domestic market and abroad (the Czech Republic and Slovakia), not only for molding applications, but also for chemicals, aggregates for concrete and mortar, abrasives, etc.

Another important producers of industrial sand are:

- **Kwarc Ltd.** of **Krzeszówek**, delivering mainly ***sand for construction chemistry***, ***for sandblasting***, and ***for filtration***, in smaller amounts — ***foundry sand***, total amount do not exceed 10,000–11,000 tpy; after bankruptcy of Krzeszówek Sand Mine, the production of company was based on raw material buying from other suppliers;
- **Minerals Cooperative** in **Opole**, supplying ***filtration sand and gravel***, utilized also in abrasives and blasting, basing on mining output from natural aggregate deposits (Brzezie, Groszowice, Przywory, Zielina), recently at ca. 10,000 tpy;
- **Opole Mineral Mines Ltd.** (**Górażdże Kruszywa** group) producing ***foundry sand*** using for molding application as well as in construction chemistry based on the natural aggregate **Nowogród Bobrzański I** deposit, in amount of above 20,000 tpy.

Smaller producers of industrial sand are: **Bolesławiec Refractory Plant**, **Zawisna II Foundry Sand Mine Ltd.** (based on mining output from **Zawisna II** deposits), **Kuźnica Warężyńska Sand Pit** (***sand for construction chemistry***), and **Walmar Mietków** (***filtration sand and gravel***). ***Drying sand for construction chemistry*** could be produced according to demand by **Kotlarnia Sand Pit**, which exploits Kotlarnia filling sand deposit. ***Chalcedonite filtration sand and grits*** are manufactured by **Mikrosil** of **Radom** in Inowłódz mine.

The total actual production volume of foundry sands has not been possible to present based on the data available from the Central Statistical Office since 2011. It is only possible the estimation based on mining output and production data obtained from the three largest suppliers (Grudzeń Las, Biała-Góra, DB Schenker Rail Polska). Their combined production, after limitation in 2009 to less than 590,000 t, in 2010 exceeded 800,000 t, and in folowing years reached the level of 850,000-880,000 tpy. In contrast, volume reported by the Central Statistical Office in 2009-2010 have been corrected for Wielkopolska voivodeship and Opole voivodeship (Tab. 2). In the first one the production of foundry sand does not occur at all and probably the production of other quartz sand, or worse natural sand was wrongly classified to this position. The very low value of average unit value of these sand sales in this voivodeship (only 11.5 PLN/t) testified for the mistake in clasiffication. In the Opole voivodeship, the volume of production reported by manufacturers operating there (e.g. OKSM, SPSM in Opole) is significantly lower than the Central Statistical Office statistics. Moreover the average unit value of foundry sand sale is also very low (only 18.5 PLN/t).

Due to the same reasons, a similar adjustment was made in relation to the value of total production data of Central Statistical Office for the year 2010, so that the production volume amounted to 920,000 t (Tab. 2). It is not possible to present the data corrected in the same way for the subsequent years 2011-2012, based on the available statistical data. The data obtained from the three largest suppliers (Grudzeń Las Sp., DB Schenker Rail Poland SA, TKSM Biała-Góra Ltd.) indicated that their combined foundry sand production, after decrease to only 590,000 t in 2009, rose to over 800,000 t in 2010 (Tab. 2). The production levels in the following years can be estimated at 870,000-880,000 tpy based on data from two main suppliers (the data from DB Schenker are not available since 2011).

In recent years, the shares of foundry sand in the group of the industrial sands declined significantly. Whereas there is noticed a increasing demand for sand used for manufacturing of mortar, plaster and other building applications, especially that they are offered in majority by the same producers as foundry sand. The production of filtration sand and gravel, estimated recently at about 130,000 tpy, is also included in the group of ***industrial sand***. Ca. 70% of their production came from the Tomaszów Mazowiecki region (including about 40,000-80,000 t from **Grudzeń Las** and 20,000-30,000 t from **Biała Góra**). The part of filtration sand and gravel was also utilized in plasters production and others products of construction chemistry.

Tab. 2. Foundry sand production in Poland

'000 t

Production/Year	2009	2010	2011	2012	2013
Production according the Central Statistical Office data	720.0*	920.0*	980.0[e]	950.0[e]	.
Production of three the biggest suppliers**	586.7	807.0	884.0[e]	873.2[e]	850.0

* the value without production recorded in Wielkopolskie and Opolskie Voivodeships

** data from: Grudzeń Las Ltd., DB Schenker Rail Polska Joint Stock Co., TKSM Biała-Góra Ltd.

Source: ***The Central Statistical Office (GUS)****, own sources*

Trade

As ***foundry sand*** and ***other industrial sand*** are regarded as raw materials of domestic importance, they are not traded internationally. The small amount was exported from DB Schenker Rail Polska mainly to Slovakia and Czech Republic. Their trade is recorded together with glass sand under one common CN number (**CN 2505 10**), but most likely the latter constitutes the majority in this group (see: **SAND, GLASS**).

Consumption

Foundry sand is the basic auxiliary raw material for foundry work, used for molding purposes. The development of that technology resulted in the introduction of ***synthetic molding mixes***, manufactured mainly from quartz sand and clay binding materials, such as bentonite. When necessary, small amounts of chromite, zirconium, corundum, olivine, sillimanite, and staurolite sands are also applied. Most of these are deficit materials, the demand for which is covered by imports.

The demand for ***foundry sand*** in Poland is practically satisfied by the domestic production. Continuous reductions in the output of castings, especially of ***cast iron*** and ***cast steel***, resulted in decrease in the foundry sand consumption. The significant part of ***foundry sand*** is currently utilised in other applications, of which the most important is the ***construction chemistry*** sector, which year by year consumed increasing amounts of ***foundry and other industrial sand*** (e.g. from **Grudzeń-Las**, **Biała Góra**, **Badger Mining**, **DB Schenker Rail Polska**, **Kwarc Krzeszówek**, etc.). The total consumption of sand in the ***construction chemistry*** industry is estimated to be even ca. 3.0 Mtpy, but the remaining part of sand is delivered by natural aggregates producers.

Principal companies involved in industrial sand production in Poland, as of December 2013

- Tomaszowskie Kopalnie Surowców Mineralnych Biała Góra Sp. z o.o. w Smardzewicach (Biała Góra Minerals Mines Ltd. of Tomaszów in Smardzewice), 97–200 Tomaszów Mazowiecki, P.O. Box 73, tel. +48 44 7261801, fax +48 44 7245760, www.piasek.com.pl — *1K foundry sand, sand for construction chemistry and ceramic industry, sand for steel construction sandblasting, sand for cement durability testing, filtration sand and gravel, quartz powder for tar paper.*
- Grudzeń Las Sp. z o.o. w Unewelu (Grudzeń-Las Ltd. of Unewel), 26–345 Unewel, tel./fax +48 44 7573234, www.grudzenlas.pl — *1K and 2K foundry sand*, *sand for construction chemistry and ceramic industry*, *filtration sand and gravel*, *quartz powder for ceramics*.
- Badger Mining Poland Sp. z o.o. w Tomaszowie Mazowieckim (Badger Mining Poland Ltd. of Tomaszów Mazowiecki), ul. Spalska 178, 97–200 Tomaszów Mazowiecki, P.O. Box 67, tel. +48 44 7248822, fax +48 44 7248493, www.badgermining.com.pl — *1K foundry sand, sand for construction chemistry, filtration sand and gravel, sand for steel construction sandblasting, sand for hydraulic fracturing in oil & gas industry.*
- DB Schenker Rail Polska S.A. (DB Schenker Rail Polska Joint Stock Co.), ul. Bukowa 12, 43–602 Jaworzno, tel. +48 32 7537711, fax 48 32 6177470, www.ptkigk.com.pl *–1K-2K foundry sand, sand for construction chemistry, sand for steel construction sandblasting.*
- Kwarc Sp. z o.o. in Krzeszówek. (Kwarc Ltd. of Krzeszówek), 58–405 Krzeszów, tel./fax +48 75 7423175, www.kwarc-krzeszowek.pl — *foundry sand, sand for construction chemistry, sand for steel construction sandblasting, filtration sand and gravel.*

- Spółdzielnia Pracy Surowców Mineralnych w Opolu (Minerals Cooperative of Opole), ul. Kardynała Bolesława Kominka 3, 45–032 Opole, tel. +48 77 4542766, fax +48 77 4544942, www.spsm.pl — *foundry sand, filtration sand and gravel, sand for steel construction sandblasting, construction sand and gravel.*
- Opolskie Kopalnie Surowców Mineralnych Sp. z o.o. (Opole Mineral Mines Ltd.), ul. Cementowa 1, Chorula, 47–316 Górażdże, tel. +48 77 4468600, fax +48 77 4468602, www.heidelbergcement.pl/aggregates — *foundry sand, sand for construction chemistry, construction sand and gravel.*
- Przedsiębiorstwo Eksploatacji Kruszywa Walmar w Mietkowie (Walmar Aggregates Construction Enterprise of Mietków), 52–081 Mietków-Proszkowice, tel. +48 71 3168244, fax +48 71 3337203, www.pekwalmar.com.pl — *filtration sand and gravel, sand for steel construction sandblasting.*
- Kopalnia Piasku Kotlarnia S.A. (Kotlarnia Sand Pit Joint Stock Co.), ul. Dębowa 3, 47–246 Kotlarnia, tel. +48 77 4848801, fax. +48 77 4848800, www.kotlarnia.com.pl — *3K foundry sand, building sand.*

SCANDIUM

Overview

Scandium (**Sc**) is the lightest of the rare earth elements. Some minerals of scandium are known, e.g. ***thortveitite*** (up to 53.5% Sc_2O_3), ***befamite***, and ***kolbeckite*** (up to 39.2% Sc), which very occasionally form small deposits. These serve as sources of commercial mineral concentrates. However, as scandium occurs in many ores in trace amounts, it is mainly produced as a byproduct during processing of ***uranium ores*** or recovered from tailings or residues remaining after the processing of ***wolframite*** obtained from greisenic deposits. ***Phosphates***, ***coal***, etc. also have potential importance.

Metallic scandium is used as a catalyst, as a constituent of special heat-resistant steel and aluminum alloys applied in space technology, and for laboratory purposes. As an additive **scandium oxide** improves the quality of special glass, and is also used in the production of lasers, semi-conductors, ***yttrium-gallium-scandium garnets***, and ***ferrites*** for electronics. **Scandium arsenide** and **scandium phosphide** are used in the production of the most temperature-resistant refractories (with a melting point near 2,700°C).

Sources

Poland has neither ***scandium*** nor any ***scandium-bearing*** mineral deposits.

Production

There is no production of ***scandium-bearing*** minerals or ***scandium commodities*** in Poland.

Trade

Domestic demand for scandium commodities has been satisfied entirely by imports, which are not separately recorded by the **Central Statistical Office** (**GUS**). They are listed together with the group of ***rare earth metals*** and ***yttrium***. In the years of 2009–2013, the total imports of these ***metals*** ranged between 67 kgpy and 27.0 tpy (see: **RARE EARTH ELEMENTS**). The main sources of imports in recent years have been Germany, the Netherlands, and other Western European countries, especially France in 2013, China, and the Czech Republic in the years 2012–2013. The trade balances of ***scandium commodities*** have been consistently negative in recent years, depending on import volume and the market price.

Consumption

The consumption pattern of ***scandium*** and ***scandium compounds*** in Poland is not available. Most likely they are used as catalysts, in the production of special glasses, lasers, and semi-conductors, and in electronics.

SCHIST, MICA AND PHYLLITE

Overview

Mica-schist and **phyllite-schist** are metamorphic rocks containing mainly minerals of the ***mica*** group (***sericite***, ***muscovite***, ***biotite***). They are used as mineral powders for ***tar papers***, as well as ***mineral fillers*** in bituminous pavement mixes, paints, and plastics. Phyllite schist, easily split into thin plates, was formerly also used to make roof tiles (***roofing slate***).

Sources

The total resources of ***mica-schist*** recognized in **Orłowice** deposit near Świeradów Zdrój and in **Jawornica** deposit near Kłodzko amounted to 6.7 Mt, as of 31 December 2013. ***Phyllite-schist*** occurs in the vicinity of Głuchołazy and Głubczyce (Opolskie voivodeship), in the large **Dewon-Pokrzywna** deposit, and the smaller **Chomiąża** deposit. In 2010 another deposit of ***phyllite-schist*** was recognized in **Pokrzywna** area and the total resources of these rocks in Poland increased to 17.7 Mt, as of 31 December 2013.

Production

Mica-schist has been extracted from the **Orłowice** deposit in the **Jerzy** mine, in the amount of 2,000–5,000 tpy (Tab. 1). The owner of the mine was **Jelenia Góra Mineral Mines** but in 2013 the company ceased the operation. Originally, the raw material from this mine was milled into ***mineral powder*** (fraction 0.32–2.5 mm, 80% of production) and two grades of ***dust*** (the by-product of milling: under 0.315 mm and under 0.08 mm) but owing to low demand from domestic tar paper manufacturers the production was terminated. The schist milling plant has been moved to Jarnołtówek, where company mined ***phyllite-schist*** from **Dewon-Pokrzywna** deposit. In 2013 Orłowice mine was rented by **Wyrwa Schist Mine Antoni Tomaszewski**, delivering exclusively building and decorative split tiles. Small amounts of ***mica-schist*** (300–1,000 tpy) have been also extracted in **Jawornica** mine.

Tab. 1. Mica-schist and phyllite-schist statistics in Poland

'000t

Year	2009	2010	2011	2012	2013
Mica schist					
Production = Consumption[a]	3.1	3.0	5.3	3.1	2.8
Phyllite schist					
Production = Consumption[a]	23.9	56.7	157.0	189.6	143.4

Source: ***Mineral Resources Datafile, producer's data***

Phyllite-schist has been extracted in the **Dewon-Pokrzywna** deposit in Jarnołtówek. Until 2009 the mine has been operated by the **Jelenia Góra Mineral Mines**, delivering phyllite-schist for decorative and building purposes, as well as ***mineral powders*** and ***dusts*** for tar paper production. A new owner of the mine has been **Dewon**. The company strongly increased the volume of ***phyllite-schist*** output, from ca. 24,000 t in 2009 to 140,000–190,000 t in the years 2011–2013 (Tab. 1), however ***mineral powders*** and ***dusts*** have no longer been produced.

Trade

Mica-schist and ***phyllite-schist*** are not traded internationally.

Consumption

Mineral powder, produced formerly on the basis of ***mica-schist*** and then ***phyllite-schist***, was utilized for ***tar paper*** production. Due to decreasing tar paper production in Poland, consumption of schist powder in this application was terminated. ***Mineral dust***, the by-product of ***mica-schist*** or ***phyllite-schist*** milling, were utilized in the production of insecticides and for insulation, and as filling ballast in paints, plastics, and bituminous pavement mixes. The ***phyllite-schist*** products of the finest grain size were used as a pigment for paints — ***schist gray***.

Currently, ***mica-schist*** and ***phyllite-schist*** are used exclusively as decorative and building stones.

Companies involved in mica-schist and phyllite-schist production in Poland, as of December 2013

- Wyrwa Kopalnia Łupka Antoni Tomaszewski (Wyrwa Schist Mine Antoni Tomaszewski), Orłowice 41/1, 59–630 Mirsk, tel. +48 602614435, www.lupek-wyrwa.pl — *mica-schist tile.*
- Przerób Kamienia Sebastian Nowak (Sebastian Nowak, Processing of Stone), Jawornica 9, 57–343 Lewin Kłodzki, tel./fax +48 74 8698665, www.marmur.fr.pl — *mica-schist tile.*
- Dewon Sp. z o.o. (Dewon Ltd.), 48–267 Jarnołtówek, tel. +48 77 4397581, fax +48 77 4397770 — *phyllite-schist tile.*

SELENIUM

Overview

Despite there are known over 40 **selenium** (**Se**) minerals, they do not form deposits of industrial importance. Selenium as an admixture, or as an accompanying element, is usually associated with copper (***chalcopyrite***, ***bornite***), and also with iron (***pyrite***), lead, nickel, cobalt, molybdenum, silver, and others. Selenium has been predominantly recovered from ***selenium-containing anode slimes*** (containing usually 10–30% Se) or from ***furnace dust***, generated in copper smelters, as well as – though to a dwindling scale – from scrapped selenium-based copier drums.

The largest consumer of **selenium** has been the glass-making industry. It has been also utilized in metallurgy and chemistry, and in the production of photoreceptors, pigments, agricultural feed additives.

Sources

Selenium occurs as dispersed element in the ***copper ore*** deposits of the **Fore-Sudetic Monocline**, but its resources have not been estimated. The selenium content varies from 3.6 to 6.1 g/t (ave. 4.5 g/t), depending on the type of ore. It is recovered from the ***anode slime*** generated in course of copper concentrate metallurgical processing. The slime contains an average of 1.0–1.7% Se. Recovery is mandated by regulations, due to the high toxicity of selenium emitted into the atmosphere.

Production

The only ***selenium*** producer in Poland has been copper manufacturer **KGHM Polska Miedź**. ***Black selenium powder***, containing approx. 99% Se, has been obtained at its **Precious Metals Plant**, in the **Boliden Kaldo** process from ***anode slime*** and ***furnace dust*** generated at the **Głogów** and **Legnica** copper refineries. In the analyzed period the output of selenium, which generally has followed fluctuations of the refined copper production, varied from 73 to 90 tpy, achieving its highest level in 2012, with an 11% reduction last year (Tab. 1).

Trade

The exportation of selenium from Poland has ranged from 48 to 76 tpy, according to fluctuations of principal buyers' demand (Tab. 1). The top destinations for selenium from Poland in recent years have been China, Hong-Kong, and the United Kingdom (Tab. 2). Variable amounts of selenium were simultaneously imported to Poland, basically from France (45% of the total imports in 2013), Germany and Austria. The positive trade

Tab. 1. Selenium statistics in Poland — CN 2804 90

t

Year	2009	2010	2011	2012	2013
Production	73.1	79.0	84.7	90.2	80.2
Imports	8.2	14.5	13.2	13.0	10.3
Exports	51.0	48.1	54.1	59.1	75.5
Consumption[a]	30.3	45.4	43.8	44.1	15.0

Source: ***The Central Statistical Office (GUS), producers' data***

balance, which until 2010 averaged 5-6 million PLN per annum, in the following years significantly improved, approaching 17 million PLN in 2012 (Tab. 3). In 2013, however, it was reduced to 10 million PLN.

Tab. 2. Polish exports of black selenium, by country — CN 2804 90

t

Year	2009	2010	2011	2012	2013
Exports	**51.0**	**48.1**	**54.1**	**59.1**	**75.5**
Belgium	–	4.1	–	13.4	1.0
Bulgaria	–	–	–	0.8	1.8
China	5.3	11.0	–	–	31.1
Czech Republic	1.3	–	–	–	2.1
Estonia	–	0.2	0.3	0.1	0.8
Finland	–	–	2.0	0.6	3.0
Germany	7.7	4.8	3.1	0.4	–
Hong-Kong	–	–	27.3	37.7	13.5
Hungary	–	1.0	–	–	0.0
India	–	–	–	0.6	2.1
Italy	32.1	21.6	17.0	0.6	2.0
Lithuania	–	0.9	0.6	0.9	0.7
Slovenia	–	–	–	1.0	2.5
Spain	–	1.0	–	–	–
Ukraine	2.9	3.0	2.7	1.6	2.0
United Kingdom	–	–	0.4	0.9	12.5
Others	1.7	0.5	0.7	0.5	0.4

Source: ***The Central Statistical Office (GUS)***

The unit values of ***selenium*** exportation from Poland matched the changes in international prices of selenium, fluctuating in the wide range from ca. 42,000 to 114,000 USD/t in the last five years (Tab. 4). In 2013 they dwindled by a half as compared to the previous year due to the international prices deterioration.

Tab. 3. Value of black selenium trade in Poland — CN 2804 90

'000 PLN

Year	2009	2010	2011	2012	2013
Export	6,663	8,950	18,257	20,538	12,461
Import	1,063	2,745	3,946	3,684	2,614
Balance	**+5,600**	**+6,205**	**+14,311**	**+16,854**	**+9,847**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. The unit values of selenium exports from Poland — CN 2804 90

Year	2009	2010	2011	2012	2013
PLN/t	130,638	186,072	337,473	347,508	165,046
USD/t	42,388	60,845	113,935	106,610	52,369

Source: ***The Central Statistical Office (GUS)***

Consumption

The apparent consumption of selenium in Poland, which has been stabilized at 44-45 tpy until 2012, significantly dropped last year owing to substantial foreign sales (Tab. 1). The principal domestic applications of selenium are the following: the glass manufacturing industry, ceramics, glazes, paints, and plastics, special types of steel, nonferrous metals alloys, chemistry, etc. The detailed end-use distribution of ***selenium*** and ***selenium salts*** in Poland has been difficult to ascertain.

Companies involved in selenium production in Poland, as of December 2013

- KGHM Polska Miedź S.A. w Lubinie (KGHM Polska Miedź Joint Stock Co.), ul. Skłodowskiej-Curie 48, 59–301 Lubin, tel. +48 76 8478200, fax +48 76 8478500, www.kghm.pl — *black selenium*.

SILICON

Overview

Commercial **silicon metal** (**Si**) is obtained by the reduction of ***quartz*** or ***quartzite*** with coal or coke in electric furnaces. There are five grades distinguished: ***Si99***, ***Si98.5***, ***Si98***, ***Si97***, and ***Si96*** (where the digits represent the respective percentage of Si). **Silicon** is used mainly in the production of aluminum and in the chemical industry. It may serve as a constituent of alloys with copper, nickel-copper, nickel, ferronickel for plastic working, and with vanadium; in Fe-Si-Mg alloys, or pre-alloys with aluminum; and solders for aluminum, copper, brass, or bronze. It is also used for the production of ***carbocorundum***, ***silicides***, and ***silica-organic compounds*** (***silicones***), which are becoming increasingly popular in the refractory, abrasives, and other branches of industry. **Metallic semiconductor-grade silicon** and **high purity Si monocrystals** are also very common in electronics (integrated circuits). The widely known **silicon carbide** (**carbocorundum**, **SiC**) is suitable for the production of silicon carbide refractories and abrasive materials. It is also used in the production of the resistance elements in electric furnaces (***silite rods*** and ***products***).

Silicon compounds, **ferrosilicon**, and **silicon-rich ceramic products** (containing SiO_2), as well as enamels, glass, etc. are produced from ***quartz*** and ***rocks*** rich in SiO_2, not from **metallic silicon**. Ferrosilicon is used almost exclusively in the steel-making industry as an oxygen-removing alloy additive.

Sources

High quality ***crystalline quartzite*** from the Świętokrzyskie Mountains and ***vein quartz*** from deposits in the Lower Silesia (see: **QUARTZITE AND QUARTZ**) may be a domestic source of raw materials for the production of ***commercial grade silicon***, ***silicon compounds***, and ***alloys***. The extent to which these materials could be utilized will depend upon the cost and the energy requirements, as well as on demand from the domestic economy.

Production

The **Topsil Semiconductor Materials S.A.** (former **Cemat-Silicon** of **Warsaw**) has been the only domestic supplier of ***polished silicon plates*** and ***plates with epitaxial layer*** (approx. 100,000–140,000 items per month in a form of 100 mm polished wafer equivalent) made of ***pure*** and ***doped silicon monocrystals*** obtained by the Czochralski single crystal growth method. The production has based on imported ***polycrystalline silicon*** (30–45 tpy). The product assortment has been constantly expanded, in pace with the increasing demand from the electronic industry. However, the exact data are not available.

By 2012 the **Łaziska Smelter** ws the only domestic manufacturer of various grades of ***ferrosilicon***, primarily those containing 75% Si, but also 65% and 45% Si (Tab. 2). It delivered also decreasing amounts of ***ferrosilicomanganese*** (9,700 t in 2009, 112 t in 2010, 378 t in 2011 and only 81 t in 2012, and 99 t in 2013 see: **MANGANESE**). In fact, in 2012 **Łaziska Smelter** became an enterprise in systemic bankruptcy, and in the years of 2012–2013 served **RE Alloys Ltd.** of Łaziska Górne. Taking into account the ***ferrosilicon*** trade statistics, the domestic demand in the years 2009–2013 can be evaluated at the level of ca. 9,400–22,100 tpy (Tab. 2).

Trade

Domestic demand for ***silicon metal*** has been supplemented by imports, which in 2009 amounted to almost 12,000 t, and in the period 2010–2013 was continously increasing, approaching the record level of 23 kt last year (Tab. 1). The regular suppliers of ***silicon*** have been Norway, Germany, Australia, China, the Netherlands, Brazil, France, the US, and Belgium, but recently the main suppliers have become Brazil, the Netherlands, France, Germany, Taiwan and Russia (Tab. 3). Variable amounts of ***ferrosilicon*** have been also traded. In the period 2009–2013 its imports varied between 15,500–22,900 tpy. The exportation has exceedeed the level of imports – even 4 times – changing between 63,700 and 82,500 tpy, except for 2009 when they dropped to only 16,200 t (Tab. 2).

Tab. 1. Silicon statistics in Poland — CN 2804 61–69

t Si

Year	2009	2010	2011	2012	2013
Production	NA	NA	NA	NA	NA
Imports	11,943	17,093	17,572	17,802	22,756
Exports	1,089	803	1,383	1,674	2,165
Consumption[a]	NA	NA	NA	NA	NA

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Ferrosilicon statistics in Poland — CN 7202 21–29

'000 t (gross weight)

Year	2009	2010	2011	2012	2013
Production	9.7	53.2	72.7	78.1	73.6
Imports	15.9	21.9	18.7	15.5	22.9
Exports	16.2	63.7	76.0	72.1	82.5
Consumption[a]	9.4	11.4	15.4	21.5	14.0

Source: ***The Central Statistical Office (GUS), the data from producers***

The trade balances in ***silicon*** have been negative in recent years (Tab. 4). In 2010 it deepened to the record -242 million PLN. In the following two years it improved, varying from almost -176 million PLN and -186 million PLN, due to lower international

Tab. 3. Polish imports of silicon, by country — CN 2804 61–69

t Si

Year	2009	2010	2011	2012	2013
Imports	**11,943**	**17,093**	**17,572**	**17,802**	**22,756**
Australia	5	–	48	336	6,352
Austria	374	121	47	–	186
Belgium	3	27	37	38	61
Bosnia and Herzegowina	936	354	336	791	312
Brazil	4,519	4,693	6,654	7,825	1,180
China	48	1,105	567	24	392
Croatia	–	–	–	–	1,606
Czech Republic	316	510	46	73	–
Denmark	57	141	88	78	65
France	1,146	2,155	1,025	1,445	2,064
Estonia	–	24	2	–	–
Germany	952	1,408	2,247	2,139	2,174
Italy	42	112	222	857	11
Japan	–	16	1	0	72
Kazakhstan	–	–	–	–	540
Latvia	47	–	–	–	6
Macedonia	–	24	–	–	–
Malaysia	–	–	60	–	–
Netherlands	1,189	2,331	2,932	2,484	3,239
Norway	26	284	240	1,008	3,024
Philippines	73	22	–	0	–
Russia	656	1,549	871	387	434
Slovakia	114	11	–	–	–
Sweden	–	–	–	–	406
Taiwan	1,395	1,666	1,468	2	3
Thailand	–	473	527	286	216
United Kingdom	8	24	119	2	407
USA	12	41	10	2	3
Others	24	2	25	25	3

Source: ***The Central Statistical Office (GUS)***

prices (Tab. 5). In the years 2009–2013 the trade balances of ***ferrosilicon*** were positive (Tab. 4), ranged widely, between almost 4 million PLN and 295 million PLN. The changes on international markets influenced the unit values of ***silicon commodities*** imports to Poland (Tab. 5).

