

# Shale Gas Resources of Europe and the Need for a Pan-European Coordinated Assessment

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# Agenda

- Definitions
- Status on shale gas resources of Europe
- Need for coordinated Pan-European assessment
- Acknowledgement

# Definitions

- **Resources** are those quantities of a commodity that are **estimated at a given time** to exist within a jurisdiction or a geographic area. Resources are of two types:
  - **Discovered or in-place** (i.e. an existing commodity whose location and characteristics are known, being assessed on the basis of scarce data ),
  - **Undiscovered, or inferred** (i.e. not yet found but assumed to exist based on inferences from geological knowledge and/or various analyses).

From Bachu et al., 2007

# Definitions cont.

- What is *Technical Recoverable Resources* (TRR)
  - Ambiguous concept
  - The total amount of resource, discovered and undiscovered, that is thought to be recoverable with available technology, regardless of economics.
- *Resources* are estimated:
  - From available geological data
  - From recovery factors (depends on the geological conditions)

# Definitions cont.

- **Reserves** are those quantities of a commodity that are **known to exist** and that are **commercially recoverable** under present technological and economic conditions.
  - Their assessment integrates the technical, economic, environmental, societal and regulatory factors available **at the time of the assessment**.
  - Reserves are a subset of resources, and usually accessibility, technology and economic cutoffs are used to define and delineate reserves.
  - They are divided in Proved – Proved and Probable – and Proved and Probable and Possible reserves



# Highly Productive U.S. Gas Shales “sweet spots”

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- Carbon rich:  $> 2$  wt % C in Type II organics
- Thermal Maturity:  $> 1.1\% R_o$ ;  $< 3.5\% R_o$
- Shale gas had an oil precursor
- Net high-gamma ray thickness:  $>20$  meters
- Overpressured:  $>0.45$  psi/ft
- Low clay content – brittle lithology
- Enclosing rocks can confine hydrofractures

