

# Safety of groundwater resources in terms of development of shallow geothermal energy installations

*Maciej Kłonowski\*, Kirsti Midttømme\*\*, Randi Kalskin Ramstad\*\*\*, Hans de Beer\*\*\*\*, Eliza Dziekan-Kamińska\*,  
Jacek Kocyla\*, Grzegorz Ryżyński\*, Magdalena Sidorczuk\*, Atle Dagestad\*\*\*\*, Anna Seither\*\*\*\**

\*Polish Geological Institute – National Research Institute, \*\*Christian Michelsen Research AS,  
\*\*\*Norwegian University of Science and Technology, \*\*\*\*Geological Survey of Norway



44<sup>th</sup> IAH Congress,  
Dubrovnik, Croatia, 25-29.09.2017

## Outline of this presentation:

- Definitions of shallow geothermal energy (SGE)
- Market situation
- Types of SGE installations
- Possible effects and threats to subsurface including groundwater
- Conclusions

## Definitions:

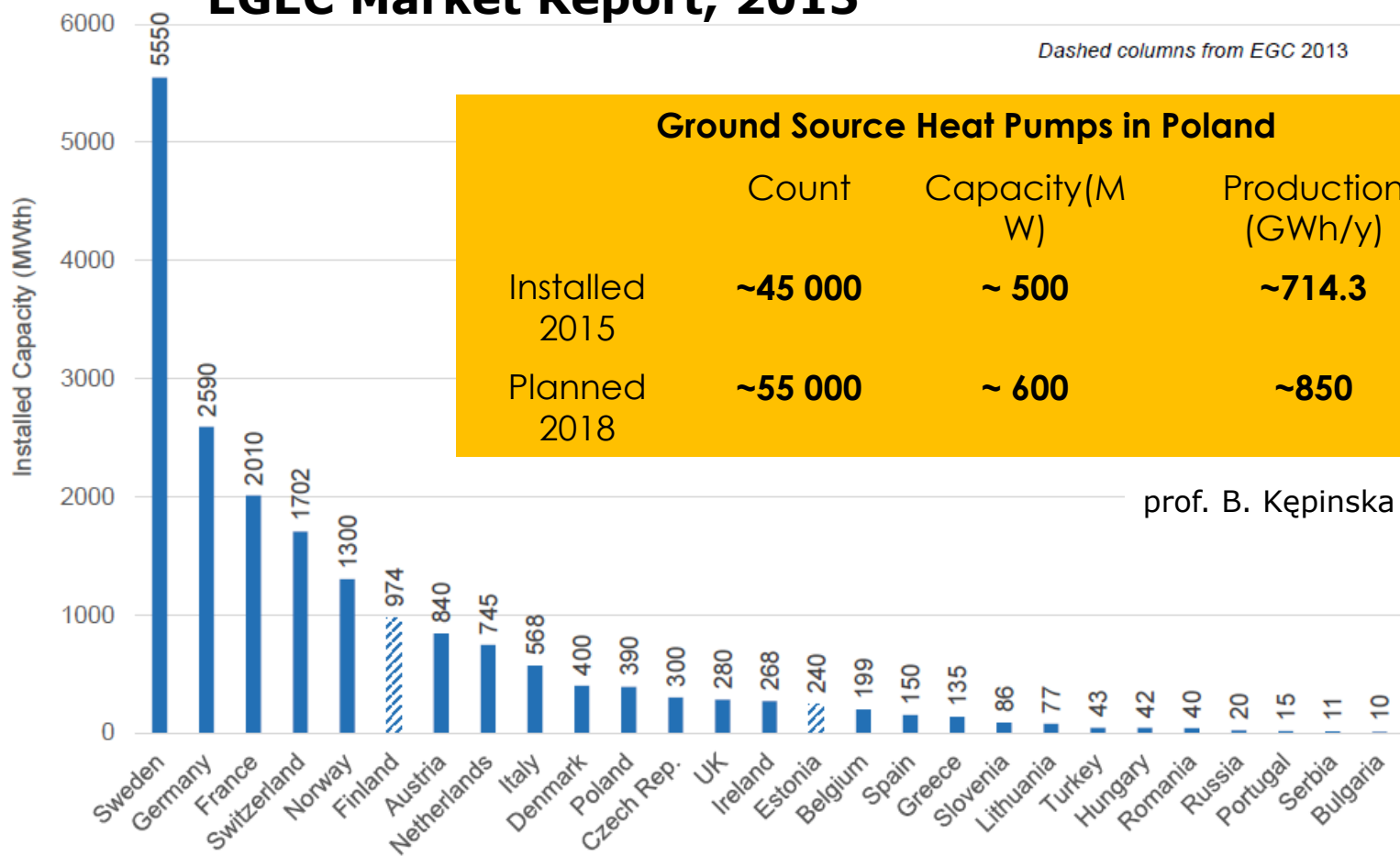
Directive 2009/28/EC of the European Parliament and of the Council of 23<sup>rd</sup> April 2009 on the promotion of the use of energy from renewable sources, Article 2 (c):