Tab. 4. Value of silicon commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Silicon CN 2804 61–69					
Exports	26,443	40,434	41,852	40,466	58,884
Imports	122,856	282,690	228,052	216,206	244,511
Balance	**-96,413**	**-242,256**	**-186,200**	**-175,740**	**-185,627**
Ferrosilicon CN 7202 21–29					
Exports	70,676	299,671	401,997	324,914	367,042
Imports	66,708	106,235	106,442	87,119	116,552
Balance	**+3,968**	**+193,436**	**+295,555**	**+237,795**	**+250,490**

Source: ***The Central Statistical Office*** *(GUS)*

Tab. 5. Unit value of silicon commodities imports to Poland

Year	2009	2010	2011	2012	2013
Silicon CN 2804 61–69					
PLN/t	10,287	16,538	12,978	12,146	10,745
USD/t	3,394	5,469	4,419	3,712	3,424
Ferrosilicon CN 7202 21–29					
PLN/t	4,195	4,851	5,700	5,614	5,089
USD/t	1,365	1,603	1,944	1,719	1,622

Source: ***The Central Statistical Office*** *(GUS)*

Consumption

Several dozen tons of ***high purity silicon*** are consumed by the domestic electronics, and the remaining ***silicon***, containing less than 99.99% Si, is used by the non-ferrous metal industry for the production of alloys with Al, Cu, Ni, for solder, etc.

Alloyed steel producers are the main users of ***ferrosilicon*** and ***ferrosilicomanganese*** (see: **MANGANESE**), both of domestic and foreign origin, which have consumed between 60 and 80 ktpy.

Companies involved in silicon materials production in Poland, as of December 2013

- Topsil Semiconductor Materials S.A. w Warszawie (Topsil Semiconductor Materials Joint Stock Co. of Warsaw), ul. Wólczyńska 133, 01–919 Warszawa, tel. +48 22 8351939, fax +48 22 8657735 www.topsil.com — *plates of silicon monocrystals*.
- Huta Łaziska S.A. w Łaziskach Górnych (Łaziska Smelter Joint Stock Co. of Łaziska Górne), ul. Cieszyńska 23, 43–170 Łaziska Górne, tel. +48 32 2241500, fax +48 32 2241523, www.hlsili.pl — *ferrosilicon, ferrosilicomanganese*.

SILVER

Overview

Silver (**Ag**) is known and used since ancient times. It was used in jewellery and as instrument of payment (coins of silver and its alloys). The last function was very important in the Middle Ages, but it lost its significance after discovery of America, when great amounts of American silver entered European market. Nowadays, industrial applications are the most important: initially in photography, but currently mainly in electronics. Jewellery is still important consumer of silver.

The majority of the world **silver** supply comes from primary sources. However, only 20–25% of silver mine production originates from its primary deposits, while 75–80% is recovered as a by-product of base metals ore treatment. Considerable quantities of silver are also recycled.

Sources

In Poland ***silver*** occurs in ***copper ore*** deposits in the **Fore-Sudetic Monocline**, which contain 40–80 g Ag/t of ore (57 g Ag/t in average). Silver occurs in the form of impurities, mainly in ***bornite*** and ***chalcocite***, while silver minerals such as ***stromeyerite***, ***tennantite***, and ***native silver*** are of minor importance. Traditional sources of silver — ***Zn-Pb ore*** deposits in the **Silesia-Cracow** region — have currently marginal significance. Silver is present mainly in ***galena*** and ***sphalerite***, but average silver content in the ore is below 10 g/t. The total silver resources in ***copper ore*** amounted to 103,182 t, including 70,738 t in deposits currently operated or developed (as of 31 December 2013). The deposits of ***zinc-lead ore*** contain only 1,160 t of silver.

Production

Silver contained in copper ores extracted by **KGHM Polska Miedź** passes into copper concentrates. ***Silver contents in copper concentrates*** have amounted to 400–1,000 g/t. The total silver volume in copper concentrates ranged from 1,150 to 1,200 tpy in recent years (Tab. 1). These concentrates, as well as some imported silver-bearing copper concentrates are processed at the KGHM's copper smelters to copper anode, which is used in copper electrorefining process, with the so-called ***silver-bearing anode slimes*** (35–50% Ag) as a by-product. They are entirely processed by the **Precious Metals Plant** at the **Głogów Copper Smelter** (capacity about 1,400 tpy Ag). This plant produces ***high-purity refined silver*** graded at more than 99.99% Ag, mainly in ***granule*** (pellet) and ***bar*** form. Silver bars of **KGHM-HG** brand have been granted a **Good Delivery** certificate by the **London Bullion Market Association**. In the last five years the production of silver by the **Precious Metals Plant** ranged from 1,161 to 1,274 tpy.

Tab. 1. Silver raw materials statistics in Poland

t Ag

Year	2009	2010	2011	2012	2013
Silver-bearing copper ores concentrates					
Production = Consumption[a]	1,207	1,183	1,167	1,149	1,200
Silver, refined - CN 7106 91					
Production	1,221	1,175	1,278	1,292	1,197
Imports	47	3	7	5	6
Exports	1,171	1,192	1,188	1,309	1,163
Consumption[a]	97	-14	97	-12	38

Source: ***The Central Statistical Office (GUS)***

Small amounts of ***refined silver*** have been produced on the basis of silver scrap by the **Mennica-Metale Szlachetne Co.** in **Warsaw** (daughter company of the State Mint) and from some silver-bearing wastes from KGHM copper smelters by **Non-ferrous Metals Institute** in **Gliwice**. By 2005 a small producer of ***refined silver*** on the basis of ***metal Dore*** manufactured by **Miasteczko Śląskie Zinc Smelter** (20–40 tpy) was **Ag-Tech Ltd.** of **Katowice**. The ***refined silver*** production out of KGHM has recently amounted to 18-33 tpy. In the years 2009-2013 the total domestic ***refined silver*** production ranged from 1,175 to 1,292 tpy (Tab. 1).

Trade

Poland — precisely **KGHM Polska Miedź** — is the largest European exporter of ***refined silver*** to Western Europe (Tab. 2). The **Good Delivery** certificate was granted for KGHM's ***silver bars*** by the **London Bullion Market Association** and by the **London Metal Exchange**, while for KGHM's ***silver granules*** by the **London Metal Exchange**. This is why a large portion of silver has been sold to the United Kingdom to London market. However, in some years exports to London market were temporarily reduced, with increasing deliveries to Belgium, Germany, the US, and - irregurarly - to other countries (Tab. 2). The share of ***silver granules*** in the total sales amounted to ca. 80%, while ***bars*** - about 20%.

Imports of ***refined silver*** to Poland were usually negligible and irregular, przedominantly approaching 5-7 tpy (Tab. 1). However, in 2009 they incidentally rose to 47 t, coming mainly from Germany and Italy.

Silver trade balances have been consistently positive. In the last two years, due to very high international silver prices, it climbed to a record value of ca. 4 billion PLN/y, with 35% drop in 2013 resulting from silver prices reduction (Tab. 3, 4). Silver exports have significant share in the total Polish turnover, especially regarding minerals trade.

The average unit values of ***silver*** exports from Poland rose more than four times since 2005, what was in general accordant to its world prices increase. However, recently they dropped by 35% (Tab. 4).

Tab. 2. Exports of silver from Poland, by country — CN 7106 91

t Ag

Year	2009	2010	2011	2012	2013
Exports	**1,171**	**1,192**	**1,188**	**1,309**	**1,163**
Belgium	200	120	93	68	51
Canada	–	–	19	–	–
China	–	0	–	–	–
Czech Republic	–	–	0	3	7
Estonia	20	–	0	–	–
Germany	120	156	19	20	62
India	–	3	–	–	–
Netherlands	–	–	–	–	14
Slovakia	–	–	0	41	19
Switzerland	–	–	–	20	41
United States	20	195	278	–	56
United Kingdom	800	710	777	1,155	910
Others	11	8	2	2	3

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Value of silver trade in Poland — CN 7106 91

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	1,684,407	2,310,590	3,962,470	4,256,955	2,734,140
Imports	71,590	4,777	7,863	18,399	14,611
Balance	**+1,612,817**	**+2,305,813**	**+3,954,607**	**+4,238,556**	**+2,719,529**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Average unit values of silver exports from Poland — CN 7106 91

Year	2009	2010	2011	2012	2013
PLN/t	1,438,633	1,938,878	3,335,527	3,252,298	2,351,890
USD/t	462,415	647,772	1,140,605	995,135	748,033

Source: ***The Central Statistical Office (GUS)***

Consumption

The structure of ***silver*** consumption in Poland is difficult to ascertain, because data on silver scrap recovery, as well as on the changes of producers' and users' stocks are unavailable. Users of silver, especially in jewellery, are very dispersed. Apparent consumption of primary silver has amounted to max. 100 tpy in recent years, though it approached even negative values due to high level of exports, probably partly from stocks (Tab. 1). The real industrial consumption of primary silver is estimated at 25–40 tpy, while in jewellery and other silver and silver-plated goods - up to 100 tpy. Supplies of coinage with silver from the State Mint has been occasional. The pattern of silver demand in Poland probably differs a lot from demand pattern in developed countries. Photographic and electronic industries shares have been negligible. Production of rolled and drawn products, as well as some catalysts, have been probably the main industrial applications of silver in Poland. The real level of silver consumption (with silver scrap taken into account) may be even a few times higher (300–500 tpy), while share of jewellery and other silver and silver-plated goods in the total consumption mey reach even 90%.

Companies involved in silver production in Poland as of December 2013

- KGHM Polska Miedź S.A. w Lubinie (KGHM Polska Miedź Joint Stock Co. of Lubin), ul. Marii Skłodowskiej-Curie 48, 59–301 Lubin, tel. +48 76 8478200, fax +48 76 8478500, www.kghm.pl — *refined silver*.
- Mennica-Metale Szlachetne S.A. w Warszawie (Mennica-Metale Szlachetne Joint Stock Co. of Warsaw), 00–958 Warszawa, ul. Pereca 21, tel. +48 22 7639901, fax +48 22 7639907, www.mennica-metale.com.pl — *refined silver*.
- Instytut Metali Nieżelaznych w Gliwicach (Non-ferrous Metals Institute of Gliwice), 44–100 Gliwice, ul. Sowińskiego 5, tel. +48 32 2380200, fax +48 32 2316933, www.imn.gliwice.pl — *refined silver*.

SODIUM COMPOUNDS

Overview

Sodium compounds include various types of **sodium carbonates** and **sulfates**, either extracted from deposits or produced synthetically. **Synthetic sodium carbonate** (**calcined soda**) is manufactured mainly by the ***Solvay*** method, based on ***brine*** and ***limestone***. This method provides approx. 70% of the world's production of **sodium carbonate**. The remainder is extracted from deposits, mainly of ***trona***. **Sodium sulfates** are obtained from natural sources — deposits of ***mirabilite*** and ***thenardite***, but also as by-products of the manufacture of ***synthetic fibers***, ***hydrochloric acid***, etc.

Another important sodium commodity is **sodium hydroxide** (**caustic soda**) NaOH - exclusively an artificial product. In the past it was produced from ***calcined soda***; cutrently it is obtained in course of the electrolysis of ***sodium chloride*** NaCl (by which ***chlorine*** is also obtained).

Sodium compounds belong to the most important raw materials for the chemical, glass-making, detergent, and paper-making industries. Poland became one of the most significant producers of **calcined** and **caustic soda** in Europe, as well as an exporter of **calcined soda**.

Sources

Domestic sources for the production of ***calcined soda*** are ***limestone*** and ***salt*** deposits. There are two active soda plants in the Kujawy region, utilizing ***limestone*** from **Piechcin** and **Barcin** deposits and ***brine*** from **Góra** and **Mogilno** ***salt*** deposits.

Rock salt is also a basic material for the production of ***caustic soda***. The companies that manufacture the latter one consume ***salt brine*** from **Góra** and **Mogilno** ***salt*** deposits, as well as ***rock salt*** from **Kłodawa** ***salt*** deposit.

Production

The soda industry in Poland consists of two large plants — **Mątwy** and **Janikowo** — in the Kujawy region in central Poland, which belong to **Soda Polska CIECH Co.** The ***calcined soda*** production in these plants was around 1,100,000 tpy in the recent years, only in 2009 it dropped to below 900,000 t due to lower exports and domestic consumption level (Tab. 1). However, since 2010 domestic demand rose significantly and the production recovered, with a small reduction in 2013. Each of the above mentioned plants provides around 50% of the total production.

There is no information on the production volume of ***sodium sulfate*** in Poland. It is known that it has been manufactured by the **Alwernia Chemical Works**.

Tab. 1. Calcined soda statistics in Poland — CN 2836 20

'000 t

Year	2009	2010	2011	2012	2013
Production	892.8	1,019.7	1,071.2	1,125.5	1,054.9
Imports	30.6	18.7	12.0	12.6	22.1
Exports	349.3	361.1	386.6	439.2[s]	482.1[s]
Consumption[a]	574.1	677.3	696.6	698.9	594.9

Source: ***The Central Statistical Office (GUS)***

Almost 80% of the production of ***caustic soda*** (***sodium hydroxide***) in Poland is made by the electrolysis of ***sodium chloride solution***, in course of ***chlorine*** manufacturing. The main producer is the **Anwil Nitrogen Plant** of Włocławek (basing on ***brine*** from **Góra** and **Mogilno** deposits of the **Inowrocław Salt Mines**). The production of ***sodium hydroxide*** decreased to only 610 kt in 2010, while in the next years it rose sharply approaching 910 kt in 2013. Concentration of ***soda lye*** (main form of sodium hydroxide) varied between 37% and 48% NaOH. The production of ***soda lye*** amounted to 630,000 t gross weight in 2013 (304,000 t NaOH), while ***solid caustic soda*** production — 76,500 t gross weight. Total production in terms of NaOH tonnage rose from 274,200 t in 2010 to 380,400 t in 2013.

Tab. 2. Caustic soda statistics in Poland — CN 2815 11

'000 t

Year	2009	2010	2011	2012	2013
Production	880.4	610.3	828.4	875.1	907.5
Imports	6.2	9.4	10.7	8.7	5.5
Exports	59.1	44.8	49.8	64.3	63.2
Consumption[a]	827.5	574.9	789.3	819.5	849.8

Source: ***The Central Statistical Office (GUS)***

Trade

In the years 2009-2013 the exportation of ***calcined soda*** from Poland was gradually increasing, last year exceeding 480,000 tpy (Tab. 3). It has been shipped to over 40 countries. Among the main recipients have been the Czech Republic, Germany, Finland, Sweden, and Norway. Over the analyzed period the importation of ***calcined soda*** varied widely, from 12 to 31 ktpy (Tab. 1), coming mainly from Bosnia and Herzegovina, and Belgium.

Caustic soda in the form of ***soda lye*** has been also traditionally exported to many European customers, as well as to numerous Latin American, Southeast Asian, and African countries (over 50 recipients). The volume of these exports has varied between 45 and 64 ktpy (Tab. 4). Imports of ***caustic soda*** are marginal, i.e. in the range of 5–11 ktpy (Tab. 2).

Tab. 3. Polish exports of calcined soda, by country — CN 2836 20

'000 t

Year	2009	2010	2011	2012[s]	2013[s]
Exports	**349.3**	**361.1**	**386.6**	**439.2**	**482.1**
Austria	32.8	2.6	5.9	5.9	7.6
Belarus	–	–	–	2.7	5.0
Belgium	1.5	1.6	7.4	2.0	2.1
Czech Republic	121.3	136.3	112.2	164.4	150.3
Denmark	1.9	3.1	1.5	3.5	2.0
Estonia	7.5	12.3	0.0	0.1	0.0
Finland	37.2	43.4	45.5	50.1	50.3
France	5.7	0.8	10.1	7.8	16.4
Germany	38.4	28.1	46.9	65.4	82.5
Hungary	0.0	9.3	6.2	0.3	5.6
India	0.0	5.0	–	–	4.9
Indonesia	–	–	15.9	–	8.6
Italy	3.7	1.8	1.3	2.9	14.4
Lithuania	3.4	3.6	5.9	10.3	11.9
Netherlands	4.7	4.7	6.4	9.6	10.9
Nigeria	–	0.5	5.1	–	1.2
Norway	24.4	28.5	36.6	36.4	36.1
Slovakia	14.2	14.4	0.5	0.9	1.0
Sweden	42.7	59.5	55.1	51.3	29.1
Thailand	–	–	8.5	1.8	14.1
Ukraine	–	–	–	3.0	9.0
United Kingdom	5.4	1.7	1.8	1.8	4.7
Venezuela	–	1.0	4.0	0.9	0.7
Others	4.5	1.0	9.8	18.1	13.7

Source: ***The Central Statistical Office (GUS)***

Sodium sulfate imports to Poland have amounted to 52,000–84,000 tpy, coming mainly from Spain, Austria, the Czech Republic, Russia, and Germany. Their exports have been marginal, except for 2011 (Tab. 5).

The balance of ***calcined soda*** and ***caustic soda*** trade has been constantly positive, in the range of 215-350 and 45-102 million PLN/y, respectively. The balance of ***sodium sulfate*** trade has been always negative and recently the deficit has deepened, to around –51 million PLN in 2013 (Tab. 6).

The average unit values of ***calcined soda*** exportation have shown increasing tendency since 2010, when it dropped by almost 20% as compared to the previous year (Tab. 7). Average unit values of ***calcined soda*** exports and ***sodium sulfates*** imports have been very variable due to their low volume. Average unit values of ***sodium sulfates*** importation have varied between 167 and 201 USD/t. Over the analyzed period the average unit values of ***caustic soda*** trade have noticeably risen, with temporary reduction in 2010 (Tab. 7).

Tab. 4. Polish exports of caustic soda, by country — CN 2815 11

'000 t

Year	2009	2010	2011	2012	2013
Exports	**59.1**	**44.8**	**49.8**	**64.3**	**63.2**
Algeria	-	-	-	-	6.6
Angola	-	-	1.9	2.4	3.7
Belarus	1.0	2.4	1.4	1.4	0.8
Belgium	0.4	0.6	0.7	0.9	1.4
Brazil	9.6	7.6	6.0	5.9	7.7
Chile	1.1	1.6	0.5	1.7	0.7
China	3.5	2.5	2.4	2.4	2.6
Colombia	2.4	2.3	2.7	2.8	2.6
Czech Republic	2.2	1.8	1.8	2.8	2.2
Ecuador	1.4	1.7	1.0	1.5	1.3
Germany	1.6	1.8	1.9	1.2	2.1
Italy	2.1	1.8	2.5	3.0	2.1
Lithuania	0.7	1.2	1.0	1.6	0.9
Peru	3.1	0.5	0.6	1.3	1.4
Saudi Arabia	-	-	2.9	4.7	0.5
Senegal	-	-	0.7	1.5	0.2
Spain	1.5	1.3	1.0	1.1	0.9
Ukraine	3.7	2.1	0.7	3.2	3.2
Venezuela	1.7	0.9	1.3	1.0	2.0
Others	23.1	14.7	18.8	23.9	20.3

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Sodium sulfate statistics in Poland — CN 2833 11–19

'000 t

Year	2009	2010	2011	2012	2013
Production	NA	NA	NA	NA	NA
Imports	52.3	56.9	76.0	71.4	83.9
Exports	1.0	0.5	9.6	2.8	3.6
Consumption[a]	NA	NA	NA	NA	NA

Source: ***The Central Statistical Office (GUS)***

Tab. 6. Value of sodium compounds trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Calcined soda CN 2836 20					
Exports	283,113	227,576	268,638	341,991[s]	370,505[s]
Imports	24,165	12,077	10,218	12,165	20,377

Balance	**+258,948**	**+215,499**	**+258,420**	**+329,826[s]**	**+350,128[s]**
Caustic soda CN 2815 11					
Exports	88,022	58,317	76,563	120,193	114,115
Imports	10,489	13,790	19,556	19,352	11,860
Balance	**+77,533**	**+44,527**	**+57,007**	**+100,841**	**+102,255**
Sodium sulfate CN 2833 11–19					
Exports	587	493	7,175	2,164	2,435
Imports	30,645	28,778	39,606	43,306	53,095
Balance	**-30,058**	**-28,285**	**-32,431**	**-41,142**	**-50,660**

Source: ***The Central Statistical Office (GUS)***

Tab. 7. Average unit values of sodium compounds trade in Poland

Year	2009	2010	2011	2012	2013
Calcined soda CN 2836 20					
Exports unit values					
— PLN/t	810.5	630.2	694.9	778.7[s]	768.5[s]
— USD/t	259.0	209.3	235.9	238.1[s]	244.8[s]
Imports unit values					
— PLN/t	790.2	644.8	851.2	965.0	922.8
— USD/t	236.0	213.5	287.3	296.3	293.8
Caustic soda CN 2815 11					
Exports unit values					
— PLN/t	1,489.0	1,302.6	1,538.0	1,868.7	1,804.3
— USD/t	474.8	431.4	519.1	574.6	573.8
Imports unit values					
— PLN/t	1,681.3	1,461.6	1,820.1	2,219.0	2,144.2
— USD/t	542.5	479.8	629.9	676.8	682.0
Sodium sulphate CN 2833 11–19					
Exports unit values					
— PLN/t	573.6	1,002.4	746.8	780.0	674.5
— USD/t	189.5	334.3	256.3	242.7	215.3
Imports unit values					
— PLN/t	585.8	505.5	521.2	606.0	633.2
— USD/t	188.8	166.9	177.7	185.9	201.5

Source: ***The Central Statistical Office (GUS)***

Consumption

The principal consumers of ***calcined soda*** in Poland are the glass-making, detergents, and chemical industries. The development of the first two above mentioned industries (financed partly by foreign capital) should be continued, and assure stable domestic demand in the coming years (Tab. 1). ***Sodium sulfate*** has similar applications, but the main customer is the paper industry. ***Caustic soda*** is utilized mainly in the chemical and paper industries, as well as in sewage-treatment plants. It competes with calcined soda in some applications.

Companies involved in sodium compounds production in Poland, as of December 2013

- Soda Polska CIECH S.A. (Soda Polska CIECH Joint Stock Co.), ul. Fabryczna 4, 88–101 Inowrocław, tel. +48 52 3541500, fax +48 52 3537043, www.ciechgroup.com/PL/GrupaCiech/Soda_Polska_Ciech_SA — *calcined soda.*
- Anwil S.A. we Włocławku (Anwil Joint Stock Co. of Włocławek), ul. Toruńska 222, 87–805 Włocławek, tel. +48 54 2363091, fax +48 54 2361983, www.anwil.pl — *caustic soda.*

STONE, DIMENSION

Overview

The group of **crushed** and **dimension stones** consists of magmatic, metamorphic, and sedimentary rocks, characterized by suitable resistance to climatic factors, compression, and wear. They are suitable for the production of **dimension stone elements** (***blocks***, ***slabs***, ***ashlars***, ***pitcher***, ***curbs***, etc.) and **crushed stone** (**crushed aggregates**), commonly used in building, road, and railway construction (see: **AGGREGATES, MINERAL**). In order to determine whether they can be applied in buildings, roads, or railways, the rocks should be thoroughly examined with regard to: mineral composition to detect any constituents, which may decompose under prevailing climatic conditions, and the physical and mechanical properties — density, water absorption, compression strength, grindability, freeze-resistance, emulgation index, etc.

Deposits of **dimension stones** should be mined manually (by stopping), with the use of expansive mortars, with special machines for block cutting (cutting burner, diamond rope) or with a special type of explosives (blasting powder). **Stone road pitcher** and **curbs** are manufactured almost entirely from ***granites*** in Poland.

Sources

Rocks utilized for the production of ***crushed*** and ***dimension stone*** are classified in one common group. The majority of these rocks is useful only for the production of crushed aggregates, therefore reserve base of this group of rocks is presented in detail in separate chapter: **AGGREGATES, MINERAL**.

The majority of deposits of rocks suitable for ***dimension*** and ***road stone*** production, including deposits of ***granite***, ***syenite***, ***marble***, and ***sandstone***, is located in the Lower Silesia. Moreover, there are numerous ***decorative limestone*** and ***sandstone*** deposits in the Świętokrzyskie Mountains and in the Carpathians. A few deposits of ***dolomite*** and ***travertine*** are of minor importance. ***Dimension granite*** deposits of commercial value occur in three massifs in the Lower Silesia: **Strzegom-Sobótka**, **Strzelin-Żulowa**, and **Karkonosze**. The total recognized resources of granite (most of them suitable for the production of dimension stone) amount to ca. 1,623 Mt[1].

Syenite is another magmatic rock suitable for the production of dimension stone in the Lower Silesia. It occurs in the **Niemcza** area in two varieties: **Przedborowa** and **Kośmin**, with total reserves of ca. 56 Mt.

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[1] From the total reserves and output of ***building and road stone*** according to ***Mineral Resources Datafile***, the reserves and output of ***granite*** utilized for quartz-feldspar raw material production were excluded.

Marbles are recognized also entirely in the Lower Silesia: in the **Kaczawa Mountains**, **Kłodzko** area and **Eastern Sudetes**. Total resources of 11 deposits amount to ca. 48 Mt.

Sandstone in numerous varieties ranks the second among rocks suitable for the production dimension stone in Poland. Regarding the resources, the main varieties are: ***white "joint" sandstone*** of the **Stołowe Mountains** (8 deposits, ca. 38 Mt) and **North Sudetic Depression** (26 deposits, 55 Mt); ***white and yellow Szydłowiec sandstone*** (41 deposits, 85 Mt), and ***Żarnów sandstone*** of recently increasing importance (29 deposits, 7 Mt) in the northern part of the Świętokrzyskie Mountains in the central Poland, and some types of sandstone in the **Polish Flysch Carpathians**. Among the ***Carpathian sandstones*** the most significant are ***Green Godula sandstone*** from **Brenna** area in the western part of the Carpathians (12 deposits, 66 Mt), ***Grey Krosno sandstone*** (8 deposits, 134 Mt), ***Grey-yellow Istebna sandstone*** (9 deposits, 3 Mt), and ***Grey Magura sandstone*** (11 deposits, ca. 132 Mt). Such varieties as: ***Red Permian sandstone*** of **Intrasudetic Depression** (3 deposits, 5 Mt); ***Red Suchedniów*** and ***Tumlin sandstone*** in the northern part of **Świętokrzyskie Mountains**, as well as other varieties of ***Carpathian sandstone***: Cergowa and Ciężkowice ones, are of minor importance.

Production

Mining output of rocks suitable for the production of ***slabs***, ***pitcher***, ***curbs***, etc., increased from 1.2 Mtpy to 1.5 Mtpy in the years 2009–2011, while in 2013 it dropped to 1.2 Mt (Tab. 1). In reality, it can be higher by max. 10%, if the production of accessory ***blocks*** and ***pitcher*** in ***limestone*** and ***granite crushed aggregates*** plants will be included. Mining output is dominated by granites. They were obtained in the amount of 0.9–1.2 Mtpy in the years 2009–2013, primarily in the Strzegom area (Tab. 1). However, in recent years the rapid growth of granite extraction for aggregate production purposes has been observed. It has concerned both the Strzegom as well as Strzelin area.