Photo: David Houseknecht

# Status on shale gas resources of Europe

Major unconventional natural gas resources in Europe



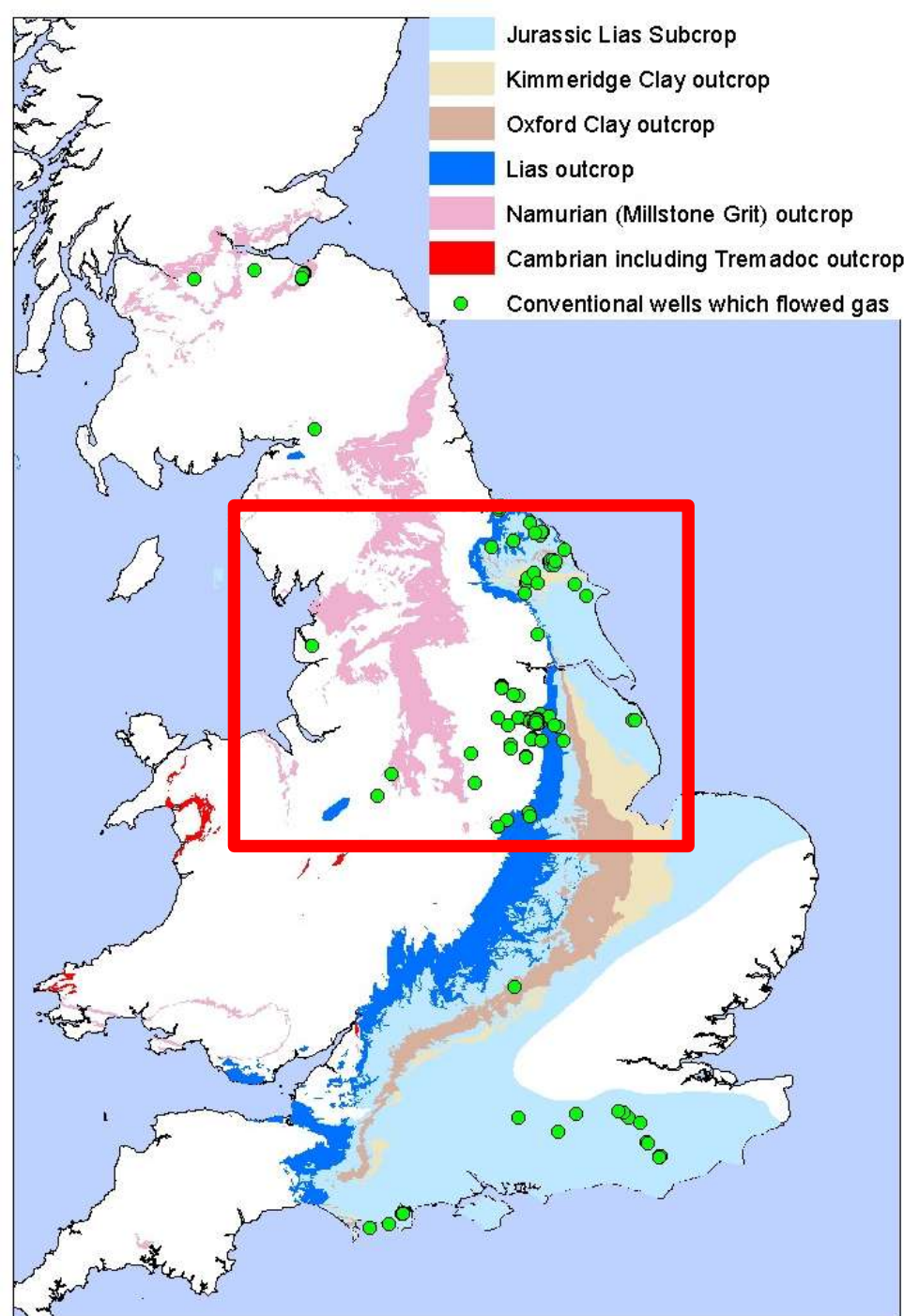


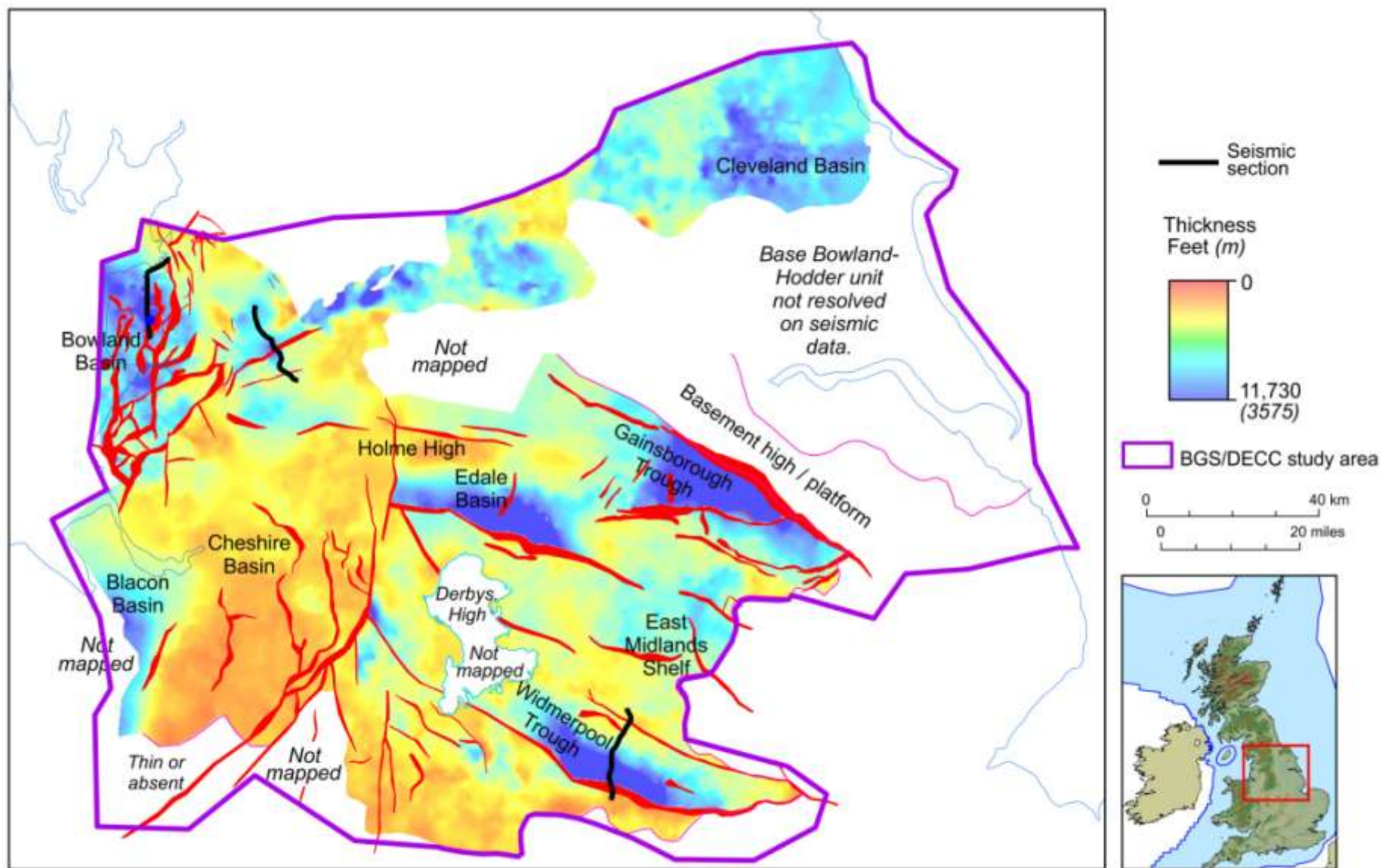
## Major unconventional natural gas resources in Europe