**“geothermal energy means energy stored in the form of heat beneath the surface of solid earth”**

Legal definitions of the EU member countries are based on:

- heat capacity, temperature, depth, associated use, etc.
- those always include open and closed systems

## EGEC Market Report, 2015



### Ground Source Heat Pumps in Poland

	Count	Capacity(M W)	Production (GWh/y)
Installed 2015	~45 000	~ 500	~714.3
Planned 2018	~55 000	~ 600	~850

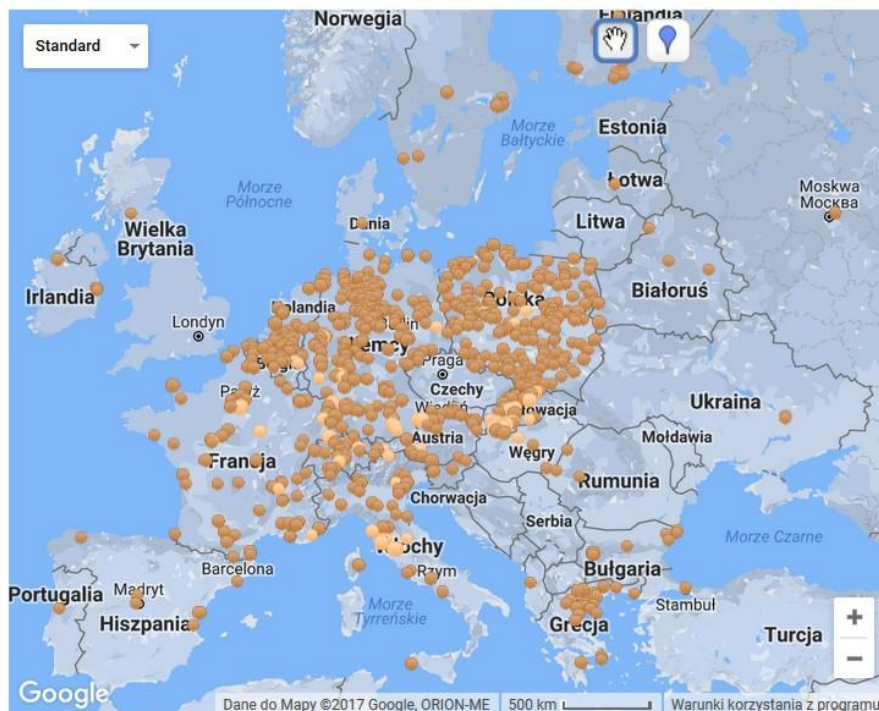
prof. B. Kępinska 2016

## repowermap

Renewable energies and energy efficiency in your neighbourhood.

Enter a country, city and street








Go!