Tab. 1. Mining output of the rocks suitable for dimension stone production

'000 t

Year	2009	2010	2011	2012	2013
Dolomite	3	3	4	3	2
Granite	973	1,050	1,241	1,189	929
Limestone	14	8	6	5	8
Marble	2	7	3	3	1
Sandstone	256	218	257	221	218
Syenite	8	8	7	4	14
Total	**1,256**	**1,294**	**1,518**	**1,425**	**1,172**

*Source: **Mineral Resources Datafile, authors' estimations***

Sandstone is another important dimension stone, especially ***Cretaceous sandstone*** variety from the Lower Silesia (Tab. 1). Mining output of dimension sandstone fluctuated between 210 and 260 ktpy in the years 2009–2013. It was a period of the significant changes in areas of concentration of the production. In the Lower Silesia the extraction of "joint" sandstones from **Lwówek Śląski** region decreased by 35% in the years 2009–2012 due to ceasing or considerable reduction of the mining output in three deposits: Zbylutów I, Żerkowice and Żerkowice-Skała, providing ca. 60% of total deliveries. On the other hand, the level of production of "joint" sandstones from **Radków** and **Długopole** area sharply increased. In the Świętokrzyskie area, the mining output of ***Szydłowiec sandstone*** nearly doubled in 2009, whereas the growing trend in the ***Żarnów sandstone*** supply has been stopped. The extraction of the ***Carpathian sandstones*** firstly increased as a result of reopening the Górka Mucharz mine, but afterwards it dropped because of the suspension of **Wola Komborska** deposit extraction in 2012. Recently, the number of sandstone deposits, from which ***split tiles*** and ***ashlars*** has been obtained, has significantly grown in the northern part of ***Świętokrzyskie Mountains***, especially in **Mroczków Gościnny**, **Tresta Wesoła** and **Pilichowice** areas. They have been also extracted in many quarries in the ***Carpathians*** (e.g. **Barcice**, **Wierchomla,** and newly opened mine in **Palcza**). The share of sandstones in the total output of dimension stone has fluctuated between 15% and 21% (Tab. 1), whereas share of limestone – dropped to less than 1%. Decreasing importance of dimension limestone in favour of crushed aggregates production has been reported, especially in the Świętokrzyskie area. Other types of rocks have had small share in the total output, no more than 1% each, and are not expected to increase.

The reported domestic production of ***dimension*** and ***road stone*** (Tab. 2) is currently much higher than their mining output (Tab. 1). It is partly a result of the production of accompanying dimension and road stone in some ***granite***, ***gneiss***, ***basalt***, and ***limestone crushed aggregates*** plants (the total production of these plants is estimated at 0.1 Mtpy), and partly due to the production of ***pitcher***, ***splits***, and ***other elements*** from pebbles in some sand & gravel mines in northern Poland. Moreover, some dimension rock products manufactured on the basis of imported blocks can also be included. Additional feature that should be considered is illegal mining, especially of sandstone and limestone in central and eastern Poland, the scale of which is unknown.

Tab. 2. Dimension and road stone statistics in Poland — CN 2515,2516,6801,6802[1]

'000 t

Year	2009	2010	2011	2012	2013
Production[2]	**3,836.4**	**4,598.5**	**6,223.6**	**4,118.0**	**3,913.0**
• dimension blocks and raw slabs	3,576.4	4,430.7	5,897.8	3,828.8	3,585.7
— *from granite*	*1,059.7*	*1,891.2*	*1,736.7*	*1,535.6*	*1,533.3*
— *from marble*	*1.4*	*1.6*	*1.2*	*1.1*	*3.3*
• pitcher and other road stone	260.0	167.8	325.8	289.2	327.3
Imports	**455.5**	**490.4**	**1,436.6**	**1,542.9**	**438.7**
Exports	**162.6**	**163.3**	**182.3**	**200.9**	**208.7**
Consumption[a]	**3,929.3**	**4,925.6**	**7,477.9**	**5,460.0**	**4,143.0**

[1] with the exception of **CN 6802 10**

[2] sold, only production of companies with over 10 employees is reported

Source: ***The Central Statistical Office (GUS)***

Official data on the total production of ***dimension stone*** and ***road stone*** in Poland, as well as of their assortment, are reported by large and medium companies only (over

10 employees). According to the Central Statistical Office the total domestic production of ***dimension stone*** rose to the record level 6.2 Mt in 2011, with a drop to 3.9–4.1 Mt in the following two years (Tab. 2) However, the real production estimated on the basis of mining output of dimension stone and the mentioned above accompanying production, as well as from imported raw blocks and slabs, in the years 2009–2013 probably ranged from ca. 1.4 to 1.9 Mtpy. ***Road stone*** production strongly fluctuated between 167,800 tpy and 327,300 tpy in the recent five years (Tab. 2). Data on assortment structure of ***dimension stone*** show that ***granite*** constitutes 77–83% of their total supply, ***sandstone*** — 15–21%, with marginal share of other types of rocks. In the structure of ***road stone*** production (***pitcher*** and ***curbs***) ***granite*** predominated (over 90%), with marginal shares of ***syenite*** and ***basalt*** pitcher and curbs.

The most important dimension stones in Poland have been traditionally ***granites*** obtained primarily in the Lower Silesia. The total production of these rocks, concentrated especially in the **Strzegom** area and – to a lesser extent - near **Strzelin,** dropped to ca. 929 kt in 2013. In 2013 ***dimension granite*** was extracted in 26 quarries: 18 of them delivered only ***dimension stone*** and/or ***road stone*** (pitcher etc.), while 8 of them — both dimension and road stone, as well as ***crushed aggregates*** (Tab. 3). In the **Strzegom** area the most important producers have been: **Borowskie Kopalnie Granitu Borów, Grabinex Strzegom, Skalimex-Borów Kostrza, Morstone Strzegom, Granit Strzegom**, **PPHiU Piramida Strzegom**, **GT&F Corporation Polska Kostrza**, **Wekom II Kostrza, Kwarc Kostrza**, **Skalimex-Grantin Sobótka, Granimex Strzegom** (Tab. 3). The production of dimension granite has been also carried out by dozen smaller mines in this area, providing in the majority ***blocks***, ***raw slabs***, ***pitcher***, and ***curbs***. Since 2009 ***dimension stones*** have not been extracted in **Gniewków Granite Mine** which was taken over by **Olsztyńskie Mineral Mines** (a large producer of ***mineral aggregates***). Also **Graniczna II Mine** in **Strzegom** and **Zimnik Mine** in **Mściwojów** (since 2012 belonging to **Tinarg)**, traditionally big suppliers of ***dimension granite***, commenced the production of ***crushed aggregates***. On the other hand, the extraction of granite blocks from **Borów-Południe** deposit, commenced by **Grażyna Hyżyńska** in August 2009, has been systematically increasing in recent years. Moreover, in the years 2010–2011 a small quantity of granite blocks was obtained from the newly opened **Strzegom-Artur** mine by **Kampol**.

Quarries of **Strzelin** granite have been of minor importance as dimension granite producers (Tab. 3). Granite blocks and smaller dimension elements have been delivered exclusively by two mines operated in this area, in the total amount of dozens of thousand tpy. The majority of the production came from Strzelin mine, belonging to **Kruszywa Strzelin** in the years 2009–2011, and afterwards to the **Stonopol** and **Mineral Polska**. The mine considerably increased the the output of granite, however, the extracted raw material has been predominantly crushed into aggregates. The blocks of granite have been obtained exclusively by the **Stonopol**.

Until 2011 only one quarry extracted ***dimension granite*** of **Karkonosze** type in **Szklarska Poręba**.

Tab. 3. Main producers of dimension and road stone in Poland in 2013

Producer	Type of rock	Deposit	Mining output ['000 t]	Yield of blocks [%][e,1]
• **Borowskie Kopalnie Granitu, Borów**	GSgm	Borów	198	>90
• **Grabinex, Strzegom**	GSgm	Grabina Śląska kam.15/27	125	>70
• **Skalimex-Borów, Kostrza**	GSgm	Borów 17	114	>75
• **Morstone, Strzegom**	GSgm	Morów II	86	>90
• **Granit Strzegom, Strzegom**	GSgm	Strzegom kam. 25/26, Żółkiewka I	104	>60
• **PPHiU Piramida, Strzegom**	GSgm	Borów I — quar. 49A	60	>95
• **GT & F Corporation Polska, Kostrza**	GSgm	Kostrza-Piekiełko, Kostrza-Lubicz	59	>95
• **Wekom II, Kostrza**	GSgm	Kostrza	44	>80
• **PWPiSKB Kwarc, Kostrza**	GSgm	Borów I — quar. 49	39	>95
• **Skalimex-Grantin, Sobótka**	GSgm	Strzeblów II	60	50
• **Granimex, Strzegom**	GSgm	Graniczna II	180	<20[2]
• **PPU Czernica-Granit, Czernica**	GSgm	Czernica	39	70
• **Przerób Kamienia Export-Import Grażyna Hyżyńska, Borów**	GSgm	Borów-Południe	30	>90
• **PPHU Ted-Rob T. Kaliciński, R. Lema**	GSgm	Barcz I	21	>95
• **Granit Wiatrak, Graniczna III Mine**	GSgm	Graniczna III	21	80
• **Braun-Granit, Nowa Sól**	GSgm	Czernica-Wieś	51	>30
• **Globgranit Strzegom, Żółkiewka**	GSgm	Żółkiewka IV	19	80
• **Euro-Granit, Strzegom**	GSgm	Żółkiewka-Wiatrak	10	>95
• **Tinarg, Zimnik**	GSgm	Zimnik, Zimnik I	105	<10
• **Kopalnia Paszowice, Paszowice**	GSgm	Pokutnik	9	>95
• **Fer-Granit, Rogoźnica**	GSgm	Rogoźnica-Las	5	>95
• **Kruszywa Strzelin, Strzelin**	GStn	Strzelin	921	<10
• **Mikoszów Wieś Granite Mine Bronisław Badecki, Mikoszów**	GStn	Mikoszów-Wieś	1	>95
• **Sjenit, Piława Górna**	Sy	Kośmin	434	<5
• **Slag Recycling, Kraków**	Sy	Przedborowa	4	<15
• **PWiOM Marmur-Sławniowice, Sławniowice**	M	Sławniowice	1	>95

• **Dolomit, Libiąż**	D	Libiąż	319	<1
• **Morawica Limestone Mine**	LD	Morawica III	1,638	<1
• **Bolechowice Building Stone Company, Kraków**	LD	Bolechowice	100	>1
• **Marmur-Płytki Jacek Łata, Podłęże**	LD	Włochy	1	>90
• **Hofmann Polska, Kraków**	SJ	Wartowice	25	>70
• **Drebol, Zbylutów**	SJ	Wartowice V	22	>70
• **Gruszecki, Bielany Wrocławskie**	SJ	Czaple, Skała, Zbylutów	21	>70
• **Jan Zbylutów IV Sandstone Mine, Zbylutów**	SJ	Zbylutów IV –Jan	21	>70
• **Piasmar Z.R. Więcławek, Bystrzyca Kłodzka**	SJ	Długopole	10	>70
• **PRBM Budomontaż, Nowa Ruda**	SP	Bieganów	1	>70
• **Surowce Mineralne, Kielce**	ST	Tumlin-Gród	1	>70
• **Sosnowica, Sosnowica**	ST	Sosnowica, Kopulak 1	2	>50
	SSz	Szydłowiec	14	>70
• **TOMKAM Waldemar Tomczyk, Szydłowiec**	SSz	Broniów V	11	>70
	SSz	Śmiłów 1	6	>70
• **Kamieniarz , Kielce**				
• **Roman Kaczmarczyk, Opoczno**	SZ	Żarnów 1	2	>70
• **Andrzej Kosek, Miedzna**	SZ	Sielec I	2	>80
• **Kamieniarstwo Pawlik, Strzałków**	SCrZ	Chełmska Góra II, -III	3	>80
• **Polski Kamień Naturalny Mucharz-Skawce, Zembrzyce**	SCa	Górka Mucharz	20	<30
• **ZKB Skalnik, Barcice**	SCa	Barcice I	11	<50
• **Tadeusz Brach, Wola Komborska**	SCa	Wola Komborska I	7	>30
• **B. & W. Mleczek, Stróża**	SCa	Tenczyn-Lubień I	1	<50
• **Kamieniołom Barwałd, Barwałd**	SCa	Barwałd	151	<1
• **Kopalnia Łupka Szarogłazowego, Jenków**	S	Jenków	36	

Legend: **D** — Dolomite, **GKa** — Karkonosze Granite, **GSgm** — Strzegom Granite, **GStn** — Strzelin Granite, **LD** — Decorative Limestone, **M** — Marble, **S** — Slate, **SB** — Jurassic Borucice Sandstone, **SCa** — Carpathian Sandstone, **SCrZ** — Cretaceous Zagórze Sandstone, **SJ** — Joint Sandstone, **SP** — Permian Sandstone, **SSz** — Jurassic Szydłowiec Sandstone, **ST** — Triassic Sandstone, **SZ** — Jurassic Żarnów Sandstone, **Sy** — Syenite, **T** — Travertine

[1] blocks and smaller dimension stone [2] mainly lumps use for pitcher and ashlar production

Source: ***Mineral Resources Datafile, authors' estimations***

Syenite is another magmatic rock traditionally used for the production of dimension stone. It has been mined from the **Kośmin** deposit, by **Sjenit,** and from **Przedborowa** deposit by **Slag Recycling.** The total output of ***syenite blocks*** and ***smaller dimension stones*** has ranged from 4 to 14 ktpy in recent years (Tab. 3).

Marbles are important as ***dimension stone***, as well as for the production of ***marble grits***. They have been extracted from **Sławniowice** deposit in Eastern Sudetes and until 2011 in **Stronie Śląskie** area (Tab. 3). The total mining output has amounted to a few thousand tpy. The production of ***large marble blocks*** has usually not exceeded 1 ktpy, while the rest has been used for ***small tiles*** and ***grits for terazzo***. Minor importance have had dimension stones derived from other metamorphic rock deposits, including ***serpentynite*** from **Nasławice mine** and ***eyelet gneiss*** from **Pomianów–Doboszowice** mine, where the yield of blocks as well as their sizes have been low.

Among sedimentary rocks, ***sandstone*** of various types is currently the most important dimension stone in Poland. A few different types are used for this purpose: Lower Silesian white ***"joint" sandstone*** from **Lwówek Śląski**, **Radków**, and **Bystrzyca Kłodzka** areas, ***sandstone of Szydłowiec type*** and ***Żarnów type*** (the Świętokrzyskie Mts.) and various types of ***Carpathian sandstone***. "Joint" sandstones from **Lwówek Śląski** region are currently the most important of them. Seven mines belonging to five companies are active there, while their total mining output considerably dropped from 82 kt in 2009 to 54 kt in 2012. In 2013, due to growth in the production in **Wartowice** area, the total volume of extracted raw material exceeded the level reported prior to the reduction. The "joint" sandstone deposits occurring in the **Radków** and **Bystrzyca Kłodzka** areas provided 10–45 ktpy of blocks and lumps in the years 2009–2013, with the overwhelming majority deriving from **Radków** and **Długopole** deposits. Further growth of the mining output of these sandstones is forecasted due to the construction of another mine in **Długopole Górne**. There is a wide range of sandstone varieties in the Świętokrzyskie Mountains. The most important of them are white and yellow ***Jurassic sandstones*** extracted in the ***Szydłowiec*** area by over dozen of private persons. Their total output strongly increased, from ca. 20 ktpy in the years 2009–2012 to almost 40 kt in 2013. The other operated quarries of coloured ***Jurassic sandstones***, situated near **Żarnów** and **Opoczno**, have supplied between 14 and 55 ktpy of sandstone split tiles and blocks (extracted only in **Sielec**, **Dąbie** and **Wolica** area). The ***Cretaceous sandstone*** occurring in the Świętokrzyskie Mountains has been exploited in the amount of a few thousands tpy from deposits situated near **Przedbórz**. There was a significant decrease of the output of red ***Triassic sandstone*** (especially ***Tumlin sandstone*** from **Sosnowica** and **Tumlin-Gród** deposits, and additionally ***Suchedniów sandstone*** from **Kopulak 1** deposit), from 8 kt in 2009 to 3-4 ktpy in the last two years (tab. 3). In the Carpathians the main producer of dimension sandstone has been **Tadeusz Brach**, the production of which varied widely from 45 to 83 ktpy. Recently, the supplies considerably dropped as a result of the suspension of extraction of **Wola Komborska** deposit in 2012. A new important supplier of blocks of ***Krosno sandstone*** from **Górka Mucharz** mine has been recently reopened, i.e. **Polski Kamień Naturalny Mucharz-Skawce.** Small quantities of ***blocks*** and ***smaller dimension stone*** have been extracted in **Barwałd** and **Sobolów** quarries and also in the **Brenna** area. Other producers, e.g. **Skalnik** of **Barcice**, have provided mainly split tiles.

Decorative dimension limestone has been extracted for centuries from various deposits of so-called ***Kielce “marbles”*** situated in the majority in the Świętokrzyskie Mountains near Kielce. The prominent supplier of these rocks was **Pińczów Dimension Stone Works,** but after dismissing **Bolechowice**, and **Wola Morawicka** mines, the company has operated exclusively **Pińczów** deposits on irregular bassis. The level of the limestone blocks production has significantly dropped in recent years. The majority of valuable varieties, such as ***Devonian*** and ***Jurassic limestone***, has been obtained in a small amounts (a few thousand tpy) in crushed aggregate mines. The former has been extracted in **Bolechowice mine** (acquired by **PKB Bolechowice**), and - to a lesser extent - in **Jaźwica mine**, whereas the latter - in **Morawica III** and **Wola Morawicka** mines (operated irregularly by **Pol-Bot Kruszywa**). Since 2008 a producer of limestone blocks and slabs of the Pińczów type limestone has been **Marmur-Płytki**, operating **Włochy** deposit, but the output has been insignificant. The company, as the owner of some other undeveloped limestone deposits in the Świętokrzyskie area, i.e.: **Włochy I** (another deposit of ***Pińczów type limestone***), **Wola Morawicka Góra Orla** (***Jurassic limestone of Morawica type***), and **Gołuchów** (***Jurassic oolitic limestone***), has been developing its production potential. The plans of reopening of ***Devonian black limestone*** deposit in **Dębnik**, near Kraków have been announced by the **Trans-Ziem.** Another interesting variety of dimension limestone has been so called **travertine** occurring in the **Raciszyn-Zalesiaki** area in central Poland. It has been traditionally obtained from **Raciszyn II** deposit by **WKG Trading**, but since 2009 the company has primarily concentrated on the crushed aggregate production. However, the development of the travertine block production by this company is very probable, as a modern processing plant has been under construction. A negligible importance in terms of travertine blocks extraction (a few dozen tons in 2010) have had **Raciszyn** and **Zalesiaki** mines, opened in this area in recent years. Moreover, sources of small amounts of limestone lumps were **Józefów** and **Babia Dolina** deposit in the Lublin area as well as **Czepów** deposit near Łódź. The other carbonate rocks utilized for the production of blocks and smaller dimension stones have been Triassic ***dolomite*** from **Libiąż** (a few thousand tons per year).

Trade

In recent years both the volume and structure of ***dimension*** and ***road stone*** trade have changed considerably. ***Dimension stone*** imports strongly increased, from 427–457 ktpy in the years 2009–2010 up to 1.3–1.5 Mtpy in 2011–2012, while in 2013 it returned to the previous level of ca. 400 ktpy. ***Raw blocks*** and ***slabs*** comprised a majority of these imports, with the exception for 2010 and 2013, when ***worked dimension stone*** predominated (Tab. 4, 5). The majority of the supplies accounted for ***granite*** and ***related rocks.*** Deliveries of ***processed slabs*** of these rocks fluctuated between 150 and 240 ktpy, whereas the imports of ***raw granite blocks and slabs***, usually ranging from 168 to 230 ktpy, increased to the record level of 0.9–1.2 Mtpy in the years 2011–2012. The periodical growth of supplies concerned a significant demand for hydrotechnical stone in northern Poland, related to investments on the Baltic Sea coast (e.g. construction of new breakwaters in Kołobrzeg). ***Raw granite blocks and slabs*** have been purchased primarily from South Africa and India, excluding the years 2011–2012 when deliveries from Sweden and Norway (in 2012) prevailed (Tab. 4). Important suppliers were also

Finland, Ukraine, Zimbabwe, and Spain (Tab. 4). Deliveries of ***marble*** and ***relative rocks*** declined from 6,700 tpy in 2009 to 2,300 tpy in 2013, with Italy and Germany (until 2010) as main suppliers. Imports of ***sandstone*** blocks and slabs have been marginal, whereas supplies of other rocks have varied widely (between 3,100 tpy and 157,400 tpy). The considerable growth of purchases of other rocks from Norway had been probably driven by hydrotechnical works, similarly as in the case of considerable demand for granite.

Tab. 4. Crude or roughly worked dimension stone imports to Poland

'000 t

Year	2009	2010	2011	2012	2013
Imports, total	**239.8**	**218.1**	**1,067.0**	**1,270.6**	**183.0**
Marbles, limestones and other carbonate rocks CN 2515	**6.7**	**5.9**	**4.7**	**2.6**	**2.3**
Germany	1.8	1.0	0.1	0.1	0.0
Italy	2.7	3.2	3.0	1.7	1.6
Portugal	0.5	0.2	0.3	0.2	0.1
Spain	0.8	0.5	0.6	0.2	0.1
Turkey	0.2	0.4	0.1	0.1	0.1
Others	0.7	0.6	0.6	0.3	0.4
Granites CN 2516 11,12	**228.9**	**195.1**	**904.2**	**1,228.4**	**167.9**
Angola	4.4	5.4	6.5	6.0	8.2
Belgium	0.2	1.1	0.2	0.5	0.5
Brazil	9.0	5.5	4.5	4.9	3.9
China	0.1	1.1	2.5	1.1	0.4
Finland	22.3	15.1	13.0	10.9	11.7
France	0.9	1.2	1.7	0.8	0.8
Germany	5.8	6.5	0.4	3.4	2.7
India	45.3	29.6	35.1	30.3	26.8
Italy	1.8	0.2	0.4	0.4	0.4
Norway	2.6	2.8	2.4	274.1	3.1
Portugal	0.1	0.7	2.7	1.0	0.6
Russia	0.6	0.4	0.0	0.1	0.0
South Africa, Republic of	87.0	64.4	66.9	70.7	60.1
Spain	9.8	7.6	17.2	7.2	8.3
Sweden	19.2	33.9	737.2	805.1	20.4
Ukraine	16.1	18.1	10.6	7.7	9.8
Zimbabwe	1.5	1.4	2.3	3.5	9.5
Others	2.2	0.1	2.9	0.7	0.7
Sandstones CN 2516 20	**1.1**	**1.0**	**0.7**	**0.7**	**1.1**
Germany	0.0	0.3	0.0	–	0.6

India	0.3	0.3	0.4	0.2	0.1
Spain	0.5	0.0	–	0.0	0.1
Ukraine	0.1	0.2	0.2	0.3	0.2
Others	0.2	0.2	0.1	0.2	0.1
Other rocks CN 2516 90	**3.1**	**16.1**	**157.4**	**38.9**	**11.7**
China	0.1	0.0	0.2	0.4	0.0
Lithuania	–	–	–	–	5.3
Norway	–	13.5	154.0	33.2	–
Sweden	0.4	–	0.1	3.7	5.2
Ukraine	2.1	2.3	2.7	1.1	0.5
Others	0.5	0.3	0.6	0.5	0.7

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Worked dimension stone imports to Poland

'000 t

Year	2009	2010	2011	2012	2013
Imports, total	**187.4**	**238.9**	**273.5**	**221.2**	**220.4**
Marbles, limestones and other carbonate rocks CN 6802 21,91,92	**31.8**	**29.6**	**29.3**	**26.6**	**25.3**
China	2.0	2.6	3.0	3.5	1.5
Czech Republic	6.1	5.9	4.2	3.8	3.4
Egypt	0.9	0.6	0.6	0.7	0.5
Greece	0.2	0.0	0.1	0.1	0.1
Germany	1.3	2.1	2.2	2.4	3.0
India	1.3	1.6	3.2	1.1	0.8
Italy	8.3	7.2	6.2	6.5	7.8
Portugal	0.2	0.3	0.3	0.5	0.4
Spain	3.7	3.2	3.2	2.5	2.8
Turkey	4.6	3.9	4.1	3.7	3.2
Others	3.2	2.2	2.2	1.8	1.8
Granites CN 6802 23,93	**149.8**	**200.8**	**235.2**	**180.7**	**167.1**
Belgium	2.1	5.6	2.3	0.6	1.6
Brazil	2.8	3.1	1.4	0.9	0.5
China	98.7	124.7	168.1	122.6	111.2
Germany	2.4	3.9	5.6	6.0	6.5
India	25.1	36.1	41.3	38.2	38.4
Italy	6.0	6.5	5.0	3.5	3.1
South Africa, Republic of	3.0	9.6	2.9	1.5	2.0
Spain	3.3	3.3	3.5	1.7	1.4

Sweden	4.7	2.9	0.5	1.7	0.0
Others	1.7	5.1	4.6	4.0	2.4
Other rocks CN 6802 29,99	**5.8**	**8.5**	**9.0**	**13.9**	**28.0**
China	1.5	2.1	3.6	4.2	3.0
Czech Republic	0.1	0.7	0.2	0.4	0.4
Germany	0.2	0.1	0.4	4.0	11.5
India	0.8	1.2	0.9	0.6	1.6
Italy	2.5	3.3	0.1	1.8	3.1
Sweden	–	0.0	–	–	6.1
Spain	0.0	0.1	1.3	0.6	1.4
Others	0.7	1.0	2.5	2.3	0.9

Source: ***The Central Statistical Office (GUS)***

Imports of ***processed slabs*** ranged from ca. 187 to 274 ktpy in the years 2009–2013 (Tab. 5). The vast majority of purchases constituted granite slabs, generally of Chinese and Indian origin. The deliveries of these rocks fluctuated between ca. 150 and 235 ktpy in the years 2009–2013. The amount of ***marble*** slabs imports, traditionally reported on the much lower level, were systematically reduced to only 25,300 t in the years 2009–2013. It was a result of decreasing deliveries from most of the leading supplying countries, such as Italy, the Czech Republic, and Turkey. On the contrary, imports of the ***other rocks***, especially from Germany and Sweden, significantly increased and in 2013 exceeded the amount of purchased ***marble*** slabs.

Imports of ***road stone*** varied over a wide range, from ca. 28 to 9 ktpy, as a result of changing supplies from China, Slovakia, and Germany (Tab. 6).

Tab. 6. Pitcher and curbs imports to Poland — CN 6801

'000 t

Year	2009	2010	2011	2012	2013
Imports	**28.3**	**33.4**	**96.1**	**51.1**	**35.3**
China	0.5	4.7	45.4	25.2	21.2
Germany	5.1	5.9	7.0	1.0	1.9
Slovakia	17.5	18.2	37.0	21.5	7.7
Ukraine	4.5	3.9	5.2	3.3	4.1
Others	0.7	0.7	1.5	0.1	0.4

Source: ***The Central Statistical Office (GUS)***

Exports of ***dimension stone*** from Poland was constantly increasing, from 94,300 t to 172,100 t in the last five years (Tab. 7, 8). The highest growth, from 75,400 t up to 139,100 t, was reported in ***raw blocks*** and ***slabs*** exports (Tab. 7). Considerably lower share in the total sales had a ***processed stone*** — 18–33 ktpy (Tab. 8). ***Granite blocks*** and ***slabs*** — raw and processed — were primarily exported (Tab. 7, 8). Their main recipient was Switzerland, where the considerable amounts of the Strzegom granite ashlars were utilized to strengthen of embankments in the Alps, and Germany. The ***processed slabs*** from ***other stones*** (including sandstones) were sold in the amount of 6–13 ktpy, primarily to Germany. Exports of ***raw block*** and ***slabs*** from ***sandstone*** and ***other rocks*** (probably ***syenite*** and/or ***travertine***) generally have not exceeded a few thousand tpy, with the exception for 2013, when ca. 16 kt of other rocks (probably slate) has been sold to the Czech Republic (Tab. 7).