# Where?

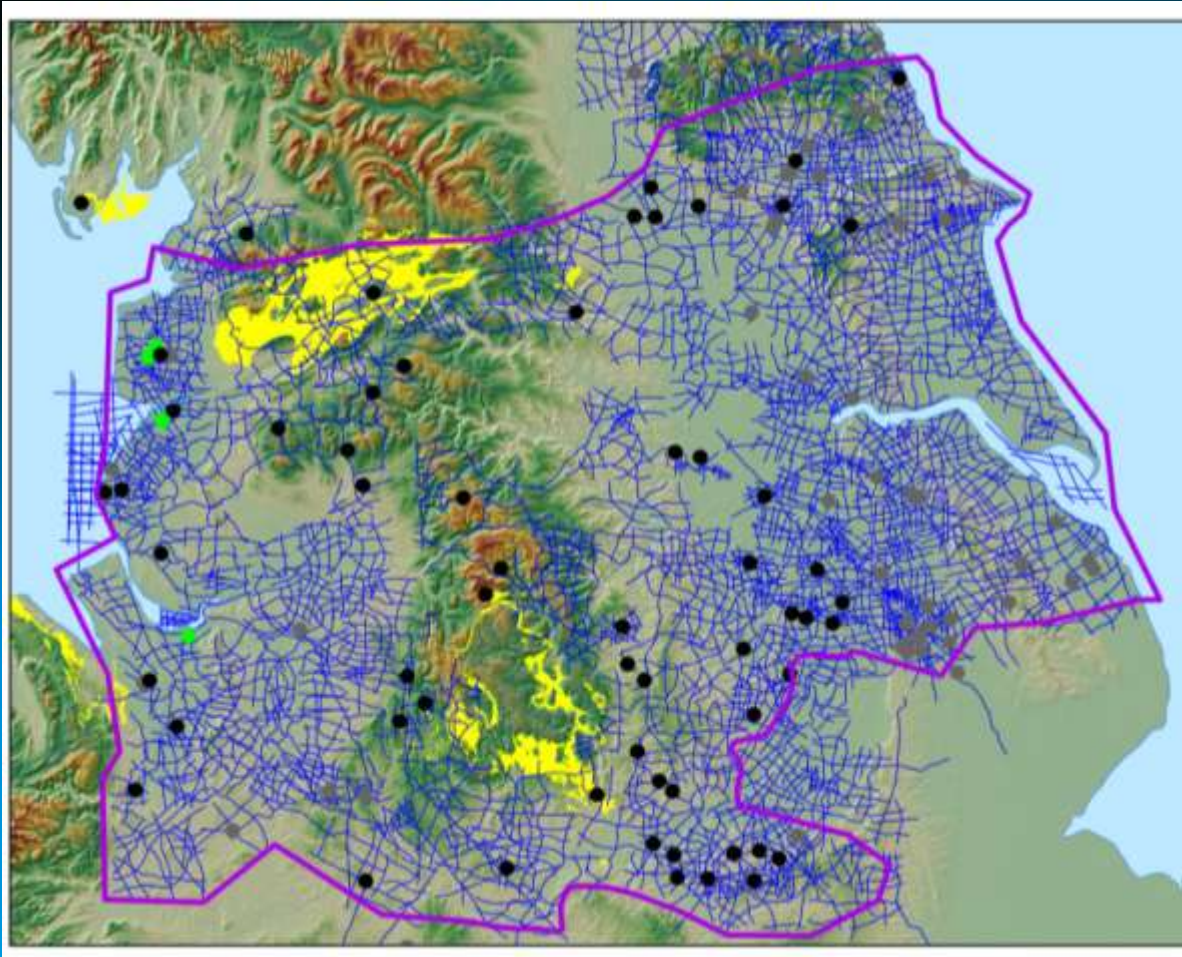




Thickness of the Bowland-Hodder unit



# Very detailed assessment for the North of England



**GIP 1329 tcf (37.7 tcm)**

## Major unconventional natural gas resources in Europe

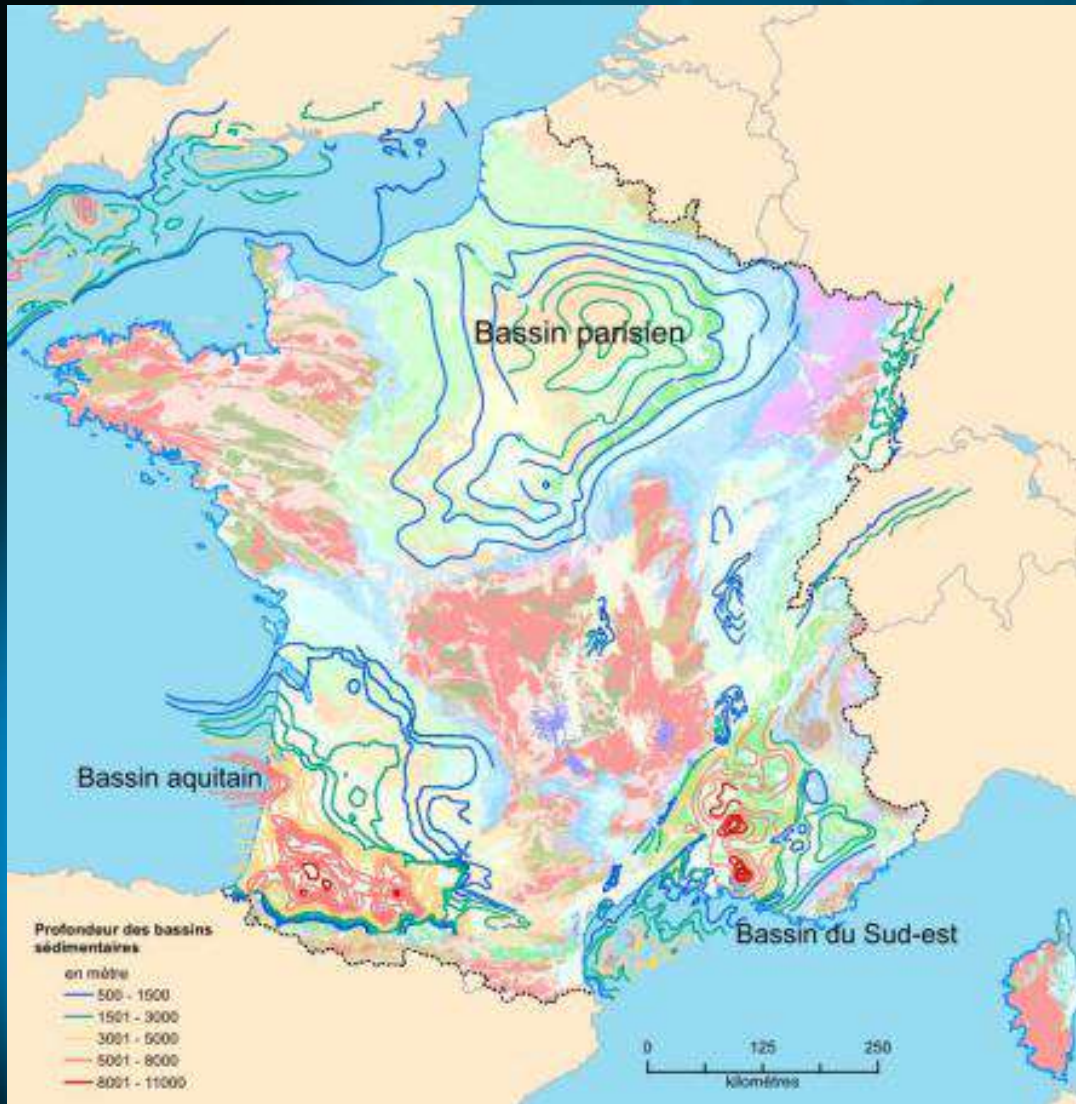
- Shale gas
- Coalbed methane

Currently there is a moratorium  
on Hydro-fracking in France





# Unconventional Hydrocarbons in France



Targets for shale oil  
and gas plays

Geological units