### Technologies

- |   |  |
|---|--|
| <input type="checkbox"/>  Solar Electricity                      | <input type="checkbox"/>  Biogas Energy   |
| <input type="checkbox"/>  Solar Thermal                          | <input type="checkbox"/>  Wood Energy     |
| <input checked="" type="checkbox"/>  Geothermal Heat Pump        | <input type="checkbox"/>  Other Bioenergy |
| <input type="checkbox"/>  Aerothermal or Hydro-thermal Heat Pump | <input type="checkbox"/>  Hydro           |
| <input checked="" type="checkbox"/>  Other Geothermal Energy     | <input type="checkbox"/>  Ocean Energy    |
| <input type="checkbox"/>  Energy Efficient Building              | <input type="checkbox"/>  Wind            |

### Categories

- |  |  |
|--|--|
| <input checked="" type="checkbox"/>  Existing Sites | <input type="checkbox"/>  Events          |
| <input type="checkbox"/>  Planned Projects          | <input type="checkbox"/>  Energy Actors   |
| <input type="checkbox"/>  Service Providers       | <input type="checkbox"/>  Energy Cities |
| <input type="checkbox"/>  Energy Regions          |  |

Keyword

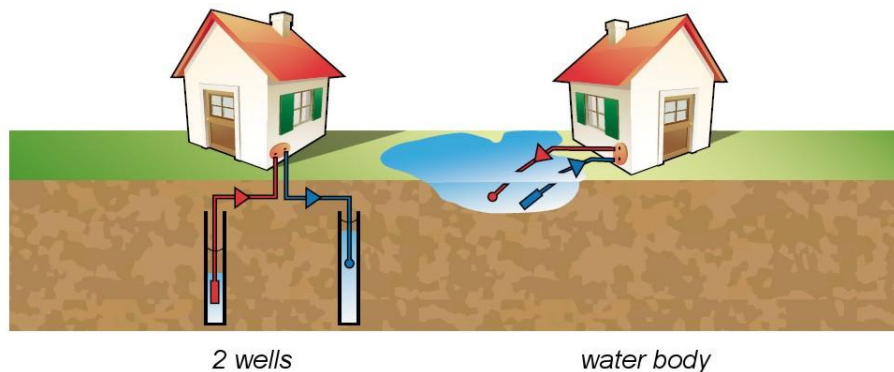
Company

 Update map

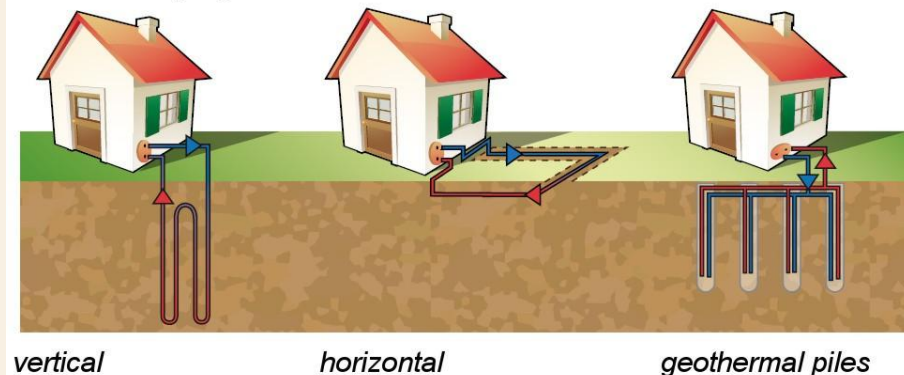
## Shallow geothermal energy installations:

- Open loop systems - production well and injection well
- Closed loop systems - Ground Source Heat Pumps (GSHP): horizontal, vertical, other
- Thermal energy storage: UTES, ATES, BTES

*open loop system*



*closed loop system*





## Definition of pollution by EU Water Framework Directive:

*„pollution is the direct or indirect introduction, as a result of human activity, of **substances or heat** into the air, **water** or land, which may be harmful to human health or the quality of **aquatic ecosystems or terrestrial ecosystems** directly depending on aquatic ecosystems, which result in **damage to material property**, or which impair or interfere with amenities and other **legitimate uses of the environment**”*