Tab. 7. Crude or roughly worked dimension stone exports from Poland

'000 t

Year	2009	2010	2011	2012	2013
Exports, total	**75.4**	**80.0**	**99.1**	**105.4**	**139.1**
Marbles, limestones and other carbonate rocks CN 2515	**0.8**	**0.9**	**0.8**	**1.0**	**0.7**
Slovakia	0.7	0.5	0.4	0.7	0.4
Others	0.1	0.4	0.4	0.3	0.3
Granites CN 2516 11,12	**69.8**	**77.1**	**96.5**	**102.5**	**118.4**
Austria	0.1	–	0.0	0.1	0.1
Czech Republic	0.0	0.7	0.6	1.1	0.9
France	1.2	0.3	0.3	0.6	0.1
Germany	29.3	29.7	34.4	30.2	25.7
Switzerland	39.0	45.7	60.3	69.8	90.4
Others	0.2	0.7	0.9	0.7	1.2
Sandstones CN 2516 20	**4.8**	**1.9**	**0.8**	**1.8**	**4.0**
Germany	4.8	1.8	0.7	1.5	3.8
Others	0.0	0.1	0.1	0.3	0.2
Other rocks CN 2516 90	**0.0**	**0.1**	**1.0**	**0.1**	**16.0**
Czech Republic	–	–	–	–	15.9
Slovakia	0.0	0.0	0.9	0.0	–
Others	0.0	0.1	0.1	0.1	0.1

Source: ***The Central Statistical Office (GUS)***

Tab. 8. Worked dimension stone exports from Poland

'000 t

Year	2009	2010	2011	2012	2013
Exports, total	**18.9**	**20.9**	**18.6**	**32.8**	**33.0**
Marbles, limestones and other carbonate rocks CN 6802 21,91,92	**1.2**	**1.4**	**1.4**	**5.6**	**2.6**
Germany	0.0	0.0	0.0	3.1	0.0
Russia	0.6	0.8	0.8	1.4	1.1

Ukraine	0.4	0.3	0.2	0.2	0.3
Others	0.2	0.3	0.4	0.9	1.2
Granites CN 6802 23,93	**11.5**	**10.2**	**8.5**	**14.0**	**21.4**
Austria	0.4	0.3	0.3	0.3	0.6
Czech Republic	0.4	0.5	0.1	1.3	1.3
Germany	7.0	6.0	4.4	9.0	13.8
Russia	0.9	0.3	0.2	0.1	0.8
Slovakia	0.4	0.9	1.0	0.6	0.1
Switzerland	1.6	1.5	1.7	1.7	2.2
Others	0.8	0.7	0.8	1.0	2.6
Others rocks CN 6802 29,99	**6.2**	**9.3**	**8.7**	**13.2**	**9.0**
Germany	5.1	8.6	8.3	12.6	8.4
Others	1.1	0.7	0.4	0.6	0.6

Source: ***The Central Statistical Office (GUS)***

Stone pitcher and ***curbs*** were important export products of this group, however their sale decreased by nearly half, from 62,500–68,300 t in the years 2009–2012 to only 36,600 tpy in 2013 (Tab. 9). The drop in exports volume was a consequence of decline in demand from Germany — traditionally the most prominent recipient of these products, as well as from Slovakia — the second major sales direction.

Tab. 9. Pitcher and curbs exports from Poland — CN 6801

'000 t

Year	2009	2010	2011	2012	2013
Exports	**68.3**	**62.5**	**64.6**	**62.7**	**36.6**
Austria	0.2	0.3	0.2	0.2	0.2
Czech Republic	0.9	1.1	0.7	0.7	1.3
Germany	54.7	48.1	36.9	41.8	33.1
Latvia	0.0	0.0	0.2	0.2	0.1
Lithuania	0.0	0.2	0.7	0.9	0.2
Slovakia	11.7	12.5	25.4	17.6	0.1
Sweden	0.2	0.0	0.1	0.1	0.1
Others	0.6	0.3	0.4	1.2	1.5

Source: ***The Central Statistical Office (GUS)***

The trade balance in ***crude*** or ***roughly worked dimension stone*** has been consistently negative and fluctuated between ca. 100 and 190 million PLN in the years 2009–2013 (Tab. 10). The trade balance in ***worked dimension stone*** has also been negative and the deficit varied between 199 and 330 million PLN/year (Tab. 10). The trade balance in ***pitcher*** and ***curbs*** used to be positive, however, the situation changed in 2011 due to considerable growth of imports from China and Slovakia, and in 2013 - owing to decline in export to Germany and Slovakia. In the years 2009–2013 deficit varied depending on imports volume between 351 and 507 million PLN/year.

Tab. 10. Value of dimension stone trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Crude or roughly worked dimension stone CN 2515,2516					
Exports	75,338	27,777	36,711	45,851	53,805
Imports	239,712	156,132	205,607	234,896	154,661
Balance	**-164,374**	**-128,355**	**-168,896**	**-189,045**	**-100,856**
Worked dimension stone CN 6802					
Exports	21,711	53,318	55,718	76,031	34,859
Imports	221,191	383,051	381,719	352,802	308,422
Balance	**-199,480**	**-329,733**	**-326,001**	**-276,771**	**-273,563**
Pitcher and curbs CN 6801					
Exports	19,587	17,332	16,576	18,002	11,856
Imports	6,758	9,565	28,605	17,085	14,879
Balance	**+12,829**	**+7,767**	**-12,029**	**+917**	**-3,023**

Source: ***The Central Statistical Office (GUS)***

The average unit values of trade of ***raw blocks*** and ***slabs*** made of ***marble*** and ***other carbonate rocks*** are very variable due to low level of this trade. In the last five years they were reported at the level of 1,025–3,740 USD/t in exports and 575–668 USD/t in imports (Tab. 11). The average unit values of ***granite raw blocks*** and ***slabs*** exports have ranged from 97 to 124 USD/t in recent years, while their imports unit values usually oscillated at much higher level (245–290 USD/t), except for the years 2011–2012, when they considerably dropped owing to very low cost of deliveries from Norway (25 USD/t) and Sweden (27 USD/t) (Tab. 11). The average unit values of trade of ***sandstone raw blocks*** and ***slabs*** have been very variable due to very low quantities of their imports and exports (Tab. 11). The unit costs of trade of ***raw blocks*** and ***slabs*** made of ***other rocks*** have varied widely due to significant changes in their assortment structure. The average unit values of ***pitcher*** and ***other road stone*** exports dropped from 93 USD/t in 2009 to 88 USD/t in the years 2011–2012 as a result of low prices of pitcher exported to Slovakia, but in 2013 they increased to 103 USD/t. On the contrary, the unit values in imports rose from 76 USD/t to 133 USD/t in the last five years (Tab. 11).

Tab. 11. Average unit values of dimension and road stone trade in Poland

Year	2009	2010	2011	2012	2013
Marbles, limestones, and other carbonate rocks, crude or roughly worked CN 6802 21, 91, 92					
Exports unit values					
— PLN/t	3,141.2	7,620.4	6,039.5	4,291.5	11,703.2
— USD/t	1,025.2	2,486.2	2,015.4	1,308.0	3,740.1

Imports unit values					
— PLN/t	1,766.5	1,789.9	1,961.1	1,830.6	1,852.8
— USD/t	575.5	590.1	667.8	560.6	588.5
Granite, crude or roughly worked CN 2516 11					
Exports unit values					
— PLN/t	301.9	304.5	343.9	375.8	391.1
— USD/t	96.6	99.9	117.7	115.2	123.9
Imports unit values					
— PLN/t	809.0	747.0	198.3	178.5	853.8
— USD/t	258.5	245.8	68.4	54.4	269.9
Sandstone, crude or roughly worked CN 2516 20					
Exports unit values					
— PLN/t	627.3	641.2	688.5	832.3	1,162.3
— USD/t	201.4	215.4	236.9	259.2	367.6
Imports unit values					
— PLN/t	1,212.3	1,249.3	1,029.9	854.4	2,008.8
— USD/t	394.9	411.8	341.7	259.8	647.4
Other rocks, crude or roughly worked CN 2516 90					
Exports unit values					
— PLN/t	9,578.9	1,319.7	182.6	22,103.0	48.6
— USD/t	3,073.2	438.1	62.9	6,968.6	15.4
Imports unit values					
— PLN/t	488.2	161.5	70.5	128.8	244.7
— USD/t	154.2	54.0	22.4	39.7	77.6
Pitcher and other road stones CN 6801					
Exports unit values					
— PLN/t	286.6	277.3	256.5	287.0	324.4
— USD/t	92.7	91.0	88.0	88.0	103.0
Imports unit values					
— PLN/t	239.1	286.4	297.7	334.1	421.3
— USD/t	75.8	93.4	102.1	101.1	133.3

Source: ***The Central Statistical Office (GUS)***

Consumption

The majority of the compact rocks extracted in Poland are utilized for the production of ***crushed aggregates***, which are consumed by the road, railway, and civil construction industries. Only a small percentage of the total production is constituted by ***large*** and ***small dimension stone*** for civil construction, as well as by ***pitcher*** and ***curbs*** for road construction.

Total domestic consumption of ***dimension*** and ***road stone***, according to official data (the Central Statistical Office) has varied between 4 and 7 Mtpy in the recent years. According to author's estimations the level of consumption was much lower. It increased from ca. 1.6–1.7 Mtpy in the years 2009–2010 to ca. 2.8 Mtpy in the years 2011–2012, with a reduction to 1.5 Mtpy in 2013 (Tab. 2). The share of foreign suppliers on domestic market of ***blocks*** and ***raw slabs*** in terms of volume, usually below 20%, grew to 50% in the years 2011–2012. In terms of value it was even higher and constituted ca. 60% in 2013. Domestic producers have dominated (over 99%) in the ***dimension sandstone*** branch, but in the case of ***dimension granite*** this share has increased to over 80% (from ca. 50% in 2011-2012), while for ***dimension marble*** — it has been about 10%. The periodical growth of granite and the other rocks consumption, in majority of Swedish and partly of Norwegian origin, was reported in the years 2011–2012 as a result of hydrotechnical investment on the Polish sea coast.

Dimension stone elements (***wall sidings***, ***floor slabs***, ***tombstones***, etc.) manufactured mainly from domestic granite, syenite, and marble, as well as from decorative "marble" and sandstone, are used for monuments and public buildings, and — on a smaller scale — for private dwellings. ***Smaller stone elements*** (***window sills***, ***stairs***, etc.) made of the same rock materials are also in common use. Imported dimension stone blocks are used for the same purposes competing with domestic products. Domestic dimension stone has been still dressed mainly in the Lower Silesia, at plants close to the deposits. Imported dimension stone has been dressed in numerous private stone workshops spread all over the country, but mostly in the vicinity of large cities. However, large stone plants in the Lower Silesia (e.g. in Strzegom area) have also utilized increasing amounts of imported stones to diversify their market offer. The share of imported stone on the ***worked dimension stone*** market has amounted to over 50% both in volume and value terms. In a future, a competitors for the domestic dimension stones might be also an artificial slabs (consisting primarily of quartz grains), available on the market since a few years.

The consumption of ***road stone*** (***pitcher***, ***curbs***, etc.) in Poland has shown an increasing tendency, although they undoubtedly has been not as popular as in other countries, e.g. Germany. The interior market of road stone, after strong decrease from 220 to ca. 140 ktpy in 2010, spectacularly grew to 270–360 ktpy in the following three years. The rising demand for ***pitcher***, ***curbs***, etc. was caused by growing number of road investments. Polish market of road stone has been dominated (over 97%) by domestic producers of ***granite pitcher*** and ***curbs*** from Strzegom and Strzelin areas, with minor significance of manufacturers of ***syenite*** and ***basalt pitcher***. The share of foreign suppliers usually did not exceed 20%, except the years 2010–2011 when it increased to 24–27%.

Value of domestic market of ***raw dimension*** and ***road stone*** achieved the level of ca. 350–500 million PLN in the years 2009–2013, except 2011 when increased to ca. 580 million PLN. Taking into account also ***processed dimension stone***, the combined value of national market of ***dimension*** and ***road stone*** amounted to ca. 1 billion PLN, except for 2013 when it rose to 1.3 billion PLN. Share of imported stone on this market has amounted to ca. 50% in recent years.

Principal companies involved in dimension and road stone production in Poland, as of December 2013

- Borowskie Kopalnie Granitu Sp. z o.o. w Borowie (Borowskie Granite Mines Ltd. of Borów), Borów, 58–172 Gniewków, tel. +48 74 8563053, fax +48 74 8563052, www.bkg.com.pl — *granite blocks and slabs, ashlar, pitcher, curbs.*
- Grabinex Sp. z o.o. (Grabinex Ltd. Granite Mine), ul. Kopalniana 13, 58–150 Strzegom, tle. +48 74 8553399, fax +48 74 8554540, www.grabinex.pl — *granite blocks and slabs, pitcher, cubs, crushed stone, crushed aggregates.*
- Skalimex-Borów S.A. (Skalimex-Borów Joint Stock Co.), Kostrza, ul. Borowska 6, 58–150 Strzegom, tel. +48 74 8563063, fax +48 74 8563066, www.skalimex-borow.com.pl — *granite blocks and slabs, ashlar, pitcher and curbs, crushed stone.*
- Morstone Trade Sp. z o.o. w Strzegomiu (Morstone Trade Ltd. of Strzegom), ul. Wałbrzyska 10, 58–150 Strzegom, Tel. +48 746494949, fax. +48 746494940, www.morstonetrade.pl — *granite blocks and slabs.*
- Granit Strzegom S.A. w Strzegomiu (Granit Strzegom Joint Stock Co. of Strzegom), ul. Górnicza 6, 58–150 Strzegom, tel. +48 74 8560000, fax +48 74 8560001, www.granit-strzegom.com.pl — *granite blocks and slabs, ashlar, pitcher and curbs, crushed stone.*
- PPHiU Piramida Sp. z o.o (Piramida Ltd., Granite Mine), ul. Kopernika 30, 58–150 Strzegom, tel. +48 74 8553797, fax +48 74 8552923, www.piramida-strzegom.pl — *granite blocks and slabs, pitcher and curbs.*
- GT&F Corporation Polska Sp. z o.o., Kopalnie Granitu w Kostrzy ("GT&F Corporation Polska" Ltd., Granite Mines of Kostrza), ul. Kopernika 2a, 58–150 Kostrza, tel. +48 74 8554121, fax +48 74 8555036, www.mfgranit.com — *granite blocks and slabs, ashlar, pitcher, crushed stone.*
- KG Wekom II Sp. z o.o. w Kostrzy (Wekom II Ltd., Granite Mine of Kostrza), Kostrza, ul. Kościuszki 70, 58–150 Strzegom, tel. +48 74 8555310, fax +48 74 8555311, www.granit-kostrza.pl — *granite blocks and slabs, ashlar, pitcher and curbs, crushed stone.*
- Kwarc Sp. z o.o. (Kwarc Ltd. Granite Mine), Kostrza, ul. Kopernika 27, 58–150 Strzegom, tel. +48 74 8553833, fax +44 74 8516818, www.kwarc.pl — *granite blocks and slabs, pitcher, ashler, crushed stone.*
- Skalimex-Grantin Sp. z o.o. Kopalnia Granitów (Skalimex-Grantin Ltd., Granite Mine), ul. Chwałkowska 23, 55–050 Sobótka, tel. +48 71 3162025, fax +48 71 3162026, www.skalimex-grantin.com.pl — *granite blocks and slabs, ashlar, pitcher and curbs, crushed stone.*
- Granimex Sp. z o.o. w Strzegomiu (Granimex Ltd. of Strzegom), Strzegom, Al. Wojska Polskiego 63, 58–150 Strzegom, tel. +48 74 8556890 www.granimex-granit.pl — granite blocks and slabs, ashlar, pitcher and curbs, crushed stone.
- Stonpol Sp. z o.o. w Mikoszowie (Stonpol Ltd. of Mikoszów) Mikoszów 47, 57–100 Strzelin, tel./fax +48 71 329 98 28, www.stonpol.com.pl — *granite blocks, ashlar, and pitcher.*
- Sjenit S.A. w Guminie (Sjenit Joint Stock Co. of Gumin), Gumin 18, 58–230 Niemcza, tel. +48 74 8373000, fax +48 74 8371213, www.sjenit.com.pl — *syenite aggregates, syenite blocks and slabs, grits.*
- Slag Recycling Sp. z o.o. (Slag Recycling Ltd.), ul. Igołomska 28a, 31–983 Kraków, tel. +48 12 6421435, fax +48 12 6441842, www.sjenitprzedborowa.pl — *syenite*

aggregates, blocks, pitcher.

- Przedsiębiorstwo Wydobycia i Obróbki Marmuru Marmur-Sławniowice (Marmur-Sławniowice Marble Mining and Working Enterprise), Sławniowice 103, 48–300 Głuchołazy, tel. +48 77 4398018, fax +48 77 4398019, www.marmur-slawniowice.pl — *marble blocks and slabs, grits.*
- Przedsiębiorstwo Produkcyjno-Handlowe Dolomit Sp. z o.o. (Dolomit Production and Trade Enterprise Ltd.), ul. Kamienna 9, 32–530 Libiąż, tel. +48 32 6277281, fax +48 32 6277273, www.dolomitlibiaz.pl — *dolomite blocks and slabs, pitchers, curbs, crushed stones, crushed aggregates.*
- KW Morawica S.A. (Morawica Joint Stock Co., Limestone Mine of Morawica), ul Górnicza 42, 26–026 Morawica, tel. +48 41 3670211, fax +48 41 3670299, www.kwmorawica.pl — *limestone blocks and slabs, lumps, crushed aggregates.*
- Hofmann Polska Sp. z o.o. (Hofmann Polska Ltd.), ul. Morawskiego 5, 30–102 Kraków, tel. +48 12 4222589, fax +48 12 4229094, www.hofmann.com.pl — *sandstone blocks and slabs and lumps.*
- Gruszecki Sp. z o.o. (Gruszecki Ltd.), ul Wrocławska 26, 55–075 Bielany Wrocławskie, tel. +48 71 3112398, fax. +48 71 3112757, www.gruszecki.com.pl — *sandstone slabs, split tiles.*
- Kopalnia Piaskowca Jan Zbylutów IV w Zbylutowie (Jan Zbylutów IV Sandstone Mine of Zbylutów), ul. Jemiołowa 15, 59–700 Bolesławiec, tel. +48 757324133, fax +48 757324133, www.kopalniapiaskowca.pl – *sandstone blocks and slabs, pitcher, ashlars, crushed stone.*
- Piasmar Sp. j. (Piasmar General Partnership), ul. Konopnickiej 4, 57–500 Bystrzyca Kłodzka, tel./fax +48 74 8111633, www.piasmar.com — *sandstone blocks and slabs, pitcher.*
- Kopalnie Piaskowca S.A. w Bolesławcu (Kopalnie Piaskowca Joint Stock Co. of Bolesławiec), ul. Modłowa 1, 59–700 Bolesławiec, tel. +48 75 7323636, fax +48 75 7324860, www.kopalniepiaskowca.com.pl — *sandstone blocks and slabs, split tiles, crushed stone.*
- ATS-Stein Sp. z o.o. Kopalnie Piaskowca (ATS-Stein Ltd. Sandstone Mines), 59–700 Bolesławiec, ul. Ogrodowa 6, tel. +48 75 7353440, fax +48 75 7353441 — *sandstone blocks and slabs, split tiles.*
- PUH Sosnowica S.C. (Sosnowica Sandstone Mine), 26–120 Bliżyn, tel. +48 41 3745452, fax +48 41 3745070 — *sandstone blocks, slabs and split tiles.*
- Kamieniarz w Kielcach (Kamieniarz of Kielce), ul. Cedro-Mazur 6, 25–252 Kielce, tel. +48 41 3022424, fax +48 41 3022426, www.modlinski.com — *sandstone blocks and slabs, split tiles, crushed stone.*
- Zakład Kamiennych Materiałów Budowlanych, Eksport-Import Andrzej Kosek (Andrzej Kosek, Plant of Stone Building Materials, Export-Import), Miedzna, ul. Drewniana 2/2, 26–307 Białaczów, tel. +48 44 7581640, fax +48 44 7581636, www.piaskowiec.com.pl — *sandstone blocks and slabs, split tiles, crushed stone.*
- Polski Kamień Naturalny Mucharz-Skawce Sp. z o.o. (Polski Kamień Naturalny Mucharz-Skawce Ltd.), 34–210 Zembrzyce, Śleszowice 240, tel. +48 33 4880190, fax +48 33 8739028, http://www.kamieniolom-mucharz.pl — *sandstone blocks, slabs, split tiles, and aggregates.*
- Zakład Wydobycia Kamienia Budowlanego Tadeusz Brach (Tadeusz Brach, Plant of Mining of Building Stone), 38–421 Wola Komborska 55, tel./fax +48 13 4354412 — *blocks and slabs, split tiles.*

STRONTIUM

Overview

Strontium (**Sr**) forms only two minerals of practical value: ***celestite*** $SrSO_4$, and — less common — ***strontianite*** $SrCO_3$. Deposits of ***celestite*** and ***celestite-fluorite ores*** are the main source of strontium. Celestite commonly co-exists with ***native sulfur***, ***barite***, and ***Zn-Pb-Ag ores***, and is obtained as a by-product during processing. **Celestite concentrate** (90–97% $SrSO_4$), is commonly transformed into **synthetic strontium carbonate**, containing 98% $SrCO_3$ (as opposed to 90–92% in **natural strontianite**). **Metallic strontium**, produced in small amounts by the electrolysis of molten ***strontium chloride*** $SrCl_2$, is used as an additive in Al-Si alloys.

Strontium has many applications, particularly for the production of ***color picture tubes***, ***ceramic ferrites***, ***paints***, and ***pigments***, and in pyrotechnics, medicine, and the electrolysis of zinc, ceramics, etc.

Sources

There are no deposits of ***strontium minerals*** in Poland. The resources of the remaining part of the small **Czarkowy** ***celestite*** deposit (containing 15–28% $SrSO_4$) were estimated at 5,300 t. Considerable amounts of ***celestite*** occur in the ***sulfur-bearing limestone*** deposits in **Tarnobrzeg** region. The Frasch method currently used for exploitation of these deposits does not provide any possibility for extracting ***celestite***.

Production

There is no production of ***strontium minerals*** in Poland. On the basis of imported ***strontium carbonate***, some ***strontium compounds*** have been manufactured in small amounts.

Trade

The demand for ***strontium*** and ***strontium compounds*** has been covered by imports. Among them the most important has bee ***synthetic strontium carbonate***. In 2009 its imports amounted to only 80 t (Tab. 1), mostly due to the halting of TV tubes production. In the years 2010–2013 imports rose to 144–196 tpy. In the years 2009–2013 the main suppliers were: Japan (63–82%) and Germany (17-34%). Cheaper strontium carbonate of standard quality was probably imported mainly from Germany (average unit value 3,724 PLN/t in 2013), while Japan probably delivered more expensive high quality material (12,047 PLN/t in 2013). The importation and prices of Japanese ***strontium carbonate*** have influenced on the trade balance level (Tab. 2) and average unit values of imports

(Tab. 3). Previously, small amounts of strontium carbonate were incidentally re-exported to various countries. ***Strontium oxide*** and ***hydroxide*** have been also imported, but on an irregular basis. There have been incidental imports of ***strontium metal*** (max. several kgpy).

Tab. 1. Strontium carbonate statistics in Poland — CN 2836 92

t

Year	2009	2010	2011	2012	2013
Imports = Consumption[a]	80.2	144.1	196.1	169.1	174.0

Source: ***The Statistical Office (GUS)***

Tab. 2. Value of strontium carbonate trade in Poland — CN 2836 92

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	–	1	4	6	–
Imports	686	1,500	2,237	2,121	1,812
Balance	**-686**	**-1,499**	**-2,233**	**-2,115**	**-1,812**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Average unit values of strontium carbonate imports to Poland — CN 2836 92

Year	2009	2010	2011	2012	2013
PLN/t	8,554	10,409	11,406	12,543	10,415
USD/t	2,923	3,457	3,958	3,838	3,312

Source: ***The Central Statistical Office (GUS)***

Consumption

There is no accurate information on applications of imported ***strontium compounds***.

SULFUR

Overview

Sulfur (**S**) occurs in the lithosphere in its native form (***native sulfur***), but it is far more commonly encountered in many minerals and compounds. Generally, sulfur is obtained from deposits of ***native sulfur*** and ***pyrites*** (**voluntary production**) or recovered from ***crude oil***, ***natural gas***, and ***off-gases*** during the smelting of ***sulfide concentrates*** of copper, zinc, lead, nickel, and molybdenum (**involuntary production**).

Sulfur has been in use for several thousand years. Nowadays it is utilized primarily in the chemical industry for the manufacture of **sulfuric acid** and other sulfur compounds. Sulfuric acid (accounting for more than 85% of sulfur consumption) is used mostly in the production of phosphate fertilizers. Other industries, including rubber and paper-making, claim much smaller shares of the total consumption of sulfur and sulfuric acid.

Sources

Native sulfur deposits are the main source of sulfur in Poland. Other primary sources include ***copper***, ***zinc***, and ***lead sulphide ore*** deposits, as well as ***sulfurized crude oil***, ***natural gas***, and ***coal***, but these are of minor importance. The secondary sources are ***waste sulfuric acid*** and ***processing water*** from sulfur extraction.

Deposits of ***native sulfur*** occur in Poland in the northern part of the **Carpathian Foredeep**, in Miocene gypsum-displacing limestone. Deposits are generally located in three regions: **Staszów**, **Tarnobrzeg**, and **Lubaczów**. As of 31 December 2013, there were 14 deposits with 510 Mt of S. Since 2002, **Osiek** deposit has been the only deposit extracted. The geological and available resources of this deposit amounted to 23.7 Mt of S.

Until 1996 official resources of ***sulfur*** in ***sulphide ores*** of ***copper***, ***lead***, and ***zinc*** were assessed at ca. 35.5 Mt of S. In the years 2008-2009, resources of sulfur in deposits were recalculated. Currently, estimated resources of sulfur listed only for 3 undeveloped deposits were amounted to a total of 5.5 Mt of S. The resources of sulfur in ***sulphide lead*** and ***zinc ore*** 9 deposits were estimated at ca. 1.47 Mt of S, of which ca. 0.32 Mt of S in two extracted deposits (**Olkusz** and **Pomorzany**). The sulfur reserves in ***coal***, ***crude oil***, and ***natural gas*** deposits have not been estimated yet, except for 4 ***natural gas*** deposits: **Barnówko-Mostno-Buszewo** (**BMB**) — 478,600 t of S, **Cychry** — 39,200 t of S, **Zielin** — 2,800 t of S, **Górzyca** — 1,200 t of S (as of 31 December 2013).

Production

Since 2001, when **Jeziórko-Grębów-Wydrza** deposit extraction was abandoned and **Siarkopol Tarnobrzeg** declared insolvency, ***native sulfur*** has been produced only at

Osiek mine by **Siarkopol Grzybów**. In November 2013 this company was purchased (85% of shares) by **Grupa Azoty**. In 2009, native sulfur exports, as well as domestic sales, collapsed (Tabs. 1, 2). Sulfur mining output dropped by ca. 65%, while share of ***native sulfur*** in the total domestic supply of ***sulfur in all forms*** (***SAF***) decreased to only ca. 36% (Tab. 1). For the first time in history, share of sulfur from involuntary production (recovered elemental sulfur, recovered sulfuric acid) exceeded 50% of total domestic supply of SAF. In 2010, but especially in the years 2011–2012, domestic and foreign demand for sulfur rose and the production of Osiek mine increased. As a result, the share of native sulfur in SAF supply rose to over 55%. In 2013, due to the rise in the production of involuntary sulfur, this tendency reversed and the share of native sulfur in SAF supply decreased to less than 50% (Tab. 1).