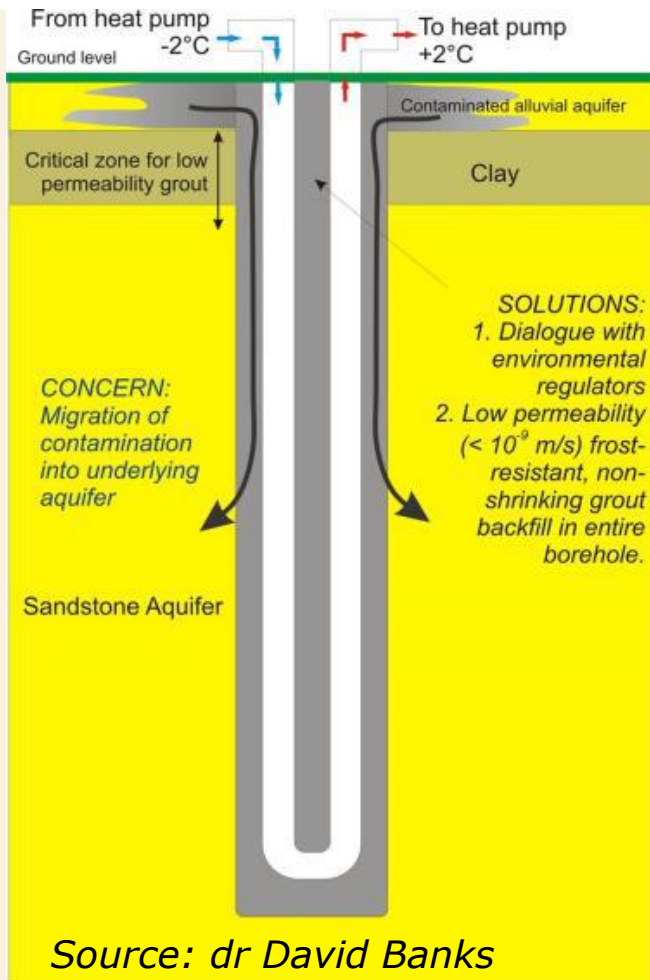
## Typical issues for open loop system:

- Ground subsidence due to drawdown
- Ground upheave due to upconing (recharge)
- Groundwater flooding during recharge
- Pumping of sand
- Mineral precipitation in aquifer
- Well clogging
- Scaling
- Corrossion of materials



*Source: Internet*





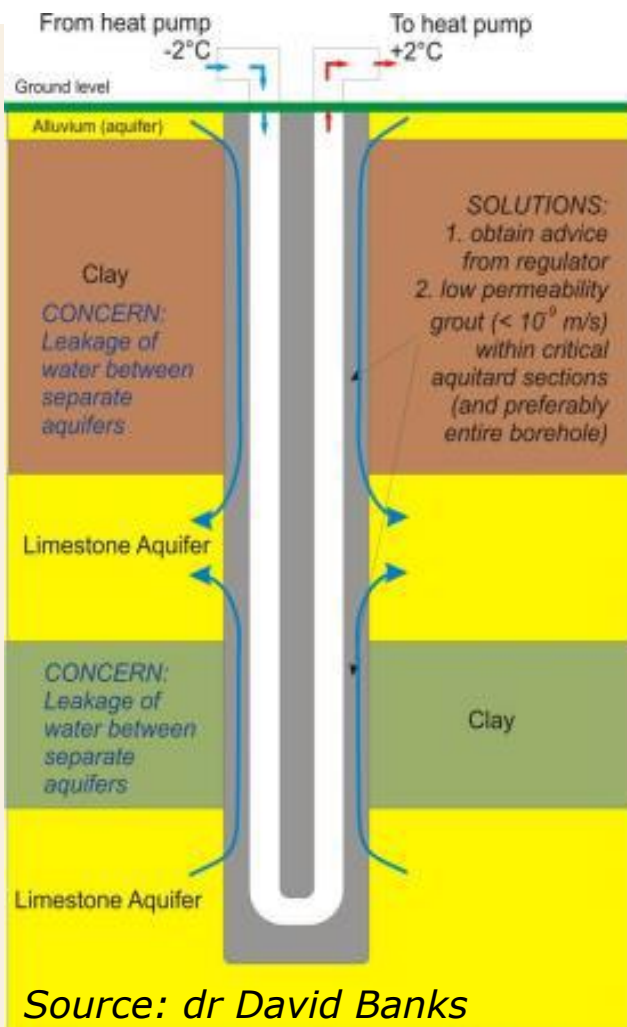
## Typical issues for closed loop system: GSHP:

- contaminated areas
- artesian and subartesian aquifers
- multilayered aquifer systems

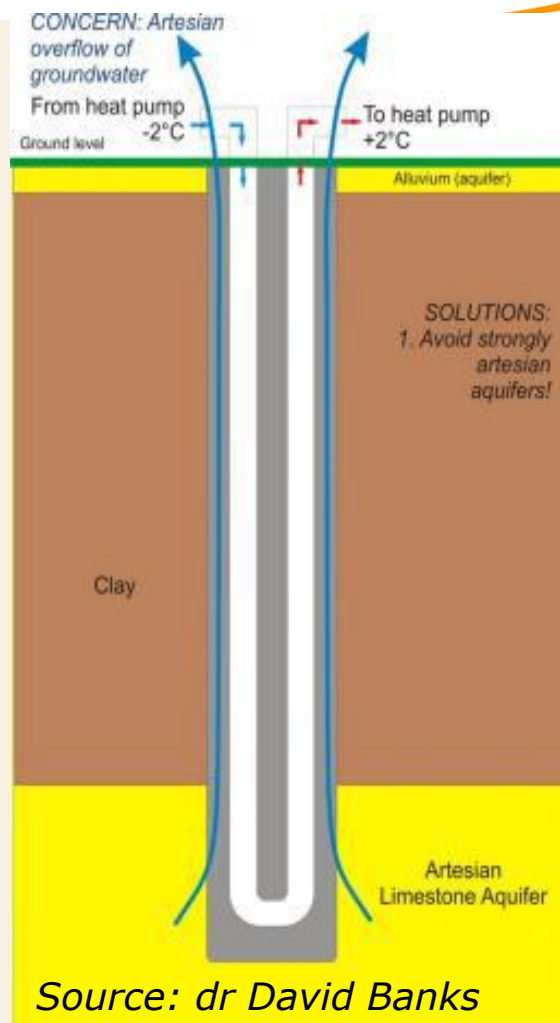


# GEO THERMAL 4 PL

Iceland  
Liechtenstein  
Norway grants



Source: dr David Banks



Source: dr David Banks



POLISH GEOLOGICAL INSTITUTE  
NATIONAL RESEARCH INSTITUTE

cmr  
Christian Michelsen Research

## Accidental spills of carrier fluids and refrigerants:

- Ethylene glycol: toxic, biodegradable
- Propylene glycol: low toxicity, biodegradable
- Ethanol: low toxicity, biodegradable
- Water: non-toxic

## Safe installation



*Source: Internet*

## Other issues:

- Geotechnical: ground stability and expansion, cavities
- Evaporites: dissolution of halite and anhydrite
- Urban environment and underground infrastructure
- Urban heat islands
- Gas migration from subsurface: CO<sub>2</sub>, radon, methane
- Microbial risk
- Geothermal plum migration and interactions between installations



## Conclusions:

- According to UE regulations heat and coolth are not potential pollutants themselves, however installing SGE installations may influence subsurface and groundwaters
- Care should be taken while designing, drilling and installing all types of SGE installations
- Usual concerns refert to perforation of artesian aquifers and drilling through multilayered aquifer systems
- Other issues are: leakege of carrier fluid and refrigerants
- Geothecnical problems, dissolution of evaporites, migration of gases