Tab. 1. Production of sulfur in all forms (SAF) in Poland

'000 t S

Year	2009	2010	2011	2012	2013
Production, total[a]	**734.7**	**1,019.8**	**1,189.1**	**1,229.2**	**1093.9**
Elemental sulfur CN 2503, 2802	**477.7**	**766.8**	**916.1**	**962.2**	**833.9**
• Native sulfur from Osiek mine (Frasch method)	262.8	516.7	657.1	676.8	526.0
• Byproduct sulfur	214.9	250.1	259.0	285.4	307.9
— *from natural gas*	*24.8*	*24.9*	*23.8*	*25.3*	*38.6*
— *from oil refineries and coking plants*	*189.6*	*224.7*	*234.6*	*259.7*	*268.8*
— *others*	*0.5*	*0.5*	*0.6*	*0.4*	*0.5*
Byproduct (sulfuric acid)[a]	**257.0**	**253.0**	**273.0**	**267.0**	**260.0**

Source: ***The Central Statistical Office (GUS), producer data***

Tab. 2. Elemental sulfur statistics in Poland — CN 2503, 2802

'000 t

Year	2009	2010	2011	2012	2013
Production	479.0	769.2	918.3	963.1	835.2
Imports	36.4	53.1	55.7	30.4	8.6
Exports	181.7	438.0	421.4	536.5	406.5
Stock changes	39.2	-98.5	7.8	6.6	53.8[e]
Consumption	294.5	482.8	544.8	450.4	383.5

Source: ***The Central Statistical Office (GUS)***

In the years 2010–2013 the volume of ***elemental sulfur*** recovered from ***petroleum*** refining at **Płock** (**ORLEN Group**) and **Gdańsk** refineries (**LOTOS Group**), and from the desulfurization of ***natural gas***, ***coke-oven gas***, and ***processing water***, was increasing (Tab. 1). In general, the share of involuntary elemental sulfur in the total SAF supply rose to 28% in 2013. The majority was coming from the desulfuring installations in both refineries, which have combined capacity of ca. 260,000 tpy of S. There are only small desulfuring systems in cokeries, gas plants, and other industrial plants (treatment of processing water), based mainly on arsenic-soda technology.

The production of sulfur in forms other than elemental made 22–25% of the total supply of ***sulfur in all forms*** in the years 2010–2013 (Tab. 1). Sulfur has been recovered in the form of ***sulfuric acid***, ***liquid sulfur dioxide*** SO_2, and ***oleum***, in copper and zinc smelters, and also in cokeries. The main sulfuric acid plants have been operated by **KGHM Polska Miedź** at **Głogów I**, **Głogów II**, and **Legnica** copper smelters, **Miasteczko Śląskie Zinc Smelter**, **ZGH Bolesław Mining and Smelting Plant**, and by cokeries.

The total production of ***sulfur in all forms*** (***SAF***) showed an increasing tendency in the years 2010–2012, when it approached 1.23 Mt of S. In 2013 it was reduced to 1.09 Mt of S, primarily due to decrease in the production of natural elemental sulfur (Tab. 1).

Trade

In 2009, ***elemental sulfur*** exports were reduced to 182 kt (Tab. 3), while the share of exports in the total domestic sales of ***elemental sulfur*** - to ca. 38% (Tab. 2). In the years 2010–2012 sulfur exports rose, up to 537 kt in 2012, while the share of exports in the total domestic sales - to 56%, i.e. to the level reported in the years 2003–2007. In 2013, exports dropped by 24% to 407 kt (the share to 49%). The most important recipient has remained Morocco, while exports to the Czech Republic were reduced by 84%. Exports to Mexico, Egypt, Nigeria and Senegal were not so important as in 2012. Only some foreign customers increased purchases, e.g. Germany, Argentina, Romania, while small quantities were sold to over 40 countries, also in Africa, Asia and both Americas (Tab. 3). Imports of ***elemental sulfur*** to Poland were reduced (Tab. 2). They were coming almost exclusively from Germany and – partly – from Slovakia.

Tab. 3. Polish exports of elemental sulfur, by country — CN 2503, 2802

'000 t

Year	2009	2010	2011	2012	2013
Exports	**181.7**	**438.0**	**421.4**	**536.5**	**406.5**
Argentina	–	–	–	15.8	16.0
Austria	0.4	4.8	1.1	0.8	1.2
Brazil	–	44.0	22.0	–	–
Croatia	1.2	2.0	2.5	1.3	0.0
Czech Republic	32.7	41.3	49.8	53.9	8.6
Egypt	–	–	5.6	10.0	–
Finland	0.0	20.8	13.2	0.2	0.2
Germany	0.8	2.3	7.0	8.8	13.6
Hungary	0.8	2.0	1.1	0.8	0.6
Italy	0.4	0.8	1.0	0.7	1.7
Mexico	–	–	–	52.7	–
Morocco	137.8	249.1	305.2	341.2	337.8
Nigeria	0.1	0.0	0.1	11.3	0.1
Romania	1.0	1.4	1.7	1.9	2.7
Senegal	–	52.8	–	26.4	13.3

Slovakia	1.0	1.4	1.7	1.8	1.8
Slovenia	0.3	0.4	0.5	0.4	0.4
Spain	–	6.6	0.0	0.0	0.1
Sweden	0.2	1.9	0.4	0.5	0.7
Ukraine	0.0	0.5	0.6	0.9	0.6
United Kingdom	0.4	0.7	0.8	0.5	0.6
Others	4.6[r]	5.2[r]	7.1[r]	6.6[r]	6.5

Source: ***The Central Statistical Office (GUS)***

The trade balance in ***elemental sulfur*** has been positive in recent years (Tab. 4). After deep decrease of trade volumes and unit prices in 2009, in the years 2010-2012 the situation reversed – volumes of trade and their unit values increased (Tab. 2, 5), so positive trade balance rose to 256 million PLN in 2012 (Tab. 4). In 2013 trade volumes and unit prices of exports decreased, and positive trade balance was reduced to 147 million PLN.

Tab. 4. Value of elemental sulfur trade in Poland — CN 2503, 2802

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	40,994	124,078	169,959	286,650	164,410
Imports	15,644	23,780	48,166	30,483	17,672
Balance	**+25,350**	**+100,298**	**+121,793**	**+256,167**	**+146,738**

Source: ***The Central Statistical Office (GUS)***

Tab. 5. Average unit values of elemental sulfur trade in Poland — CN 2503, 2802

Year	2009	2010	2011	2012	2013
Exports unit values					
PLN/t	225.6	283.3	403.4	534.3	404.5
USD/t	71.6	93.5	134.7	163.9	128.5
Imports unit values					
PLN/t	429.9	448.0	865.1	1,067.9	2,044.1
USD/t	140.0	148.2	294.2	323.8	651.9

Source: ***The Central Statistical Office (GUS)***

Consumption

The domestic structure of ***sulfur*** consumption corresponds with world trends. In recent years, ca. 80–85% of sulfur supply haas been utilized in the production of ***sulfuric acid***; 3–11% for the manufacture of ***carbon disulfide*** CS_2; while the rest for the manufacture of rubber, plastic products, paper, manufacture of food products and the production of other sulfur compounds, e.g. ***liquid hydrogen sulfide*** H_2S, ***insecticides***, etc.

In the years 2011–2012, 380–450 ktpy of ***elemental sulfur*** were used to produce 1.18–1.35 Mtpy of ***sulfuric acid*** in phosphate and nitrogen fertilizers plants. In 2013, around 0.30-0.32 Mt of ***elemental sulfur*** was consumed for the production of ca. 0.92 Mt of ***sulfuric acid***. It has been mainly recovered in the **Police Chemical Plant**, and the share of this company in the total sulfuric acid supply decreased to 60%. The production of sulfuric acid has been also recovered in other plants, i.e.: **Fosfory** of Gdańsk, **Siarkopol Chemical Plant** of Tarnobrzeg, **Nitrogen Works** of Tarnów and **Puławy Nitrogen Plant**. The rest of H_2SO_4 has been supplied by plants in non-ferrous metal smelters, with **KGHM Polska Miedź** as the main supplier (630-650 kt in 2011-2013). The total production of ***sulfuric acid*** in Poland increased to ca. 2.0–2.2 Mtpy, but in 2013 it dropped to 1.7 Mt, 14–19% of which was exported (Tab. 6).

Tab. 6. Sulfur compounds statistics in Poland

'000 t

Year	2009	2010	2011	2012	2013
Sulfuric acid CN 2807					
Production[1]	1,514.8	1,977.6	2,183.5	1,976.7	1,734.8
Imports	9.0	10.9	6.1	2.9	4.5
Exports	316.0	277.0	418.1	388.8	248.5
Consumption[a]	1,207.8	1,711.5	1,771.5	1,590.8	1,490.8
Carbon disulfide CN 2813 10					
Production	NA	NA	NA	NA	NA
Exports	30	29	23	17	7
Consumption[a]	NA	NA	NA	NA	NA

[1] together with recovered sulfuric acid

Source: ***The Central Statistical Office (GUS)***

Siarkopol Grzybów has been operated the largest ***carbon disulfide*** plant in Europe, exporting the majority of its production to the European market. In the last five years, this production ranged 10–20 ktpy of CS_2 (lack of exact data), consuming annually 15–25 ktpy of ***elemental sulfur*** (Tab. 6).

Since many years the trade balances of ***sulfuric acid*** and ***carbon disulfide*** have been positive. In the years 2010-2011 the trade balances of ***sulfuric acid*** rose thanks to higher exports volumes and prices, while in the last two years the situation reversed. The ***carbon disulfide*** exports decreased, in the years 2010-2012, while prices were rising, resulting in trade balance stable at around 30 million PLN. However, in 2013 both exports and prices were reduced, therefore the trade balance dropped to 12 million PLN (Tab. 7).

Tab. 7. Value of sulfuric acid and carbon disulfide trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Sulfuric acid CN 2807					
Exports	12,458	31,792	107,686	59,903	35,460
Imports	3,192	4,474	3,508	2,158	2,924
Balance	**+9,266**	**+27,318**	**+104,178**	**+57,745**	**+32,536**
Carbon disulfide CN 2813 10					
Exports	40,953	32,392	34,221	31,189	12,181
Imports	41	197	140	48	111
Balance	**+40,912**	**+32,195**	**+34,081**	**+31,141**	**+12,070**

Source: ***The Central Statistical Office (GUS)***

Companies involved in sulfur and sulfuric acid production in Poland, as of December 2013

- Grupa Azoty Kopalnie i Zakłady Chemiczne Siarki Siarkopol S.A. w Grzybowie (Azoty Group Siarkopol Joint Stock Co. Sulfur Mines and Chemical Plant of Grzybów), 28–200 Staszów, tel. +48 15 8643939, fax +48 15 8643717; www.siarkopol.org — *elemental sulfur (native), carbon disulfide*.
- PKN ORLEN S.A. Rafineria Płock (Polish Oil Company ORLEN Joint Stock Co. Oil Refinery of Płock), ul. Chemików 7, 09–411 Płock tel. +48 24 3650000, fax +48 24 3654040; www.orlen.pl — *elemental sulfur (byproduct)*.
- Grupa LOTOS S.A. Rafineria Gdańsk (LOTOS Group Joint Stock Co. Oil Refinery of Gdańsk), ul. Elbląska 135, 80–718 Gdańsk tel. +48 58 3087111, +48 58 3088111, tel./fax +48 58 3015733; www.lotos.pl — *elemental sulfur (byproduct).*
- KGHM Polska Miedź S.A. (KGHM Polska Miedź Joint Stock Co.), 59–301 Lubin, ul. Marii Skłodowskiej-Curie 48, tel. +48 76 7478200, fax +48 76 7478500; www.kghm.com.pl — *sulfuric acid (byproduct).*
- Huta Cynku Miasteczko Śląskie S.A. (Miasteczko Śląskie Zinc Smelter Joint Stock Co.), ul. Woźnicka 36, 42–610 Miasteczko Śląskie, tel. +48 32 2888444, fax +48 32 2888687; www.hcm.com.pl — *sulfuric acid (byproduct).*
- Zakłady Górniczo-Hutnicze Bolesław S.A. (Bolesław Mining and Smelting Plant Joint Stock Co.), ul. Kolejowa 37, 32–332 Bukowno, tel. +48 32 2955100, fax +48 32 2955000; www.zgh.com.pl — *sulfuric acid (byproduct).*
- Zakłady Koksownicze Zdzieszowice Sp. z o.o. w Zdzieszowicach (Coke Works Zdzieszowice Ltd.); ul. Powstańców Śląskich 1, 47–330 Zdzieszowice, tel. +48 77 4841000–2, fax +48 77 4841414, www.zkz.com.pl — *sulfuric acid (byproduct).*
- Grupa Azoty Zakłady Chemiczne Police S.A. (Azoty Group Police Joint Stock Co. Chemical Plant), ul. Kuźnicka 1, 72–010 Police; tel. +48 91 3171717, 3174296, fax +48 91 3173603; www.zchpolice.pl — *sulfuric acid.*
- Grupa Azoty Zakłady Azotowe Puławy S.A. w Puławach (Grupa Azoty Puławy Nitrogen Plants Joint Stock Co.), Al. Tysiąclecia Państwa Polskiego 13, 24–110

Puławy, tel. +48 81 8863431, fax +48 81 8875444, www.zapulawy.pl — *sulfuric acid, oleum.*

- Grupa Azoty Fosfory Sp. z o.o. Gdańskie Zakłady Nawozów Fosforowych (Azoty Group Fosfory Phosphate Fertilizers Plant Ltd. of Gdańsk), ul. Kujawska 2, 80–550 Gdańsk; tel./fax. +48 58 3073892, fax. +48 58 3073791; www.fosfory.com.pl — *sulfuric acid.*
- Grupa Azoty Zakłady Azotowe S.A. w Tarnowie-Mościcach (Grupa Azoty Nitrogen Plants Joint Stock Co. of Tarnów-Mościce), ul. Kwiatkowskiego 8, 33–101 Tarnów, tel. +48 14 6330781, fax +48 14 6330718, www.azoty.tarnow.pl — *sulfuric acid, oleum.*
- Zakłady Chemiczne Siarkopol Tarnobrzeg Sp. z o.o. w Tarnobrzegu (Siarkopol Tarnobrzeg Chemical Plants Ltd.), ul. Zakładowa 50, 39–402 Tarnobrzeg 4, tel. +48 15 8555710, fax. +48 15 8229797, www.zchsiarkopol.pl — *sulfuric acid.*

TALC AND PYROPHYLLITE

Overview

Talc and **pyrophyllite** are magnesium and aluminum silicates (respectively), formed in conditions of metamorphism or hydrothermally. The compacted talc variety is known as **steatite** (**soapstone**, **soap-rock**), whereas compacted pyrophyllite is called **agalmatolite**. They are commercially applied in the paper, ceramic, plastics, rubber, paint, and cosmetics industries. The higher melting point of pyrophyllite accounts for its use in refractories and in special ceramic materials.

Sources

No ***talc*** or ***pyrophyllite*** deposits are recognized in Poland. There are only some occurrences of ***talc-chlorite schist*** containing ***Ca-Mg talc*** in the Lower Silesia at **Braszowice**, **Wiry**, and **Sobótka**. Despite huge resources, the extraction of this schist has been considered uneconomic due to low quality of concentrates obtained.

Production

Neither ***talc*** nor ***pyrophyllite*** is produced in Poland.

Trade

In Poland, the domestic demand for ***talc*** and ***related commodities*** has been satisfied by imports. The volume of supplies increased substantially, from 18,400 tpy in 2009 to 34,200 tpy in 2013 (Tab. 1). Finland and Austria, which have maintained their position of the largest suppliers, have been followed by Italy, Belgium, China, France, Germany, and the Netherland (Tab. 2). Small re-exports have been also reported, mostly to Ukraine, Belarus, Estonia, Russia, Hungary and Bulgaria (Tab. 1). The trade balances of these commodities have been consistently negative. As a result of changes in the volume of supplies, the trade deficit nearly doubled, from ca. 25 million PLN to almost 46 million PLN in the last five years (Tab. 3).

Tab. 1. Talc and steatite statistics in Poland — CN 2526

'000 t

Year	2009	2010	2011	2012	2013
Imports	18.4	25.9	26.1	27.4	34.2
Exports	0.8	0.8	0.7	0.8	0.8
Consumption[a]	17.6	25.1	25.4	26.6	33.4

*Source: **The Central Statistical Office (GUS)***

Tab. 2. Polish imports of talc and steatite, by country — CN 2526

'000 t

Year	2009	2010	2011	2012	2013
Imports	**18.4**	**25.9**	**26.1**	**27.4**	**34.2**
Austria	3.2	3.2	4.4	5.8	5.7
Belgium	1.3	1.7	2.7	2.6	3.6
China	1.4	2.0	2.9	1.6	1.8
Finland	6.2	9.0	8.8	7.3	12.3
France	1.0	2.1	1.6	1.6	1.6
Germany	1.0	1.0	1.1	1.0	1.5
Italy	2.6	3.0	2.6	3.0	4.5
Netherlands	0.3	2.9	1.2	2.7	1.4
Slovakia	1.1	0.8	0.6	1.0	1.0
Others	0.3	0.2	0.2	0.8	1.8

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Value of talc and steatite trade in Poland — CN 2526

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	1,718	1,864	2,992	1,756	1,768
Imports	26,710	34,930	36,137	38,538	47,751
Balance	**-24,992**	**-33,066**	**-33,145**	**-36,782**	**-45,983**

Source: ***The Central Statistical Office (GUS)***

The average unit values of ***talc*** and ***related raw materials*** imports, varied between 431 and 474 USD/t in the recent years (tab. 4). The fluctuations generally followed by changing prices for Finnish and Austrian talc. The average unit values of talc from Finland ranged from 448 to 492 USD/t, whereas the Austrian ones (from **Naintsch Mineralwerke GmbH** – part of **Luzenac Group**) changed between 213 and 343 USD/t.

Tab. 4. Unit value of imports of talc and steatite to Poland — CN 2526

Year	2009	2010	2011	2012	2013
PLN/t	1,451.2	1,346.2	1,382.3	1,407.3	1,394.9
USD/t	473.9	446.5	472.4	430.9	443.7

Source: ***The Central Statistical Office (GUS)***

Consumption

The structure of domestic demand for ***talc*** and related materials is not known. Major markets for the highest quality grades of these commodities are the paper, ceramic, pharmaceutical, cosmetic, and plastic industries, whereas the lower grades are utilised in the production of paints, rubber (e.g. milled Slovakian talc), and roofing materials. The most important consumer of Austrian talc is ceramics (mainly the ceramic tiles industry). **Ground steatite** is utilized for example in electrotechnics ceramics (insulator) and **steatite slabs** are used for fireplace facing. The distributor of Finnish talc to Poland has been **Omya Co.** from Warszawa. The apparent consumption of ***talc*** and related materials increased from 17,600 tpy in 2009 to 33,400 tpy in 2013 (Tab. 1).

TANTALUM

Overview

The basic sources of **tantalum** (**Ta**) are ***tantalum ore*** (Nb:Ta ratio 0.3–5), ***tantalum-niobium ore*** (5–20), and ***niobium ore*** (over 20), occurring in albitite, pegmatite, and placer-type deposits. **Tantalite concentrates**, containing 60–65% Nb_2O_5+Ta_2O_5, require sophisticated chemical and metallurgical processing in order to obtain **tantalum metal**. Another source for direct tantalum recovery is ***tantalum-bearing tin slag***.

Tantalum is utilized mostly in the production of electronic components (tantalum capacitors) and in the space technology, telecommunications, transportation, and armaments (aircraft, missiles, radio communications).

Sources

There are no deposits of ***tantalum ore*** in Poland.

Production

There is no production of ***tantalum commodities*** in Poland.

Trade

Domestic demand for ***tantalum commodities*** has been met by widely variable imports (Tab. 1). ***Tantalum metal***, ***powders***, ***scrap***, ***wastes*** and ***tantalum products*** have been imported basically from Germany and Austria, and - most recently - from China, the EU countries and the US. Re-exports of ***tantalum products***, ***scrap***, and ***wastes***, most frequently to Germany, United Kingdom and Russia, have been also reported. The balances of ***tantalum commodities*** have trade reflected the type and quality of material traded. In the years 2009–2013 the values were usually negative, except for 2010 and 2013, when due to high re-exportation of ***tantalum scrap*** the trade balances turned positive (Tab. 2). The unit values of tantalum commodities imports to Poland have resulted from the imports volume and prices on international markets, especially for the years 2012–2013 (Tab. 3).

Tab. 1. Tantalum commodities statistics in Poland — CN 8103

kg

Year	2009	2010	2011	2012	2013
Imports	1,049	2,793	1,688	258	421
Exports	–	703	42	35	1,773
Consumption[a]	1,049	2,090	1,646	223	-1,352

*Source: **The Central Statistical Office (GUS)***

Tab. 2. Value of tantalum commodities trade in Poland — CN 8103

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	–	247	41	36	1,552
Imports	92	139	216	189	322
Balance	**-92**	**+108**	**-175**	**-153**	**+1,230**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit values of tantalum commodities imports to Poland — CN 8103

Year	2009	2010	2011	2012	2013
PLN/kg	88	50	128	733	764
USD/kg	28	16	44	224	242

Source: ***The Central Statistical Office (GUS)***

Consumption

The demand for ***tantalum commodities*** in Poland is not known. ***Tantalum*** is used in the production of high-speed steel, parts resistant to high temperature and chemicals (primarily in electronics), and surgical instruments.

TELLURIUM

Overview

Tellurium (**Te**) is among the elements that occur in the lithosphere in the lowest concentrations. The several dozen tellurium minerals do not form their own deposits. Tellurium also occurs as an admixture in many minerals, especially in ***copper*** and ***lead ores*** and some ***silver*** and ***gold ores***. It is obtained from ***copper anode slime*** (2–8%, average 3% Te), and - to a lesser extent - from ***lead*** electrometallurgy. The production of **pure tellurium** requires hydrometallurgical operations and the distillation or zone melting of **raw tellurium**. The production of tellurium from secondary sources is negligible.

The first commercial application of **tellurium** was as a rubber curing agent (after the Second World War). Nowadays, 50% of the world supply of this metal is consumed by the steel-making industry.

Sources

Poland has no prospects for the discovery of ***tellurium-bearing ore*** deposits. Some ***tellurium*** concentrations occur in ***copper ore*** deposits of the **Fore-Sudetic Monocline**.

Production

Tellurium is not recovered from ***anode slimes*** (the remainder after the electrolytic refining of ***copper***) in Poland.

Trade

Domestic demand for ***tellurium*** has been satisfied by imports (Tab. 1), mainly from Belgium and other European countries, and – on irregular basis - from China, the US, and Canada (Tab. 1).

Tab. 1. Tellurium statistics in Poland — CN 2804 50 90

kg Te

Year	2009	2010	2011	2012	2013
Imports = Consumption[a]	**907**	**2,260**	**1,646**	**1,514**	**134**
Belgium	405	806	301	456	122
Canada	–	–	–	–	8
China	10	5	8	319	–
Danemark	–	–	–	98	–

Germany	292	369	424	318	0
Netherlands	199	738	392	–	–
United Kingdom	–	325	520	–	0
USA	–	17	1	323	4

Source: ***The Central Statistical Office (GUS)***

The balance of ***tellurium*** trade has been always negative. The highest deficit was recorded in the years 2010–2011 as an effect of increased imports volume (Tab. 2). The variability of the unit values of tellurium imports to Poland has resulted mainly from its quantity, but in recent years mainly from high international prices, especially in 2011 (Tab. 3).

Tab. 2. Value of tellurium trade in Poland — CN 2804 50 90

'000 PLN

Year	2009	2010	2011	2012	2013
Imports = **Balance**	**-524**	**-1,461**	**-1,806**	**-946**	**-109**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit value of tellurium imports to Poland — CN 2804 50 90

Year	2009	2010	2011	2012	2013
PLN/kg	578	646	1,097	625	812
USD/kg	183	220	388	190	258

Source: ***The Central Statistical Office (GUS)***

Consumption

The structure of ***tellurium*** consumption in Poland is unknown. Most likely it is used in alloying steels and non-ferrous metal alloys.

THALLIUM

Overview

Thallium (**Tl**) is dispersed in a significant number of sulfides and other minerals in ***zinc***, ***lead ore***, and ***pyrite*** deposits. Thallium, as **thallium hydroxide**, is hydrometallurgically extracted from ***dust*** and other ***waste materials*** obtained during the processing of ***Zn***, ***Pb***, and ***Cu ores***.

Thallium was used for the first time in medicine in 1896, but it has been commercially applied since 1925, after its toxicity to rodents was discovered. Nowadays, the most promising uses of thallium are in superconductivity (***Tl-Cu oxide***) and laser techniques based on X-ray radiation emitted by excited thallium atoms, a non-invasive technology for obtaining three-dimensional pictures of parts of living cells.

Sources

Thallium occurs in ***zinc*** and ***lead ore*** deposits in the **Silesia-Cracow** region, in amounts of 0.02–0.1% Tl. The resources of thallium were estimated at 11,410 t Tl (as of 31 December 2008). In the years of 2009–2013 these reserves were not reported in the Mineral Resources Datafile of Poland.

Production

Thallium production was abandoned in 1988 and up to date has not been recommenced.

Trade

The domestic demand has been satisfied by imports of ***thallium-bearing materials*** and ***end-products***. Imports of ***thallium unwrought*** and ***powders*** in 2009 and in 2010 was not recorded by the Central Statistical Office, while in the years of 2011–2013 imports amounted to 1 kgpy. In the years 2011–2012 it came exclusively from Switzerland, but in 2013 Germany and China became the main suppilies. In these years it did not exceed 2,500 PLN per year. In the last five years there was no trade in ***thallium waste materials and scrap*** recorded. In the case of ***other thallium products*** in 2009 the volume of these imports amounted to 3 kg valued at 2,200 PLN (795 USD) and the sole supplier was the US. In 2010 the deliveries were not recorded, while in the years 2011–2013 the sole supplier were Germany, and the imports amounted to 14 kg valued at 10,305 PLN (3,248 USD) in 2011, 30 kg valued at 20,744 PLN (6,433 USD) in 2012, and 525 kg valued at 2,548 PLN (810 USD) in 2013. Exports of thallium commodities were recorded in 2010, when 7 kg valued at 73,192 PLN were sold to the

US, and in 2011, when they amounted to less than 1 kg valued at 3,269 PLN, sold to Switzerland and the US.

Consumption

No data about the structure of ***thallium*** consumption in Poland are available.

THORIUM

Overview

Thorium (**Th**) forms many minerals, but its individual deposits are unknown. The main sources of thorium are concentrates of ***thorium-bearing monazite*** and ***zircon***; occasionally other minerals occuring in ***pegmatite*** deposits.

Thorium is a radioactive element (isotope Th^{232}); however, only a small percentage of the supply is utilized as nuclear reactor fuel.

Sources

There are ***thorium minerals*** concentrations at occurances of **Bogatynia**, **Szklarska Poręba**, and **Wołowa Góra** (the Western Sudetes), as well as of **Różanka** (Kłodzko Valley), but they are of no economic value.

Production

Thorium is not recovered in Poland.

Trade

Thorium and ***thorium compounds*** and ***alloys*** were occasionally imported until 1998, mainly from Canada. Between 1999 and 2013 there were no imports recorded. In recent years there have been regular and very changeable imports of ***thorium products*** (bars, rods, tapes, sheets, etc.), which dropped to ca. 8.3 t in 2010. In 2011 imports sharply increased to 154.3 t, while in 2012 it decreased to 91.9 t. In 2013 it amounted to a record volume of 959.7 t in (Tab. 1). In the years 2009–2011 and 2013 the regular supplier were Germany, while the other sources were Western European countries such as Belgium, Finland, France, and Sweden. In 2011 there were some imports from the US. In 2012 the deliveries came mainly from Hungary, Western European countries, China and South Korea. Moreover, in 2013 the main supplier were Czech Republic, Lithuania, and Slovakia, whereas deliveries from other European countries were of minor improtance. In the last five years variable amounts of thorium products were also exported (Tab. 1). In the years 2009–2010 the main recipients were the Netherlands and Germany, in 2011 Lithuania and Ukraine, in 2012 the Netherlands and Denmark, while in 2013 Germany, Austria and Italy.

The trade balances of ***thorium products*** have been always negative, deepening to around 1.2 million PLN in 2011 and to almost 2.4 million PLN in 2013, following increased importation volumes (Tab. 2 and 1). It followed the quantity of imports and market price, influencing the unit values of imports. It was particularly evident in 2010,

Tab. 1. Thorium products statistics in Poland — CN 2844 30 61

t

Year	2009	2010	2011	2012	2013
Imports	89.8	8.3	154.3	91.9	959.7
Exports	0.0	–	4.6	0.4	0.7
Consumption[a]	89.8	8.3	149.7	91.5	959.0

Source: ***The Central Statistical Office (GUS)***

Tab. 2. Value of thorium products trade in Poland — CN 2844 30 61

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	0	–	15	13	172
Imports	324	227	1,244	875	2,531
Balance	**-324**	**-227**	**-1,229**	**-863**	**-2,359**

Source: ***The Central Statistical Office (GUS)***

when the lowest volume of imports was coupled with the highest unit value of imports of thorium products (Tab. 1 and 3).

Tab. 3. Unit values of thorium products imports to Poland — CN 2844 30 61

Year	2009	2010	2011	2012	2013
PLN/kg	3.6	27.5	8.1	9.5	2.6
USD/kg	1.2	9.1	2.7	2.9	0.8

Source: ***The Central Statistical Office (GUS)***

Consumption

Thorium products are believed to be used in Poland in the production of highly fire-resistant and robust materials, but detailed consumption data are not available.

TIN

Overview

Tin (**Sn**) forms a large number of minerals, but only ***cassiterite*** SnO_2 is of commercial importance. It forms individual primary deposits of the vein, stockwerk, graisene or porphyry types, but secondary deposits — alluvial and beach placers — are more important. A significant amount of **tin metal** is also obtained from secondary sources.

Tin metal is utilized for the production of alloys with copper, lead, and other metals, as well as for solders, and chemicals. The most common end-uses include tinning steel plates (for canned goods, soft drinks, etc.) and solders for electronics.

Sources

The resources of ***tin ore*** in Poland, recognized in two deposits, i.e. **Gierczyn** and **Krobica** in the Izerskie Mts. (4.6 Mt with ave. 0.5% of Sn), have been re-classified into non-economic due to the poor quality of the ore and their small size. Actually, they have been cancelled from the Mineral Resources Datafile. However, there are prospective resources of tin ore in the **Stara Kamienica shale range** (**Western Sudetes**) that are estimated at 20 Mt with ca. 100,000 t of metallic Sn.

Production

Primary tin has not been produced in Poland. ***Secondary tin 99.9%*** has been obtained at the recycling plant opened in 2004 by the **Fenix Metals Ltd**. in Chmielów. The company was formed in 2003 as a joint venture between **Dan Engineering** of Denmark and **Stoop** of Belgium. ***Pure tin*** has been recovered from almost any combination of tin-lead containing residues (even with as low as 15% Sn and a balance of Pb, Sb and Bi) by the use of a smelting short rotary furnace (commissioned in 2005) and a electric vacuum distillation furnace added in 2008 (the capacity of 3,500 tpy of metal). The business of **Fenix Metals** has been basically a combination of tin material recycling and manufacturing of ***solder products*** (including ***lead-free Sn-Cu soldering alloys***) and ***pure tin*** (min. 99.9% Sn), as well as other ***alloys*** (e.g. ***Sn-Sb-Pb***, ***Sn-Bi-Pb***, ***Sn-Cu-Co - Fenix100***, ***white metals***, and ***jewellery alloys***) in a form of ingots, bars, and sticks. Until 2012 the total production of ***secondary tin*** and ***tin-based alloys*** at the plant usually ranged from 2,600 to 3,200 tpy (including 700-1,300 tpy of Sn), while in 2013 it approached 3,700 tons (Tab. 1). Since 2014 the nominal production capacity of these commodities is to be expanded up to 9,500 tpy. **Fenix Metals** has become a fully integrated tin business and a pre-eminent supplier of tin solder alloys to the European market. The company has also offered ***secondary lead-based alloys*** with antimony and bismuth (300-2,400 tpy).

Tab. 1. Tin and tin alloys statistics in Poland — CN 8001

t

Year	2009	2010	2011	2012	2013
Production*	3,002	2,566	3,095	3,170	3,692
• tin CN 8001 10	696	893	858	1,299	1,716
• tin alloys CN 8001 20	2,306	1,673	2,237	1,871	1,976
Imports	1,630	1,330	1,566	1,525	1,154
Exports	263	410	535	529	551

* the Fenix Metals' production

Source: ***The Central Statistical Office (GUS), producer's data***

Trade

From among ***tin commodities*** imported to Poland, the most important have been: ***tin metal*** (including ingots and other shapes of remelted tin waste and scrap) (Tab. 2), ***tin scrap and waste*** (3,037; 3,688; and 4,638 tpy in 2011-2013 respectively, basically from the Netherlands, Belgium, and Germany) for the needs of **Fenix Metals**, and ***tin alloys*** (39, 296, 93 tpy in 2011-2013, mainly from Germany, and Italy). In the last five years the importation of ***tin metal*** ranged between 1,100 and 1,600 tpy, showing generally a declining tendency (Tab. 3). Recently its principal suppliers have been the Netherlands, Indonesia, and Belgium. Some amounts of tin commodities have been also exported, including ***tin metal*** sold basically to Poland's neighbouring countries such as Belarus, Ukraine, Slovakia, and Germany (Tab. 2). ***Tin alloys*** have been sold in much smaller quantities (6-23 tpy), basically to the European Union countries, such as France, the Czech Republic, and Romania, as well as to Ukraine.

In the years 2009-2013 the deficit in ***tin*** trade varied widely in a range from 35 to 72 million PLN per annum, recently showing a declining tendency (Tab. 3), matched with LME quotations of tin metal.

The unit values of ***tin*** imported to Poland followed the changes in tin metal quotations at the **LME**, ranging from 11,500 USD/t in 2009, when they dropped as a consequence of international prices reduction, to 25,700 USD/t in 2011. In the following two years, however, in response to lower international prices, the unit costs of tin importation were reduced to around 22,000 USD/t (Tab. 4).

Consumption

In Poland ***tin*** has been utilized for the production of ***wire***, ***bars***, ***solders***, and a variety of alloys, e.g. ***bearing alloys***, ***printer's alloys***, and ***low-melting alloys*** (produced by the **Hutmen** of Wrocław, among others), ***tin soldering alloys*** (***bulk*** and in various grades: ***battery, radiator, electronic, lead-free***) from ***Sn-bearing wastes and scrap*** (**Fenix Metals** of Chmielów, **Innovator** of Gliwice) and from imported ***pure tin 99.99% Sn*** (**PPHU Cynlut** of Radom and **Cynel Unipress** of Warsaw), as well as for various ***bronzes*** and ***bronze products*** (manufactured by **Łabędy Metals Mill**, and the **Non-Ferrous Metals Institute** in **Gliwice**), ***chemicals***, etc.

Tab. 2. Unalloyed tin statistics in Poland — CN 8001 10

t Sn

Year	2009	2010	2011	2012	2013
Imports	**1,591**	**1,281**	**1,517**	**1,229**	**1,061**
Belgium	5	45	199	265	166
Bolivia	20	–	–	30	–
Brazil	265	50	–	–	–
China	40	–	110	31	–
Czech Republic	–	30	–	–	–
Finland	–	24	–	–	–
France	11	15	13	15	5
Germany	557	8	72	141	75
Indonesia	33	410	287	271	278
Italy	–	6	4	4	93
Luxembourg	–	–	42	–	8
Malaysia	–	5	48	40	–
Netherlands	481	67	98	201	409
Peru	–	20	–	20	–
Portugal	–	–	3	–	–
Russia	–	1	–	–	–
Slovakia	24	–	1	–	–
Spain	5	–	6	–	–
Thailand	–	–	45	20	–
United Kingdom	120	580	590	192	26
Vietnam	30	20	–	–	–
Exports	**251**	**404**	**529**	**512**	**527**
Consumption[a]	**1,340**	**877**	**988**	**717**	**534**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Value of unalloyed tin trade in Poland — CN 8001 10

‘000 PLN

Year	2009	2010	2011	2012	2013
Exports	11,243	25,553	41,814	37,535	38,923
Imports	58,607	75,871	113,451	88,094	74,200
Balance	**-47,364**	**-50,318**	**-71,637**	**-50,559**	**-35,277**

Source: ***The Central Statistical Office (GUS)***

Tab. 4. The unit value of unalloyed tin importation to Poland — CN 8001 10

Year	2009	2010	2011	2012	2013
PLN/t	36,838	59,228	74,786	71,656	69,935
USD/t	11,532	19,756	25,681	21,947	22,288

Source: ***The Central Statistical Office (GUS)***

Traditional end-uses of ***tin*** and ***tin alloys*** include: radiator manufacturing (for the automobile industry), soldering of lead roofs, whitemetal for the railways, coating of copper wire, electroplating (cans and containers). Among the most important consumers have become the electronic industry (soldering), as well as the float glass sector (in the process of flat glass manufacturing the molten glass is floated over molten tin). The detailed domestic consumption pattern of tin is unknown.

Companies involved in tin commodities production in Poland as of December 2013

- Fenix Metals Ltd., Strefowa 13, 39–442 Chmielów, tel. +48 15 8229636, fax +48 15 8229671, www.fenixmetals.com — *secondary tin, tin-based soldering alloys*.

TITANIUM

Overview

Titanium (**Ti**) is one of the most common elements in the lithosphere and occurs in many minerals. The main sources of titanium minerals are placer deposits of ***beach sand***, containing ***ilmenite*** ***$FeTiO_3$*** and ***rutile*** ***TiO_2***. Magmatic deposits of ***ilmenite***, ***titanium magnetite***, and ***titanium hematite*** are also important. The ore from such deposits is processed into **titanium-bearing slag** (**Sorel slag**) or directly into **synthetic rutile**. Other titanium minerals, i.e. ***anatase*** ***TiO_2*** and ***leucoxene*** (hydrated and oxidized ilmenite) are of marginal importance. They are produced only in Brazil (anatase) and Australia (leucoxene).

Since the beginning of the twentieth century **titanium** has been utilised as a steel additive. Later on, it was widely used as a matrix or additive for non-ferrous metal alloys especially for the aircraft and aerospace industries. Since then it has been considered a strategic metal. In the late 1920s, after the introduction of **titanium white** (artificial titanium oxide, TiO_2), which is chemically stable and performs high covering power, the market for titanium was considerably expanded. Currently, titanium white covers 50–60% of the needs of such industries as the paint and varnish or paper-making, replacing zinc and barium white pigments formerly used. Currently, over 90% of titanium mineral commodities are used for this purpose.

Sources

Resources of ***titanium minerals*** and other heavy minerals of economic significance have been found in the **Ławica Odrzańska** and **Ławica Słupska** sandbanks. The resources of titanium minerals there have been estimated at 12 kt.

Production

Titanium ore is not mined in Poland.

Trade

The demand for ***titanium minerals*** has been satisfied by imports of ***ilmenite concentrates,*** in the amount of 84–105 tpy (Tab. 1). Their principal supplier has been **Titania AS** of Norway, which sign a long-term contract with the **Police Chemical Plant** the sole Polish producer of ***titanium white***. That company provided 95–98% of ***ilmenite concentrates*** deliveries in the last five years. Smaller amounts of this commodity came primarily from Ukraine and the Czech Republic, coupled in 2012 with China (Tab. 1). Imports of ***titanium metal*** and ***titanium powder*** varied widely, between 36 and 288 tpy, with a single jump to ca. 1,800 t in 2011 (Tab. 1). The prominent suppliers were Spain, the Netherlands, Germany, Russia (only in 2013), and China – on an irregular basis. Imports of ***titanium alloys***, mostly ***ferrotitanium*** and ***ferrosilicotitanium***, have been reported at the level of 100–300 tpy (Tab. 1). These supplies have originated mainly from the United Kingdom, Germany, France, Russia, and the Netherlands.

Tab. 1. Titanium commodities statistics in Poland, by country

Year		2009	2010	2011	2012	2013
Titanium ores and concentrates CN 2614 00						
Imports	**['000 t]**	**84.4**	**105.4**	**99.1**	**84.1**	**96.9**
China		–	–	–	1.1	–
Czech Republic		0.5	0.4	0.5	0.6	0.7
Norway		82.7	103.2	97.6	81.0	92.5
Ukraine		1.2	1.2	0.7	1.2	3.4
Others		0.0	0.6	0.3	0.2	0.3
Exports		**0.0**	**0.0**	**0.1**	**0.0**	**0.0**
Consumption[a]		**84.4**	**105.4**	**99.0**	**84.1**	**96.9**
Ferrotitanium and ferrosilicotitanium CN 7202 91						
Imports	**[t]**	**113**	**180**	**197**	**289**	**290**
China		22	–	–	–	–
France		–	–	2	16	40
Germany		0	1	31	136	64
Netherlands		4	10	31	–	37
Russia		23	93	69	80	39
United Kingdom		59	67	52	48	107
Others		5	9	12	9	3
Exports		**15**	**6**	**7**	**19**	**25**
Consumption[a]		**98**	**174**	**190**	**270**	**265**
Titanium[1] CN 8108 20						
Imports	**[t]**	**36**	**288**	**1,768**	**55**	**39**
Belgium		–	–	–	24	–
China		–	280	1,740	0	0
Germany		6	1	0	12	3
Netherlands		1	4	17	4	7
Russia		–	–	–	–	12
Spain		–	–	11	15	9
Ukraine		20	–	–	–	8

United Kingdom	9	0	0	0	0
Others	0	3	0	0	12
Exports	**34**	**0**	**–**	**1**	**6**
Consumption[a]	**2**	**288**	**1,768**	**54**	**33**

[1] together with titanium powder

Source: ***The Central Statistical Office (GUS)***

The trade balances of ***titanium concentrates***, ***titanium metal***, ***scrap***, ***waste***, ***powders***, and ***ferrotitanium*** were negative in the recent five years (Tab. 2). Deficit varied between 50 and 154 million PLN/y, depending mostly on volume of ***titanium ore*** and ***concentrates*** supplies. The unit values of titanium commodities imports to Poland depended on their volume and the market price (Tab. 3). In the years 2009–2012 the average imports unit values of ***titanium ore*** and ***concentrate*** more than doubled, from 188 to 545 USD/t, with the reduction to 392 USD/t in 2013. The average imports unit values of ***ferrotitanium*** and ***titanium metal*** varied between 2,000 and 7,000 USD/t.

Tab. 2. Value of titanium commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Titanium ores and concentrates CN 2614 00					
Exports	24	1	394	380	109
Imports	49,719	63,961	74,248	149,337	119,295
Balance	**-49,695**	**-63,960**	**-73,854**	**-148,957**	**-119,186**
Ferrotitanium and ferrosilicotitanium CN 7202 91					
Exports	167	87	78	311	456
Imports	923	2,601	3,395	5,512	4,170
Balance	**-756**	**-2,514**	**-3,317**	**-5,201**	**-3,714**
Titanium[1] CN 8108 20					
Exports	435	9	0	15	142
Imports	520	2,101	15,486	1,024	877
Balance	**-85**	**-2,092**	**-15,486**	**-1,009**	**-735**

[1] together with titanium powder

Source: ***The Central Statistical Office (GUS)***

Consumption

Ilmenite and ***rutile concentrates*** have been processed by sulphate method to ***titanium white*** at the **Police Chemical Plant**. The annual production capacity of this plant is ca. 40,000 tpy. The plans of its expansion announced by the company, to 65,000 tpy, has been recently cancelled on favour of investments in the urea production plant. The change have been related to moderately optimistic forecast for the growth of demand

Tab. 3. Unit values of titanium commodities imports to Poland

Year	2009	2010	2011	2012	2013
Titanium ores and concentrates CN 2614 00					
PLN/t	589	607	750	1,775	1,231
USD/t	188	201	254	545	392
Ferrotitanium and ferrosilicotitanium CN 7202 91					
PLN/t	8,185	14,450	17,267	19,046	14,359
USD/t	2,659	4,815	5,915	5,765	4,568
Titanium[1] CN 8108 20					
PLN/t	14,547	7,288	8,759	18,718	22,302
USD/t	4,954	2,518	3,134	5,733	7,112

[1] together with titanium powder

Source: ***The Central Statistical Office (GUS)***

for ***titanium white*** in the nearest future. Recently, the ***titanium white*** production at the **Police Chemical Plant** has stabilized at 36,400–41,700 tpy (Tab. 4). The company has provided over a dozen grades of titanium white, including particularly seven rutile types. The titanium white as a pigment (currently above dozen rutile and anatase grades) has been mainly consumed in the paint and varnish industry (for building and automotive industry), and also in the paper (large domestic consumer of titanium white for the paper production purposes is **Malta-Cekor S.A.**), plastics, rubber, textile, ceramic, cement, cosmetics and pharmaceutical industries. Moreover, the **Police Chemical Plant** has planned to build installation for the production of **nanophotocatalyst TiO_2** (to be utilized in water and liquid wastes purification as well as in disposal of hazardous substances). The wide range of applications of ***titanium white*** in different industries makes it a great indicator of the standard of living and economic development of the country.

Tab. 4. Titanium white statistics in Poland — CN 2823 00

'000 t

Year	2009	2010	2011	2012	2013
Production	36.4	41.7	39.4	39.8	38.8
Imports	0.7	1.3	0.9	0.7	0.9
Exports	0.0	0.2	0.0	0.0	0.0
Consumption[a]	37.1	42.8	40.3	40.5	39.7

Source: ***The Central Statistical Office (GUS)***

In the years 2009–2013, the importation of ***titanium white*** fluctuated between 700 and 1,300 tpy (Tab. 5). The strong position among the most prominent suppliers maintained Germany, China and France, whereas the importance of deliveries from Finland and Belgium has diminished (Tab. 5).

Tab. 5. Polish imports of titanium white — CN 2823 00

t

Year	2009	2010	2011	2012	2013
Import	**699**	**1,277**	**937**	**712**	**923**
Belgium	48	115	91	105	18
China	46	281	274	139	288
Czech Republic	74	97	0	0	41
Finland	221	242	273	142	28
France	34	52	33	104	146
Germany	167	176	183	146	310
Italy	32	194	36	35	62
Japan	26	20	1	8	2
Spain	14	11	6	1	2
Switzerland	–	–	–	6	4
Ukraine	–	40	20	–	–
United Kingdom	9	3	10	–	0
USA	5	33	8	25	22
Others	23	13	2	1	0

Source: ***The Central Statistical Office (GUS)***

The trade balances of ***titanium white*** have been negative and the deficit have remained at the relatively stable level of 10–11 million PLN in recent years (Tab. 6). The unit values of imported ***titanium white*** varied between around 3,000 and 5,000 USD/t (Tab. 7), following tendencies on the global market. The drop of prices in 2013, caused by decline in demand of leading consumption sectors, influenced the unit values of commodities imported to Poland for the production of titanium white, such as ***ilmenite*** and ***titanium slag***.

Tab. 6. Value of titanium white trade in Poland — CN 2823 00

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	200	1,675	385	269	289
Imports	9,781	12,768	10,328	10,417	10,391
Balance	**-9,581**	**-11,093**	**-9,943**	**-10,148**	**-10,102**

Source: ***The Central Statistical Office (GUS)***

Tab. 7. Unit value of titanium white imports to Poland — CN 2823 00

Year	2009	2010	2011	2012	2013
PLN/t	13,988	10,434	11,016	14,622	11,901
USD/t	4,520	3,321	3,795	4,465	3,739

Source: ***The Central Statistical Office (GUS)***

No information is available on the volume of consumption of ***titanium metal*** and ***titanium alloys*** (with Fe, Al, Cr, Mn, etc.). Titanium alloys are crucial construction materials, used by the shipyard, aerospace, electrotechnical, steel and tool-making industries, among others.

Companies involved in titanium materials production in Poland, as of December 2013

- Zakłady Chemiczne Police S.A. w Policach (Police Chemical Plant Stock Co. of Police), ul. Kuźnicka 1, 72–010 Police, tel. +48 91 3171717, fax +48 91 3173603, www.zchpolice.grupaazoty.com — *titanium white.*

TUNGSTEN

Overview

The primary commodities of **tungsten** (**W**) are mostly obtained from individual deposits of ***scheelite*** and ***wolframite ore***, or from ***complex ores*** of ***W***, ***Sn***, ***Mo***, ***Cu***, and ***Bi***. **Scheelite** and **wolframite concentrates** are processed into **ammonium paratungstate** (**APT**), currently the main tungsten market commodity, which is transformed into **tungsten powder** for metallurgical purposes, and into chemical compounds for the chemical industry. The concentrates can be the source for the production of **ferrotungsten**, whereas **tungsten powder** – for the manufacturing of **tungsten carbide**

Tungsten is characterized by the highest melting point (3,410°C) among metals, as well as by its high density, good corrosion resistance, good thermal and electrical conductivity, and low expansion coefficient. Therefore it is an important component of cutting and wear-resistant steel. **Tungsten carbide**, of hardness comparable to diamond, is used mainly for the production of the highest quality abrasives.

Sources

Poland has one porphyry-type deposit of ***molybdenum ore*** with ***tungsten*** and ***copper***, located near **Myszków**. The resources of the deposit amounted to 550.8 Mt of ore containing 238,000 t ***W*** (as of 31 December 2013). This is a stockwerk deposit with sulfides-oxides veins, of granitoid magmatism of Variscian age origin. The deposit has not been developed.

Production

There is no production of ***tungsten ore*** or ***concentrates*** in Poland. ***Tungsten powder*** and ***alloys***, as weel as ***tungsten carbide*** and other products have been manufactured from imported concentrates (see: **Consumption**).

Trade

The demand for tungsten commodities has been satisfied by imports (Tab. 1). Recently ***scheelite*** and ***wolframite concentrates*** have apparently been replaced by ***ammonium paratungstate*** (***APT***), which is reported as a concentrate in the statistics of the **Central Statistical Office** (**CN 2611**). Its imports volumes were irregular and marginal in the years of 2009–2012, but in 2013 the volume of deliveries increased to 16.9 t (Tab. 1). Moreover, in 2011 and in 2013 there were recorded huge re-exports, exceeding the importation volumes. In 2011 exports amounted to almost 314 t and the principal buyer were the Netherlands, while in 2013 the amount of 41 t was sold to Russia (Tab. 1).

Tab. 1. Tungsten commodities statistics in Poland

t

Year	2009	2010	2011	2012	2013
Tungsten ores and concentrates CN 2611					
Imports	**0.0**	**–**	**0.0**	**–**	**16.9**
Canada	–	–	–	–	10.9
Germany	0.0	–	–	–	2.0
United Kingdom	–	–	–	–	4.0
USA	–	–	0.0	–	–
Exports	**–**	**–**	**313.8**	**–**	**41.0**
Netherlands	–	–	313.8	–	–
Russia	–	–	–	–	41.0
USA	–	–	0.0	–	–
Consumption[a]	**0.0**	**–**	**-313.8**	**–**	**-24.1**
Tungsten powder and metal CN 8101 10, 8101 94					
Imports	**10.3**	**35.8**	**30.1**	**4.2**	**4.3**
Austria	0.2	0.3	0.4	0.3	0.4
China	0.0	0.4	0.3	0.3	0.0
Czech Republic	1.3	26.5	26.4	0.3	–
Germany	4.1	8.4	1.9	1.4	2.4
Italy	0.0	0.0	0.7	1.2	1.0
Netherlands	0.6	0.1	0.1	0.1	0.1
United Kingdom	4.1	0.0	0.3	0.1	0.0
USA	0.0	0.1	0.0	0.4	0.4
Other	0.0	0.0	0.0	0.1	–
Exports	–	**0.0**	**2.1**	**0.1**	**124.3**
Czech Republic	–	–	1.0	0.0	0.0
Germany	–	–	0.7	–	18.0
Italy	–	–	–	–	0.0
Latvia	–	–	0.1	–	–
Netherlands	–	–	0.2	–	–
Sweden	–	0.0	0.1	–	–
USA	–	–	–	–	106.2
Consumption[a]	**10.3**	**35.8**	**28.0**	**4.1**	**-120.0**
Ferrotungsten CN 7202 80					
Imports	**8.5**	**10.0**	**11.8**	**9.8**	**30.4**
Belgium	1.0	2.0	–	–	–
Brazil	–	–	–	–	1.3
China	3.0	2.5	5.7	7.4	3.2

Germany	1.0	0.3	1.4	0.1	0.0
Netherlands	–	0.2	1.5	1.5	–
Russia	–	–	–	–	20.3
Spain	–	1.0	1.0	–	–
United Kingdom	2.5	–	1.0	–	–
USA	0.0	0.0	0.1	0.1	0.1
Vietnam	1.0	4.0	1.0	0.7	5.5
Exports	**–**	**1.2**	**0.5**	**2.6**	**2.8**
Czech Republic	–	–	–	0.2	1.3
Germany	–	0.5	0.3	0.9	1.5
Hungary	–	–	0.2	–	–
Slovakia	–	0.5	–	0.5	–
Ukraine	–	–	–	1.0	–
United Kingdom	–	0.2	–	–	–
Consumption[a]	**8.5**	**8.8**	**11.3**	**7.2**	**27.6**

Source: ***The Central Statistical Office (GUS)***

Tungsten powder and ***metal*** have been imported mostly from the Czech Republic (until 2012), other European countries, China and the US. Until 2012, irregular and variable exports of lower grades of ***tungsten powder*** and ***metal*** have also been noted. In 2013 the foreign sales amounted to the record of 124.3 t, which significantly exceeded imports volume. The main recipients were the US and Germany (Tab. 1). ***Ferrotungsten*** has been imported in various amounts (Tab. 1). In the years 2010-2013 it was also exported (Tab. 1). In recent years the main recipients were: Germany, Slovakia, the Czech Republic, and Ukraine. Ferrotungsten has been purchased mainly from China, Germany, the Netherlands, and United Kingdom, and in 2013 – also from Russia and Brazil (Tab. 1).

In the years 2009–2012 the trade balances of ***ferrotungsten*** were negative, depending on the volume of imports and market price. In 2013 - due to high re-exports of ***tungsten powder and metal*** - the trade balance of the tungsten commodities was positive and reached ca. 5.7 million PLN (Tab. 2). Moreover, in 2011 due to huge re-exports the trade balance in ***tungsten concentrates*** turned positive (Tab. 2). The unit values of the imported commodities have been much higher than those of exported ones (Tabs. 2 and 3).