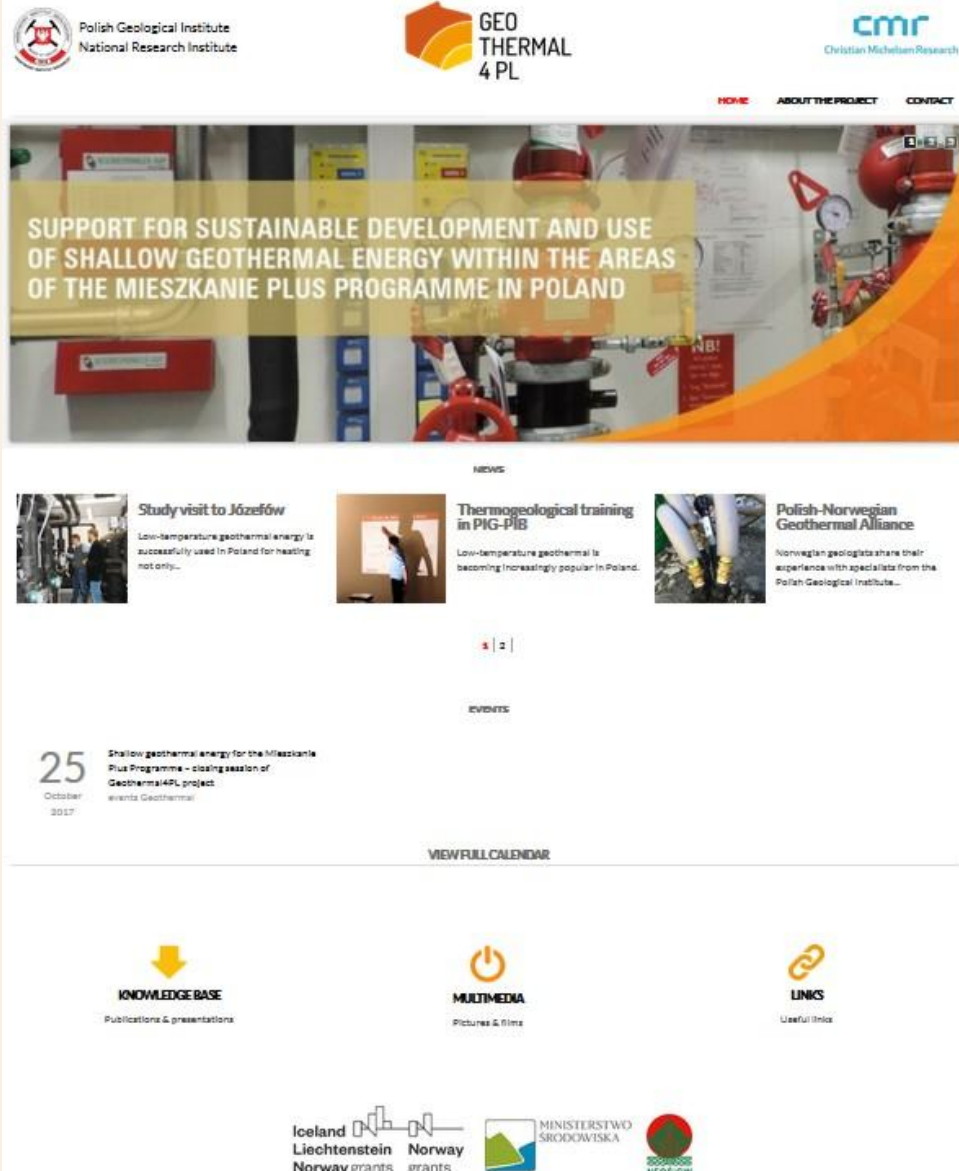


# Thank you very much!

Contact:

[Maciej.Klonowski@pgi.gov.pl](mailto:Maciej.Klonowski@pgi.gov.pl)

[www.pgi.gov.pl/geothermal4pl](http://www.pgi.gov.pl/geothermal4pl)



The screenshot shows the website for the GEO THERMAL 4 PL project. At the top, there are logos for the Polish Geological Institute National Research Institute, GEO THERMAL 4 PL, and cmr (Christian Michelsen Research). The main banner features a photograph of industrial equipment with the text: "SUPPORT FOR SUSTAINABLE DEVELOPMENT AND USE OF SHALLOW GEOTHERMAL ENERGY WITHIN THE AREAS OF THE MIESZKANIE PLUS PROGRAMME IN POLAND". Below the banner, there is a "NEWS" section with three articles: "Study visit to Józefów", "Thermogeological training in PIG-PIB", and "Polish-Norwegian Geothermal Alliance". A "EVENTS" section lists an event on "Shallow geothermal energy for the Mieszkani Plus Programme - closing session of Geothermal4PL project" on October 25, 2017. At the bottom, there are links to "KNOWLEDGE BASE", "MULTIMEDIA", and "LINKS". The footer includes logos for the Polish Geological Institute, cmr, and various grant providers including Iceland, Liechtenstein, Norway, and the Polish Ministry of Environment.