Tab. 2. Value of tungsten commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Tungsten ores and concentrates CN 2611					
Exports	–	–	413	–	158
Imports	2	–	4	–	594
Balance	**-2**	**–**	**+409**	**–**	**-436**
Tungsten powder and metal CN 8101 10, 8101 94					
Exports	–	5	261	16	9,376
Imports	2,200	4,373	6,100	2,031	1,932
Balance	**-2,200**	**-4,368**	**-5,839**	**-2,015**	**+7,444**

Ferrotungsten CN 7202 80					
Exports	–	59	25	215	139
Imports	574	730	1,180	1,131	1,452
Balance	**-574**	**-671**	**-1,155**	**-916**	**-1,313**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit values of tungsten commodities imports to Poland

Year	2009	2010	2011	2012	2013
Tungsten ores and concentrates CN 2611					
PLN/t	333,333	–	71,900	–	35,175
USD/t	115,333	–	24,940	–	11,329
Tungsten powder and metal CN 8101 10, 8101 94					
PLN/t	213,592	122,240	125,018	483,180	447,917
USD/t	68,702	40,069	44,017	147,502	142,767
Ferrotungsten CN 7202 80					
PLN/t	67,529	72,751	100,346	114,964	47,812
USD/t	21,512	24,591	33,171	35,723	15,489

Source: ***The Central Statistical Office (GUS)***

Consumption

Marginal amounts of imported tungsten concentrates, mainly ***APT***, have been processed into ***tungsten carbide*** and ***sintered carbides*** at the **Institute of Machining** in **Krakow** and utilized for the production of special steel and tool steel. They have been also used for the manufacturing of ***tungsten powder*** and ***tungsten products***. The information on production volumes is not available. In the last period, the **Polam-Warszawa High-Melting Metal Smelter** has produced ***welding electrodes*** (made of tungsten and tungsten-lanthanum) and ***tungsten products*** (wires for lightning industry, heaters used for coating surfaces with a thin film of metals, powders, sheets, sections, rods). The production of ***tungsten products*** (exluding scrap and wastes) recorded by the Central Statistical Office amounted to 8,153 kg in 2009, 4,550 kg in 2010, 6,494 kg in 2011, 2,340 kg in 2012, and 2,706 kg in 2013.

The ***ferrotungsten*** is mainly consumed in the steel and cast iron industry for the production of special steel and tool steel. The apparent consumption has depended on the trade volume and economic condition of the domestic steelmaking industry.

URANIUM

Overview

Uranium (**U**) forms many minerals, and occurs in others as an isomorphic element. A number of ***uranium-bearing minerals*** occur in pleiad in individual ***uranium ore deposits***, and in ***phosphates***, from which they are recovered as by-products (see: **PHOSPHATES**).

The career of **uranium** as a strategic element began in 1939, when the first nuclear reaction was carried out. Since the 1960s, uranium has been an important fuel for nuclear reactors in power plants.

Sources

In Poland, ***uranium minerals*** occur in many places: in crystalline and metamorphic rock in the Sudety Mountains and the Polish Lowland, in the Świętokrzyskie Mountains, and in the Carpathians. ***Uranium ore*** deposits of some economic value are known at **Rajsk** in the Podlasie Depression, as well as at **Okrzeszyn**, **Grzmiąca**, and **Wambierzyce** in the Sudety Mountains.

Production

Currently, there is no production of ***uranium ore*** or ***commodities*** in Poland.

Trade

The demand for ***uranium*** (used in the experimental reactors **Maria** and **Ewa** at the **Nuclear Institute** in **Świerk** near **Warsaw**) and for ***uranium compounds*** (**CN 2844 10**) for non-nuclear applications was formerly satisfied by imports from Russia, the Czech Republic, Spain and in 2011 – from the US. In 2011 imports of uranium commodities amounted to less than 1 kg, while in the years 2009–2010 and 2012–2013 they were not reported by the Central Statistical Office. The trade balances in ***uranium commodities*** have been negative in recent years, reaching 297 PLN in 2011.

Irregular imports of ***uranium enriched in isotope*** U^{235} (**CN 2844 20**) have been also reported. In 2010 there was less than 1 kg valued at 8,130 PLN (2,460 USD) imported from Belgium, while in 2012 around 1 kg valued at 708,197 PLN (208,600 USD) was purchased from Russia. Statistics for 2009 and 2011 are not available.

Consumption

No detailed information about ***uranium*** consumption in Poland. Most of it is used in the experimental reactors **Maria** and **Ewa** at the **Nuclear Institute** in **Świerk** near **Warsaw**.

VANADIUM

Overview

The **vanadium** (**V**) content in the lithosphere considerably exceeds the amount of copper, lead, or zinc, but it rarely forms its minerals, and in practice its deposits are unknown. Vanadium co-exists with many complex minerals, or is an isomorphous additive in other minerals. The basic sources of vanadium are ***vanadium-bearing titanium-magnetite ore***, ***U-V sandstone calcrete-type ores***, some ***phosphates***, ***bauxite***, ***bituminous sand***, and ***heavy crude oil***, as well as ***scrap of special-purpose steel*** and spent ***vanadium catalysts***. The secondary raw materials are used for the production of **vanadium oxide**, which are further processed into **metallic vanadium**, **vanadium alloys**, and **compounds**.

Vanadium is one of the most important steel alloy additives, especially as **ferrovanadium**, utilised in the production of alloyed steel and special steel grades.

Sources

Poland has considerable reserves of vanadium only in ***copper ore*** deposits in the **Fore-Sudetic Monocline** (mainly in shales), containing approximately 139,110 t of V, with an average content of 0.01–0.03% V (as of 31 December 2013). Important concentrations of dispersed vanadium are known in the ***hard coal*** of the **Upper Silesia**, and in ***Ordovician shale*** in NE Poland.

Production

In spite of the great number of domestic sources, ***vanadium*** has not been recovered in Poland to date, because an economically viable extraction method has not been developed.

Trade

The domestic market has been dependent upon imports of ***vanadium commodities***. The most important is ***ferrovanadium***, purchased at the level of 241–650 tpy (Tab. 1), mainly from the Republic of South Africa, Russia, the Czech Republic, China, and also from Western European countries, such as Austria, Belgium, the Netherlands, Germany, United Kingdom and others.

Information on the volume and structure of importation of other ***vanadium commodities*** is incomplete. In the last five years the importation of ***vanadium oxide*** reached a level of 11 tpy, and originated mainly from the Netherlands, Belgium, Germany, and Italy. In the years 2009–2013, the exportation of ***ferrovanadium***, changing between 173 and 456 tpy, were reported (Tab. 3). In recent years the main recipients of re-exported

Tab. 1. Ferrovanadium statistics in Poland — CN 7202 92

t

Year	2009	2010	2011	2012	2013
Imports	314.8	364.5	241.5	480.9	650.5
Exports	173.0	455.6	162.1	300.6	366.0
Consumption[a]	141.8	-91.1	79.4	180.3	284.5

Source: ***The Central Statistical Office (GUS)***

ferrovanadium have been the Czech Republic, Slovakia, Ukraine, Hungary, and Western European countries.

In the years 2009–2013 the trade balances of ***ferrovanadium*** were negative, except for 2010 when high volume of exports resulted in positive value of the turnover (Tab. 2). The unit values of ferrovanadium imports to Poland have depended on importation volumes and prices on international markets (Tab. 3).

Tab. 2. Value of ferrovanadium trade in Poland — CN 7202 92

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	8,229	33,701	11,970	23,156	23,599
Imports	18,593	25,961	15,916	29,120	45,925
Balance	**-10,364**	**+7,740**	**-3,946**	**-5,964**	**-22,326**

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Unit values of ferrovanadium imports to Poland — CN 7202 92

Year	2009	2010	2011	2012	2013
PLN/t	59,063	71,233	65,904	60,549	70,602
USD/t	19,471	23,714	21,818	18,469	22,514

Source: ***The Central Statistical Office (GUS)***

Consumption

Information on the consumption and applications of ***vanadium commodities*** in Poland is not available. Nevertheless, it could be assumed they are mostly used in the steel-making industry, while in smaller amounts - in the chemical and petrochemical industries (catalysts). Secondary sources of vanadium, such as scrap from vanadium steel, are not consumed in Poland.

VERMICULITE

Overview

Vermiculite, a mineral similar to clay minerals, is a product of the weathering of ***biotite***, ***phlogopite***, some types of ***chlorite***, and other silicates and aluminosilicates rich in magnesium. Small amounts of vermiculite have been found in sea deposits and soils. A characteristic feature of **vermiculite** is that when heated rapidly at temperature of approx. 900°C or higher, the water flashes into steam, and it expands from 15 to 25 times, forming so-called **expanded vermiculite**, which is very lightweight, chemically inert, fire resistant, and odorless. The expansion process is called **exfoliation**. The physical and chemical properties of vermiculite make it suitable for use as thermal and sound insulating material, both in bulk and as shaped blocks in a cement and gypsum matrix.

Sources

There are no occurrences or deposits of ***vermiculite*** in Poland.

Production

Crude ***vermiculite*** is not produced in Poland, due to the lack of domestic deposits. At the end of 2012, the company **Perlipol Co**. in Belchatów commenced the production of ***expanded vermiculite*** from the raw material of Brazilian origin. In the first year of operation the plant with a production capacity of 100,000 m^3 supplied 300 m^3 of expanded vermiculite, while in 2013 it was 390 m^3. The final product, which was completely sold on the domestic market, in 90% was used in the agriculture and horticulture, and also in animal breeding as a feed additive (as vitamins and minerals carrier), and padding for animals. The Perlipol's production has been recorded in the Central Statistical Office statistics in **PKWiU** item **23.99.19.90** as "The products of non-metallic mineral products not elsewhere classified".

Trade

The volume of imports is hard to determine, due to the change in CN classification in 2010. Until the end of 2009, according to the official nomenclature, the trade statistics of ***vermiculite*** have been not reported as a separate category, but included in the basket category ***'vermiculite***, ***chlorite***, ***unexpanded'*** under a **CN** code **2530 10 90**. Since 2010 it has been classified in the **CN** code **2530 10** – the mentioned group of raw materials but including also perlite. At the same time, ***exfoliated vermiculite*** (mainly in the form of boards) has been recorded under **CN** code **6806 20 90** together with others products obtained from porous clays, expanding slag and similar materials. Until 2009 the importation of unexpanded materials varied between 140 and 470 tpy, and in the majority originated from Germany, coupled with China, Russia, the Republic of South Africa, and Belarus. Since 2010, when perlite has been reported under the same possition of CN (the level of its imports in previous years exceeded 20,000 tpy), the volume of vermiculite importation has been impossible to ascertain. Vermiculite boards have been imported mainly from Germany by **Europolit Ltd.** — the company specializing in the production and distribution of asbestos-free heat insulation materials, as well as by other trade-companies, i.e. **Promat Top** of Warsaw, **Graftex** of Bydgoszcz, and **Refractory Insulation Plants IZO** of Gliwice. Expanded vermiculite for building and agriculture applications has been also imported from the Republic of South Africa by **Rominco Polska Ltd.** of Kraków.

WOLLASTONITE

Overview

Wollastonite — calcium silicate ($CaSiO_3$) — occurs in three polymorphous forms, two of which are natural: ***triclinic wollastonite-T*** and ***monoclinic wollastonite-2M*** (***parawollastonite***). These commonly form deposits in skarns and skarnoids. At temperatures above 1,126°C, they both change into their high-temperature modification, ***pseudowollastonite***.

The main consumer of **wollastonite** is the ceramic industry, but the rubber, polymers, and plastics industries are also its consumers. To a lesser extent it serves as a filler for paints and varnishes, as a flux in the foundry and welding industries, and as a substitute for asbestos. Increasing demand and limited possibilities for extracting natural wollastonite have resulted in the production of **artificial wollastonite** (made of ***quartz*** and ***limestone***) for metallurgical applications.

Sources

There are no ***wollastonite*** deposits in Poland, nor prospects for their discovery. Only occurrences in skarns and metasomatically altered limestones in **Gębczyce** (the **Strzelin Massif**), and also in limestones of the **Szklarka** river valley near **Krzeszowice**, have been recognized. However, they are of no economic significance.

Production

Wollastonite is not produced in Poland.

Trade

Wollastonite is imported, mainly for ceramic applications, by brokers. The volume of its importation is difficult to detect, as wollastonite trade is reported together with other minerals in the official foreign trade nomenclature (**CN 2530 90**).

Consumption

The volume and structure of ***wollastonite*** consumption in Poland are impossible to ascertain. It is sometimes utilized as an additive in ceramic glazes, improving glazing properties. Its main advantage is very low thermal coefficient that prevents cracking of ceramic products and allows for shorter time of firing.

Consumption

Vermiculite can be used mainly in the building industry in a form of vermiculite boards of heat-insulating and heat-resisting properties. These boards are applied in industrial and accumulation furnaces, boilers, heaters, fireplaces, as well as working or rear layer of thermal insulation of thermal processing equipment. Moreover, vermiculite can be used in gardening to prepare horticultural mixes, as well as in hydroponics and as subsoil for incubation of reptile's eggs. The level of vermiculite consumption in Poland is difficult to determine, but based on the Perilpol's production data it can be assumed that the demand for this raw material has been very small. There is no information about the detailed structure of its consumption in Poland.

Companies involved in vermiculite production in Poland, as of December 2013

- Perlipol s.j. K. Kusmierek, W. Derlatka, J. Benben, 97–400 Bełchatów, ul. Przemysłowa 4, tel. +48 44 6333398, fax. +48 44 6332408, www.perlipol.pl — *exfoliated vermiculite, expanded perlite*.

YTTRIUM

Overview

Yttrium (**Y**) belongs to the group of rare earth elements. It occurs in many minerals: fluorides (***gagarinite***, ***yttrium fluorite***), carbonates and fluorocarbonates (***bastnaesite***, ***parisite***, ***synchisite***), oxides (***fergusonite***, ***formanite***, ***pyrochlore***, ***samarskite***, ***euxenite***), phosphates (***xenotime***, ***churchite***), silicates (***allanite***, ***gadolinite***), etc. Unique individual concentrations are known from e.g. complex ores at **Strange Lake** and **Thor Lake** in Canada, and in the **Bokan Mountains** in the US. However, minerals containing yttrium admixtures, e.g. ***apatite*** and ***monazite***, constitute the main source for its extraction.

Metallic yttrium has been traditionally utilized in high-melting alloys and superalloys, and also in jeweler's metals. Since the 1980s, however, when high-temperature superconductivity was discovered and laser technology started to be developed, the demand for yttrium and its compounds (***synthetic yttrium garnets***: ***aluminum YAG*** and ***ferrous YIG***) has increased. The principal uses are in color TV sets and computer monitors, trichromatic fluorescent lights, temperature sensors, and X-ray intensifying screens. Future demand will depend upon the development of the electronics and optics, which require ***high-purity metal*** (max. 99.99999% Y — **Nippon Mining Co.** Japan) for their high technology products.

Sources

Deposits of ***yttrium minerals*** or ***yttrium-bearing minerals*** are not known in Poland. Potential sources of ***yttrium*** are waste ***phospho-gypsum***, containing 0.007–0.013% Y_2O_3, at the **Police** and **Wizów Chemical Plants**, among others (see: **PHOSPHATES**). The wastes are generated in course of processing of ***apatites*** (imported from the **Kola Peninsula** in Russia), containing 0.005–0.04% Y_2O_3.

Production

Yttrium and ***yttrium compounds*** are not produced in Poland.

Trade

Yttrium and ***yttrium compounds*** importation to Poland has been reported together with ***rare earth metals*** and ***scandium***. In 2009 imports of ***yttrium metal***, ***rare earth metals***, and ***scandium*** amounted to 2.4 t. In 2010, due to increased demand on the Polish market, the imports increased to 7.9 t, but in 2011 these decreased to only 67 kg. In the years 2012–2013, in turn, it increased up to 27 tpy. Imports of the ***yttrium and rare earth metals compounds*** have varied between 12 and 47 tpy, with reduction to 12–13 t in the years 2012–2013, while its highest volume of 47 tons was recorded in 2010 (see details: **RARE EARTH ELEMENTS**).

In recent years the main import sources of these raw materials have been China, Western European countries, the US, and the Czech Republic (in 2012). In the years of 2009–2010 and in 2012 the trade balances of ***yttrium and rare earth metals commodities*** were negative. In the years of 2009–2010 they varied between 1.0 and 6.4 million PLN/y, with the latter one resulting from increased imports. In 2011, due to high volume of re-exports of REE compounds, the trade balance turned positive, to +10 million PLN. In 2012 it was negative again and reached 3.4 million PLN. In 2013 the deficit improved to 2.1 million PLN, despite increased imports. The values of the trade balance have depended on imports volume and the market price, which influenced the unit values of rare earth elements importation to Poland (see: **RARE EARTH ELEMENTS**).

Consumption

The figures on ***yttrium*** consumption in Poland are not known. They are expected to follow the world consumption trends.

ZEOLITES

Overview

Zeolites is a common name for approx. 50 hydrated aluminosilicates, containing ions of alkaline metals (Na, K) and alkaline-earth metals (primarily Ca and Mg). The most common are ***analcime***, ***chabazite***, ***clinoptilolite***, ***erionite***, ***ferrierite***, ***heulandite***, ***laumontite***, ***mordenite***, and ***phillipsite***. In nature, these minerals occur in small amounts, but they can sometimes form considerable portions, or even the majority of ***zeolitic tuff***, ***tuffite***, ***clay rock***, etc.

The low production costs of **synthetic zeolites**, which are characterized by higher purity and wider ranges of channel diameters, have resulted in the development of their production, mainly for household chemical products. Among over 150 types of zeolites synthetized, the most common is ***sodium zeolite***, structurally stable up to 900°C, whereas natural zeolite degrades at much lower temperatures.

Sources

There are no ***zeolite*** deposits in Poland. Extensive investigations in the region of Rzeszów have resulted in the discovery of two prospective areas of ***clinoptilolite — montmorillonite clayshales*** with 18–21% of zeolite (in some parts even over 30%) and 50–75% of montmorillonite. The inferred resources in the **Dylągówka** and **Ulanica** localities are estimated at 900 Mt and 600 Mt respectively.

Production

Due to the lack of commercial ***zeolite*** deposits in Poland, there are ***synthetic zeolites*** and ***molecular sieves*** produced, as well as products based on imported natural zeolites. The total production of synthetic zeolites is difficult to establish because they are recorded in the wide group comprising a range of numerous chemicals (**PKWiU 20.59.52-10).** Since 2009 natural zeolites have been classified in the position **PKWiU 08.91.19**. That include the production of the **Technical-Industrial Enterprice Certech** in Niedomice, which is based on the material imported from Slovakia. Certech offers ***Zeo-Cats*** cat-litters and granulated product of the trade name ***ZM 0–8*** for agriculture and industrial applications.

In recent years the only producer of synthetic zeolites in Poland has been **Arkema** company – a subsidiary of the French chemical group, since 2000 operating **Atofina Polska Ltd. Manufacturer of Molecular Sieves** in **Inowrocław**. In 2004 it changed the name for **Arkema Ltd**. It has manufactured zeolites of A type (with pore size 3–5) in a powder form, a part of which has been granulated. The volume of Arkema production has been constant on the level between 9,000 and 9,500 tpy, while the production capacity has not exceeded 10,000 tpy. The majority of Arkema production has been consumed by foreign divisions of the corporation.

Until to the end of 2010 synthetic zeolites were also supplied by the **Soda Polska Ciech Ltd.** of **Inowrocław**, offering several types of ***sorbents*** (sodium, and potassium-sodium).

There is a possibility of artificial zeolites production on the basis of fly ash from power plants. For example, such a method of production has been patented by **Energomar Nord Ltd.** of **Warsaw**. The production on an industrial scale has not been yet implemented.

Trade

Comprehensive statistics for ***zeolites*** trade are not available — neither natural nor synthetic — because they are registered jointly with other products in **CN** code **2530 90 98** (natural zeolites) and **3824 90 98 50** (synthetic zeolites) of foreign trade nomenclature. It is known that natural zeolites have been imported from Slovakia in amounts of 160-500 tpy by Certech for the production of pet litter called ***Zeo-Cats***, as well as granulated sorbent agent for agriculture and industrial applications. Synthetic zeolites available on the domestic market in the form of ***molecular sieves*** under the trade names **Phonosorb** and **Molecular Sive** have been imported by the Poznań branch of the American company **Grace Division Ltd.**, as well as products known under the trade name **Eco-mol** offered be the company **Ecoin Ltd**. from Warsaw brought from the plant in China - the company's subcontractor. Significant amounts of artificial zeolite have been sold by **Arkema** to their foreign divisions, located mainly in Europe.

Consumption

The demand for high grade ***synthetic zeolites*** has been met entirely by imports. They have been used mainly for the manufacturing of household chemical products, as water softeners substituting phosphates. Perspective uses are: water and sewage purification (heavy metals and radioisotopes removal, oil absorbents, etc.)

Almost the entire production of **Soda Polska Ciech** was sold on the domestic market for refrigerating engineering, heat engineering (for deep drying of gasses and liquids), as well as for foundry use. Production of **Arkema** has been consumed in the construction sector as moisture absorbent in the production of double glazed windows and in air conditioning circuits, refrigerating engineering, and petrochemical sector. Similar applications have had products imported by **Ecoin Ltd.** and **Grace Division Ltd**. Zeolites and molecular sieves of various origin have been also consumed in medicine and pharmaceuticals (for the protection of medicines against moisture), optics, agriculture (additives in the fertilizer production), chemical, petrochemical, and energy sectors (decarbonation and drying of gases, dangerous wastes neutralization) etc. The detailed structure of domestic consumption is difficult to ascertain.

Natural zeolites processed by **Certech** have been sold mainly in a form of pet litters of trade name ***Zeo-Cats*** and as granulated product ***ZM 0–8*** for application in agriculture, water filtration, drying of gasses, and – to a lesser extent (approximately 10% of the production) - as an insulating component for concrete.

Companies involved in zeolites production in Poland, as of December 2013

- Arkema Sp. z o.o. Wytwórnia Sit Molekularnych (Arkema Ltd. Manufacturer of Molecular Sieves), Przemysłowa 88, 88–100 Inowrocław, tel./fax +48 52 3555720, www.arkema.com — *synthetic zeolites, molecular sieves*.
- P.T.H. Certech, 33–132 Niedomice, ul. Fabryczna 36, tel./fax +48 14 6458703, www.cer- tech.com.pl — *natural zeolites*.

ZINC

Overview

The most important primary source of **zinc** (**Zn**) is mineral ***sphalerite*** (ZnS), which occurs in deposits of stratoidal, metasomatic, vein, pyritic and other types. Deposits of ***Zn***, ***Zn-Pb***, ***Zn-Pb-Cu***, and other ***complex ores*** are the sources for the production of **sphalerite concentrate** — the main primary commodity for **zinc metal** manufacturing. Relatively small quantities of zinc, when compared to other base metals, are recovered from ***scrap*** and other ***secondary sources***, as main application of zinc (for galvanizing) makes recycling more complicated.

Sources

The exclusive primary sources of zinc in Poland are ***zinc*** and ***lead ore*** deposits of **Mississippi Valley type** in the Triassic dolomites of the **Silesia-Cracow** region. At the end of 2013 total resources of ***zinc*** and ***lead ores*** of ***sulfide type*** were 74.3 Mt (3.3 Mt of Zn). Last year there were the following deposits operated in the Olkusz region, i.e. **Olkusz**, **Pomorzany**, and **Klucze I**. They accounted for around 21.6% of domestic ***zinc ore*** resources.

Zinc and ***lead ore*** contain many accompanying elements, such as ***silver*** (mainly in ***galena***), and ***cadmium*** (mainly in ***sphalerite***). The resources of silver in deposits currently operated were estimated at 230 t, and cadmium - 3,740 t.

Copper ore in the **Fore-Sudetic Monocline** deposits, which contains ***sphalerite*** as an accompanying mineral, is potential primary source of zinc, which has not been recovered due to low metal content in the ore (max. 0.3%) and the lack of efficient technology. The only operated deposit, where zinc resources have been estimated is the **Głogów Głęboki Przemysłowy** (250,720 t, as of 31 December 2013).

Secondary sources of zinc, such as ***scrap*** of ***zinc metal***, ***zinc alloys***, and ***zinc products***, as well as various ***zinc-bearing wastes***, have been utilized only to a limited extent. Zinc-containing residues and waste are converted into ***zinc oxide***, zinc scrap and dust - directly into ***metallic zinc***, while scrap of zinc alloys - into new ***alloys***.

Zinc-Lead Ores and Concentrates

Production

Over the period 2009-2013 the mining output of ***Zn-Pb ore*** in Poland was gradually decreasing, down to 2.3 million tpy in the last two years. Simultaneously, zinc content in the run-off-mine dropped to 73,000-75,000 tpy (Tab. 1). This was a consequence of exhaustion of resources of the **Trzebionka** deposit, the operation of which was halted in the mid-2009, and the depletion of ore extracted in the Olkusz region by the **ZGH Bolesław**. The average zinc content in the output was gradually decreasing from 3.8% in 2009 to 3.15% in 2013. It is expected that by 2016-2017 the resources of these deposits will be completely exhausted. Nevertheless, some prospects for development of supplies of primary raw materials to domestic zinc smelters have recently appeared, i.e. to the north and west of deposits currently operated in the vicinity of **Olkusz**, including undeveloped deposits of **Laski** and **Klucze**, as well as in **Zawiercie** region, which has been explored by Canadian-based company - **Rathdowney Resources**. Since 2011 a new source of the raw materials has become the Balkan subsidiary of **ZGH Bolesław** (majority stake 52%), i.e. the **Gradir Montenegro** mine of Zn-Pb-Ag ores at the **Supljta Stijena** deposit with reserves of 20 Mt of Zn-Pb-Ag ore (possible future production of 30,000 tpy of zinc concentrate). In 2011-2013 sphalerite concentrates (2,300, 8,300, and 10,500 t, respectively) from the foreign subsidiary supplemented supplies of domestic raw materials for **ZGH Bolesław** smelter. **ZGH Bolesław** has created the capital group in which it has been a dominant company, while other members have been the following: **Gradir Montenegro, Bolesław Recycling**, **Boltech**, and **Miasteczko Śląskie Zinc Smelter.**

Tab. 1. Zinc ore and concentrates statistics in Poland — CN 2608 00

'000 t Zn

Year	2009	2010	2011	2012	2013
Mining output	116.0	88.5	81.8	75.2	73.4
Concentrates production	115.5	91.9	87.2	76.7	77.0
— *oxide concentrates*[1]	*18.8*	*19.4*	*22.0*	*19.0*	*18.8*
— *sulfide concentrates*	*93.3*	*72.5*	*65.2*	*57.7*	*58.2*
Imports[e]	77.4	68.5	55.3	123.4	94.3
Exports[e]	27.3	0.0	0.0	0.0	0.0
Consumption[e,a]	165.6	157.0	142.5	200.1	171.3

[1] zinc oxide recovered from waste materials

Source: ***The Central Statistical Office (GUS), producer's data***

Currently, the only unit for processing of ***zinc-lead ore*** has been the **Olkusz-Pomorzany** plant operated by the **ZGH Bolesław**. There have been ***sphalerite concentrate*** (55.3% Zn in 2013), ***bulk Zn-Pb concentrate*** (38.5% Zn and 13% Pb), and ***bulk Zn-Pb-Ag concentrate*** (29.3% Zn and 18.8% Pb) obtained. Additionally, ***zinc oxides*** (containing 61% Zn) from steel dust and from zinc-containing sludges (with 44% Zn and 15% Pb) have been recovered at the **Bolesław Recycling Ltd.** — a part of **ZGH Bolesław Capital Group** (since the end of 2013 incorporated into the structure of **Stalprodukt Capital Group -** leading manufacturer and exporter of highly processed steel products). The **Bolesław Recycling** has been the only enterprise in Poland specialized in treatment and neutralizing of waste slimes after zinc electrolysis, zinc-containing metallurgical wastes, steelmaking dusts, spent Zn-C and Zn-Mn batteries etc. in course of Waelz rotary kiln process (the processing capacity upgraded from 130,000 to 160,000 tpy). In recent years the output of ***zinc oxide*** has ranged from 35,000 to 40,000 tpy (gross weight) with 19,000-21,000 tpy Zn. At the same time, due to the closure of the **Trzebionka** mine and processing plant coupled with depletion of ore extracted in the **Olkusz** region, between 2009 and 2013 the supplies of ***sulfide zinc concentrates*** from domestic sources dropped by 33% (Tab. 1). Therefore, apart from supplementary supplies of concentrates from external sources, the share of secondary zinc oxide in the feedstock for the **ZGH Bolesław** zinc smelter is intended to be increased from current 20% to 40% in the next 3-4 years. For that purpose, at the end of 2012 a new installation for deep dechlorination, defluorination and leaching of raw zinc oxide recovered from steel dust was launched. Furthermore, the adaptation of ore processing technology to treatment of zinc-containing metallurgical sludges and the construction of new installation for enrichment of these sludges by flotation method has enabled recovery of silver in the form of Dore metal.

Trade

The importation of both ***sphalerite*** and ***complex*** (***bulk***) ***sphalerite-galena concentrates*** to Poland increased considerably in the last two years, reaching in 2012 a record level of almost 206,000 t (Tab. 2). The largest portion of imported concentrates originated from Australia (Mc Arthur) and Canada (Brunswick), while smaller quantities - from Germany, Ireland, Romania, and Balkan countries (Tab. 2). The exportation of ***sphalerite concentrates*** that until 2009 almost exclusively had been sold by the **Trzebionka**, in the following two years completely ceased. In 2012 only around 300 kg was sold to South Africa and the US, while in 2013 - there were 2.7 tons of zinc concentrate shipped to Austria and the US (Tab. 3). The balances of zinc concentrates turnover have been usually negative, as the volume and value of importation prevailed over respective figures of exports (Tab. 4). In the last two years the deficit amounted to 420 and 331 million PLN, respectively.

Tab. 2. Polish imports of zinc and zinc-lead concentrates, by country — CN 2608 00

'000 t (gross weight)

Year	2009	2010	2011	2012	2013
Imports	**129.0**	**114.1**	**92.1**	**205.7**	**157.2**
Australia	37.6	46.2	28.0	81.0	65.4
Belgium	0.4	10.2	–	–	–
Bulgaria	–	–	0.8	–	–
Canada	24.8	16.9	8.8	28.4	24.8
France	2.2	3.6	3.6	7.6	3.5
Germany	14.0	7.2	9.3	19.4	10.7
Ireland	–	–	–	17.1	8.9
Kosovo	–	–	–	0.7	6.9
Montenegro	–	0.5	6.5	9.0	7.9
Netherlands	2.0	1.1	0.7	6.4	1.1
Norway	–	–	–	–	8.5
Peru	10.9	2.2	–	–	–
Romania	10.2	13.7	15.0	14.5	1.7
Serbia	–	1.3	6.9	8.2	9.1

Slovakia	0.1	–	0.6	1.5	0.4
Spain	5.1	–	–	–	–
Sweden	–	–	3.7	3.6	4.6
Turkey	3.4	0.8	–	0.3	0.2
United Kingdom	17.4	10.0	8.2	7.8	3.4
Others	0.9	0.4	–	0.2	0.1

Source: ***The Central Statistical Office (GUS)***

Tab. 3. Polish exports of zinc concentrates, by country — CN 2608 00

'000 t (gross weight)

Year	2009	2010	2011	2012	2013
Exports	**44.3**	–	–	**0.0**	**0.0**
Austria	–	–	–	–	0.0
Bulgaria	25.2	–	–	–	–
China	11.0	–	–	–	–
Germany	5.1	–	–	–	–
India	2.0	–	–	–	–
Russia	1.0	–	–	–	–
South Africa	–	–	–	0.0	–
USA	–	–	–	0.0	0.0

Source: ***The Central Statistical Office (GUS)***

Tab. 4. Value of zinc and zinc-lead concentrates trade in Poland — CN 2608 00

'000 PLN

Year	2009	2010	2011	2012	2013
Exports	62,988	0	0	5	11
Imports	155,171	215,658	197,729	420,045	331,104
Balance	**-92,183**	**-215,658**	**-197,729**	**-420,040**	**-331,093**

Source: ***The Central Statistical Office (GUS)***

The unit values of both importation and exportation of concentrates in Poland followed zinc metal quotations in the international markets (LME, American market), depending on exchane rate of US dollar to the Polish currency. In 2013, as the international prices of zinc commodities diminished, the unit value of importation was also reduced (Tab. 5). High unit values of exportation have been a consequence of little quantities sold.

Tab. 5. The unit values of zinc concentrates trade in Poland — CN 2608 00

Year	2009	2010	2011	2012	2013
Imports					
PLN/t	1,203	1,890	2,145	2,149	2,106
USD/t	376	632	733	661	674
Exports					
PLN/t	1,422	-	-	12,105	4,036
USD/t	425	-	-	3,715	1,317

Source: ***The Central Statistical Office (GUS)***

Consumption

Between 2009 and 2011 the apparent consumption of ***zinc concentrates*** has been gradually decreasing, from almost 190,000 to ca. 140,000 tpy (Tab. 1). In 2012 the demand jumped by 41% with a 14% reduction in 2013. ***Zinc concentrates*** and ***zinc oxide*** of domestic origin have been predominantly consumed at the **ZGH Bolesław** for the production of ***electrolytic zinc*** (Tab. 3). The **Miasteczko Śląskie Smelter** has used both domestic and imported ***sulfide zinc-lead concentrates*** (***bulk***), as well as ***zinc*** and ***zinc-lead oxides*** coming from the **Bolesław Recycling**.

Zinc Metal

Production

Zinc metal in various grades has been manufactured at the following smelters:

- **HC Miasteczko Śląskie** (pyrometallurgy based on the **Imperial Smelting Process** technology, nominal capacity of 85,000 tpy), offering ***rectified zinc*** in two grades: **GOB – Z5** (98.5% Zn and 1.5% Pb), **SHG – Z1** (99.995% Zn) – in 2012 registered under **HCM.SHG.99.995** brand on the **LME**, as well as ***zinc alloy for galvanizing*** (**ZnAl**); zinc ferrous waste generated in **ISP** has been recycled in the Waelz rotary kiln process; the smelter has processed both domestic and imported ***zinc-lead concentrates*** (40% of the charge), and secondary ***zinc oxide*** (recovered at the **Bolesław Recycling** from steelmaking dust), as well as some quantities of ***scrap*** (***automobile parts***) and ***zinc-containing wastes*** of various origin;
- **ZGH Bolesław Mining and Smelting Plant** (hydrometallurgy, production capacity 75,000 tpy, possible expansion to 130,000 tpy by 2015); produces ***electrolytic zinc*** with 99.9975% Zn from its own concentrates; the product meets standards of **SHG** grade (min. 99.995% Zn) and has been registered on the **LME** under the brand **ZGHZ1**; the plant also offers ***zinc alloy for galvanizing*** (min. 99.3% Zn) with various alloy additives, e.g.: Al, Cu, Sn, and Ni (so-called ***Wegal*** alloy with 0.1–0.13% Ni), ***pressure alloy ZAMAK***, and ***zinc-based casting alloys*** (***ZnAl*** and ***ZnAlCu***);
- **ZM Silesia —** small quantities of ***zinc anodes***, made of rectified zinc 99.995% Zn, and ***zinc casting alloys***.

Upon the years 2009-2013 the total domestic production of ***zinc metal*** ranged from 135,000 to 146,000 tpy (Tab. 6). Its fluctuations have been a consequence of economic problems at the **HC Miasteczko Śląskie** (high prices of coke utilized in the **ISP** furnace) and international zinc prices variations. However, thanks to the implementation of restructuring measures, the performance of the smelter has significantly improved. Since 2010, when the enterprise was incorporated into the structure of **ZGH Bolesław Group** (and further – into **Stalprodukt Capital Group**), the expansion and modernization strategy for the whole domestic zinc metallurgy has been developed. Following consolidation, the domestic production capabilities increased to 150,000 tpy of zinc. The strategy of the Group included further expansion of total zinc smelting capacities to 200,000-240,000 tpy, the increase of the share of zinc oxides in raw materials charge for zinc metal production, and the switch of the **Miasteczko Śląskie Zinc Refinery** in order to facilitate manufacturing zinc entirely in **SHG** quality by 2015-2016 (construction of three additional rectification columns, coupled with termination of **GOB** manufacturing).

Tab. 6. Zinc metal statistics in Poland — CN 7901 11, 12

'000 t Zn

Year	2009	2010	2011	2012	2013
Production	139.1	135.1	144.1	138.3	146.3
— *Electrolytic*	*76.6*	*69.8*	*72.0*	*67.2*	*76.1*
— *Rectified*	*62.5*	*65.3*	*72.1*	*71.1*	*70.2*
Imports	21.7	56.7	41.4	51.0	49.9
Exports	84.3	95.6	105.2	107.3	128.7
Consumption[a]	76.5	96.2	80.3	82.0	67.5

Source: ***The Central Statistical Office (GUS), producers' data***

Trade

The demand for ***zinc metal*** and ***zinc products*** has been mostly satisfied by domestic manufacturers (Tab. 6). The principal zinc commodities traditionally imported to Poland have been ***zinc oxide***, ***zinc alloys***, and ***zinc waste and scrap*** (Tab. 10). The importation of ***zinc metal***, which amounted to 22,000 t in 2009, since 2010 varied at higher leve;s, from around 41,000 to 57,000 tpy (Tab. 7). In the last three years from among its numerous suppliers the largest were: Spain, Germany, and Finland. The simultaneous exportation of ***zinc metal*** has ranged from 96,000 to 107,000 tpy (Tab. 8). In recent years the largest foreign recipients of zinc from Poland have been: Germany, Slovakia, Italy, the Czech Republic, and Austria (Tab. 8). Over the years 2009-2013, the positive value of the trade balances generally showed a growing trend resulting from increase in the exportation revenue, especially in 2011 and 2013, when it exceeded 440 and 500 million PLN, respectively (Tab. 11).

The average unit values of zinc metal exportation from Poland (in USD/t) have followed zinc metal quotations on the LME. Their sharp reduction took place in 2009, however in the following two years they increased proportionally to the international prices (Tab. 9). The unit values quoted in the domestic currency depended on the exchange rates. In 2009 they improved slightly due to strenthening of Polish zloty (PLN) against US dollar, but in the following years they levelled off at around 6,750-6,700 PLN/t despite the rise in LME quotations. In the last two years both the prices of zinc and unit costs of its exportation from Poland decreased in aggregate more than 11% (in USD).

Apart from ***zinc metal***, other zinc products traded have been: ***zinc oxide***, ***alloys***, ***waste and scrap***, and also ***zinc dust***, ***powders***, and ***flakes*** (Tab. 10). Since 2009 the exportation of ***zinc oxide*** has been gradually increasing, up to 16,200 t in 2013. However, at the same time its imports grew almost five-fold that resulted in the reduction of the trade financial revenues, which last year turned negative (Tab. 11). Simultaneously, the sales of ***zinc alloys*** increased up to 9,200 t in 2013, while their imports varied in a wide range that resulted in changes in the trade deficit from almost -20 to -4 million PLN (Tab. 11). The exportation of ***zinc waste and scrap***, which in 2010-2011 stabilized at around 1,000 tpy, in the last two years substantially decreased. That, coupled with increased importation, resulted in worsening of the financial results of these raw materials turnover (Tabs. 10 and 11).

Tab. 7. Polish imports of zinc metal, by country — CN 7901 11,12

'000 t Zn

Year	2009	2010	2011	2012	2013
Imports	**21.7**	**56.7**	**41.4**	**51.0**	**49.9**
Belgium	1.2	1.5	0.3	0.4	9.1
Bulgaria	0.1	0.1	0.1	–	–
China	–	–	–	–	0.3
Czech Republic	0.9	2.7	1.9	0.6	0.2
Finland	0.8	5.3	7.5	9.9	7.1
France	–	–	2.4	3.2	4.3
Germany	3.9	11.7	4.7	7.9	3.0
Italy	0.4	1.6	0.9	0.3	0.4
Kazakhstan	4.0	7.8	9.3	–	–
Latvia	–	–	0.2	0.2	–
Luxemburg	0.5	0.2	0.6	0.6	–
Mexico	–	–	–	–	0.1
Netherlands	0.8	0.9	0.9	4.0	6.7
Namibia	–	–	–	–	0.3
Norway	–	–	–	0.2	–
Peru	–	–	–	–	0.2
Romania	–	–	0.1	–	–
Russia	0.5	0.1	–	–	–
Slovakia	4.9	1.4	0.7	0.4	0.3
Spain	2.8	20.4	11.8	21.1	12.9
Sweden	–	–	–	0.4	0.2
Switzerland	–	–	–	1.8	1.3
United Kingdom	0.8	2.3	0.0	0.0	3.3
Others	0.1	0.7	–	–	0.2

Source: ***The Central Statistical Office (GUS)***

Tab. 8. Polish exports of zinc metal, by country — CN 7901 11, 12

'000 t Zn

Year	2009	2010	2011	2012	2013
Exports	**84.3**	**95.6**	**105.2**	**107.3**	**128.7**
Austria	5.9	4.0	7.7	6.7	10.5
Belgium	1.7	–	0.3	0.5	0.0
Belarus	–	–	–	–	0.7
Bulgaria	1.0	0.2	0.0	0.0	0.9
Croatia	0.2	0.0	0.1	0.1	0.2
Czech Republic	13.5	22.4	14.9	20.7	16.1
Finland	–	–	–	–	0.3

France	3.3	2.0	3.0	2.6	2.8
Germany	13.7	20.6	23.6	24.8	30.8
Greece	–	–	0.4	0.4	0.6
Hungary	1.7	2.2	4.1	2.7	4.6
Indonesia	–	–	–	–	1.2
Israel	0.8	–	–	–	0.3
Italy	22.3	18.7	21.5	15.5	24.3
Japan	–	–	–	–	0.2
Lithuania	–	–	0.5	0.6	0.4
Malaysia	–	–	–	–	0.3
Netherlands	0.9	2.0	1.8	1.5	2.0
Pakistan	–	–	–	–	0.2
Romania	1.6	2.1	1.6	2.4	3.1
Serbia					0.6
Slovakia	13.5	16.9	20.2	23.6	24.1
Slovenia	0.6	0.8	0.0	0.0	0.2
Spain	–	–	–	–	0.2
Sweden	0.4	1.1	3.2	4.0	3.2
Switzerland	–	–	0.4	–	0.3
Ukraine	0.1	0.1	0.1	0.1	0.0
United Kingdom	2.8	1.6	1.4	0.4	0.5
Vietnam	–	–	0.2	0.2	0.0
Others	0.3	0.9	0.2	0.5	0.0

Source: ***The Central Statistical Office (GUS)***

Tab. 9. The unit value of zinc metal exports from Poland — CN 7901 11, 12

Year	2009	2010	2011	2012	2013
PLN/t	5,025	6,749	6,756	6,713	6,414
USD/t	1,627	2,253	2,310	2,058	2,043

Source: ***The Central Statistical Office (GUS)***

Consumption

Zinc has been predominantly consumed in the steel-making industry as an anticorrosive coating. Galvanizing has remained the largest direction of zinc utilization (around 60% of the total consumption), while the automobile and construction industries have been the largest end-users. Zinc has been also utilized in the metallurgy for the production of brass (ca. 20% of the total consumption), in the foundry industry (Zn-Al alloys – 9%), and in the chemical industry (zinc white – 5%). Galvanizing, mainly of steel sheets and strips, has been carried out at the former **Sendzimir Steelworks** in **Cracow** and the **Florian Steelworks** in **Świętochłowice**, which both are divisions of the **ArcelorMittal Poland**. In 2010-2011 the total domestic supply of zinc-coated steel was 455,000 and 453,000 t respectively, up from only 396,000 t in 2009, while in 2012 it jumped up to 676,000 t and

Tab. 10. Trade in selected zinc commodities (other than zinc metal) in Poland

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Year	2009	2010	2011	2012	2013
Zinc oxide CN 2817 00					
Imports	6,523	10,601	10,026	25,254	30,060
Exports	7,983	9,335	11,430	13,519	16,215
Zinc alloys CN 7901 20					
Imports	8,319	7,280	9,109	12,356	11,362
Exports	4,577	6,151	6,961	6,541	9,180
Zinc waste and scrap CN 7902 00					
Imports	3,779	7,068	10,420	11,060	14,253
Exports	1,593	1,086	1,046	487	570
Zinc dust, powder, and flakes CN 7903					
Imports	250	622	768	993	1,290
Exports	432	130	283	134	168

Source: ***The Central Statistical Office (GUS)***

Tab. 11. Value of selected zinc commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Zinc oxide CN 2817 00					
Exports	37,035	54,623	65,048	75,466	96,644
Imports	26,694	57,327	57,339	74,472	97,962
Balance	**+10,341**	**-2,704**	**+7,709**	**+994**	**-1,318**
Zinc metal CN 7901 11, 12					
Exports	423,529	645,005	710,893	719,953	825,558
Imports	114,991	319,125	270,099	327,470	317,217
Balance	**+308,538**	**+325,880**	**+440,794**	**+392,483**	**+508,341**
Zinc alloys CN 7901 20					
Exports	25,591	43,895	51,365	47,558	63,929
Imports	45,190	52,203	62,991	63,022	68,161
Balance	**-19,599**	**-8,308**	**-11,626**	**-15,464**	**-4,232**
Zinc wastes and scrap CN 7902 00					
Exports	5,674	5,146	4,293	1,998	1,859
Imports	13,250	32,613	49,998	52,408	60,139
Balance	**-7,576**	**-27,467**	**-45,705**	**-50,410**	**-58,280**

Zinc dust, powder, and flakes CN 7903					
Exports	858	1,188	2,356	1,448	1,852
Imports	2,475	5,633	7,060	6,765	10,226
Balance	**-1,617**	**-4,445**	**-4,704**	**-5,317**	**-8,374**

Source: ***The Central Statistical Office (GUS)***

in 2013 – to a record level of 914,000 t. In the 2000s, to meet the increased demand for high grade zinc-coated products, numerous galvanizing shops were launched in Poland, including **Galvanizing Shop Śląsk** of Chrzanów (belonging to German **Seppeler Gruppe**), **Stalprodukt Capital Group** of **Bochnia**, **Pokój** (the main shareholders are: German **Voight & Schweitzer** and domestic **Pokój Steelworks**), **Polimex Mostostal** (running three plants: **Siedlce**, **Dębica**, and **Częstochowa**), **Mostostal-Met Opole**, **ZinkPower Wielkopolska** (**KOPF Holding**) etc. ***Zinc alloys*** and ***zinc products*** have been manufactured by the **Silesia Metallurgical Works** (basically sheets and gutters made of titanium-zinc alloy for building engineering, zinc and ZnAl wire).

The main domestic manufacturer of ***zinc white*** (for the paint, rubber and ceramic industries) and ***zinc oxide*** (in fodder and pharmaceutical grades) has been the **Oława Metalworks** (a division of the **ZM Silesia**). The annual production of ***zinc white*** that previously ranged between 12,000 and 15,000 tpy, in the last five years varied from 8,600 (in 2009) to 13,100 tpy (in 2013). ***Zinc dust*** (98.5–99.4% Zn) manufactured at the **Boltech** of **Bukowno**, belonging to **ZGH Bolesław Group**, has been utilised for the production of ***zinc metal*** at the parent company's zinc smelter, as well as by the paint and varnishes industries. The plant has also developed the production of ***cast and rolled zinc anodes*** (based on electrolytic zinc 99.994% Zn from **Bolesław Smelter**) for the galvanizing industry and ***zinc-aluminium cast alloys*** (***ZAMAK 2,3 and 5***) for pressure foundries.

The consumption of zinc metal has depended on general condition of the domestic economy, in particular of the automobile and construction industries, as well as of the demand for household equipment. In recent years it has ranged from around 80,000 to 96,000 tpy, with a 18% drop in 2013 as compared to the previous year (Tab. 6).

Companies involved in zinc commodities production in Poland as of December 2013

- ZGH Bolesław S.A., ul. Kolejowa 37, 32–332 Bukowno, tel. +48 32 2955100, fax +48 32 2955000, www.zgh.com.pl — *Zn-Pb ore, sphalerite and complex sphalerite-galena concentrates (bulk), zinc oxide, electrolytic zinc, zinc alloy for galvanizing*.
- Bolesław Recycling Sp. z o.o., ul. Kolejowa 37, 32–332 Bukowno, tel. +48 32 2955667, fax +48 32 2955550, www.bolrec.pl — *secondary zinc oxide.*
- Huta Cynku Miasteczko Śląskie S.A. (Miasteczko Śląskie Zinc Smelter), 42–610 Miasteczko Śląskie k. Tarnowskich Gór, ul. Woźnicka 36, tel. +48 32 2888444, fax +48 32 2851885, www.hcm.com.pl — *rectified zinc*.
- ZM Silesia S.A. — Oddział Huta Oława (Silesia Metallurgical Plant — Division of Oława Metalworks), ul. Sikorskiego 7, 55–200 Oława, tel. +48 71 3134031, fax +48 71 3134035, www.silesiasa.pl — *zinc white, zinc oxide*.
- ZM Silesia S.A. (Silesia Metallurgical Plant), ul. Konduktorska 8, 40-155 Katowice, tel. +48 32 3587400, fax. +48 32 2598331, www.silesiasa.pl – *zinc anodes, zinc die-casting alloys, zinc-titanium sheets*, *zinc and zinc alloy wire.*

ZIRCONIUM

Overview

Zirconium (**Zr**) raw materials are obtained primarily from placer deposits of heavy minerals called ***zircon-rich mineral sands***. Recovery from ***waste molding sand*** and from ***scrap zircon refractory materials*** is insignificant.

Zirconium in its pure metallic form is used only as an additive for nuclear reactor cores, and as an alloy constituent with magnesium, titanium, and other metals. Its minerals have many more applications, especially **zircon** $\mathbf{ZrSiO_4}$ (for foundry, refractories, abrasives, ceramics) and - to much smaller extent - **baddeleyite** $\mathbf{ZrO_2}$, as well as its synthetic equivalent, **zirconia** $\mathbf{ZrO_2}$. Zircon and baddeleyite are the only sources of ***metallic zirconium*** and ***hafnium*** (see: **HAFNIUM**).

Sources

Zircon mineral occurs in the Baltic beach sand (5–9% of heavy fraction) and with other heavy minerals have been found in the **Ławica Odrzańska** and **Ławica Słupska** sandbanks. Resources of zircon there are estimated at 2,000 t. ***Glass sand*** from the **Osiecznica** deposit is a potential source of ***zircon***.

Production

Zirconium minerals and ***zirconium metal*** are not produced in Poland.

Trade

The domestic demand for ***zirconium commodities*** has been met by imports, mainly of ***zircon concentrates*** and ***zircon flour***. Their volume has varied between 360 and 730 tpy in recent years (Tab. 1). In 2009-2013 the consumption of zircon flour in the ceramic tile industry decreased as compared to the previous years due to very high prices of zircon commodities. It is estimated that the volume of ***zircon concentrates*** importation has amounted to less than 150 tpy, supplied primarily by Ukraine or South Africa, while the rest has been constituted by ***zircon flour***, coming mainly from Germany, France, the Netherlands, Spain, South Africa, Italy, Australia, and the United Kingdom (Tab. 1). The re-exports of ***zircon concentrates*** and ***flours*** have been also reported. They were significant in 2010, when huge re-exports of ***zircon flours*** to Russia and Belarus were recorded, and in 2013 – Sweden, the Czech Republic, and Ukraine were the main recipients (Tab. 1).

Tab. 1. Statistics on zirconium commodities in Poland

t

Year	2009	2010	2011	2012	2013
Zircon concentrates and flour CN 2615 10					
Imports	**364**	**624**	**478**	**670**	**734**
Australia	31	20	32	23	18
France	48	132	42	61	32
Germany	18	150	229	115	96
Italy	3	3	24	24	158
Netherlands	17	148	124	116	38
Russia	–	–	–	–	20
South Africa, Republic of	58	29	24	27	9
Spain	94	58	2	287	188
Ukraine	21	8	–	1	148
USA	–	25	0	11	3
United Kingdom	62	24	0	0	0
Others	12	27	1	5	24
Exports	**1**	**101**	**3**	**17**	**64**
Consumption[a]	**363**	**523**	**475**	**653**	**670**
Zirconium metal and powder CN 8109 20					
Imports = Consumption[a]	**3**	**2**	**0**	**0**	**0**

Source: ***The Central Statistical Office*** *(GUS)*

Zirconium metal has been traded on a marginal scale. In 2008-2009 some small imports occurred (Tab. 1). The deliveries originated from various countries, including: Spain, the United States, Japan, France, China and others.

The trade balances of ***zirconium commodities*** has been consistently negative, following the varying volume of imports and their prices (Tab. 2).

Tab. 2. Value of zirconium commodities trade in Poland

'000 PLN

Year	2009	2010	2011	2012	2013
Zircon concentrates and flour CN 2615 10					
Exports	5	401	51	54	385
Imports	2,575	3,344	3,689	6,213	4,271
Balance	**-2,570**	**-2,943**	**-3,638**	**-6,159**	**-3,886**
Zircon metal and powder CN 8109 20					
Imports = **Balance**	**-43**	**-47**	**-72**	**-32**	**-109**

Source: ***The Central Statistical Office*** *(GUS)*

Over the analyzed period the average unit values of imported ***zircon concentrates*** and ***flours*** varied from 1,800 to 2,800 USD/t (Tab. 3). It was in accordance with tendencies observed in the world market of zircon commodities. Two groups of commodities have been reported in the common item of CN nomenclature: ***zircon concentrates*** having unit values of 1,300-1,600 USD/t, and ***zircon flours***, which have unit values from 1,500 to over 4,000 USD/t.

Tab. 3. Average unit values of zircon concentrates and flours imports to Poland — CN 2615 10

Year	2009	2010	2011	2012	2013
PLN/t	7,081	5,361	7,716	9,271	5,822
USD/t	2,395	1,807	2,601	2,848	1,854

Source: ***The Central Statistical Office (GUS)***

Consumption

The principal domestic consumers of zirconium commodities were traditionally the foundry and refractory industries (***zircon concentrates***), incidentally — metallurgy (***zirconium***). Since the mid 1990s, ***zircon flour*** has been started to be increasingly utilized in the domestic ceramic tiles industry. As a result, this industry has become the largest consumer of zircon commodities in Poland (over 90% of the total demand), though in recent years this consumption has been distinctly reduced due to high prices of zircon.

ABBREVIATIONS AND UNITS OF MEASURE

kg	— kilograms	
t	— metric ton	= 1,000 kg
tpy	— tons per year	
m^3py	— cubic metres per year	
'000 t	— thousand tons	= 1,000,000 kg
Mt	— million tons	= 1,000,000,000 kg
Mm^3	— million cubic metres	= 1,000,000 m^3
1 carat (diamond)		= 200 milligrams
NA	— not available	
[e]	— estimated	
[r]	— revised	
[a]	— consumption apparent = production + export – import	
0	— less than 0.5 of used unit of measure	
0.0	— less than 0.05 of used unit of measure	
ave.	— average	