« Schistes cartons

» Toarcien (180 My)

« Terres Noires »

Oxfordien (155 My)

## Recoverable Resource in the Paris Basin

Estimated Ultimate Resource :  
0,03 to 1,28 Bbbl Oil

## Major unconventional natural gas resources in Europe

- Shale gas
- Coalbed methane

EIA GIP 42 Tcf, TRR 8 Tcf



## Major unconventional natural gas resources in Europe





# German Situation - Licences



## Exploration on shale gas

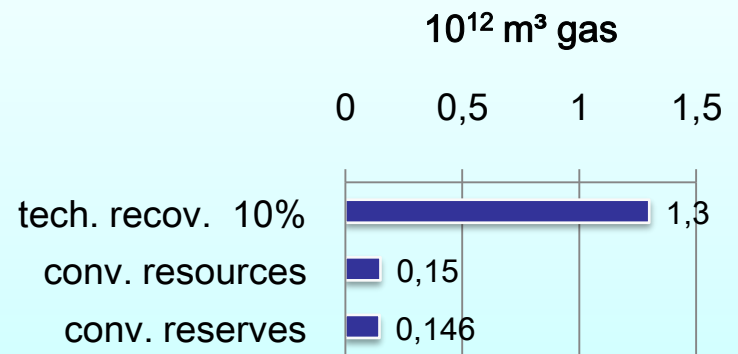
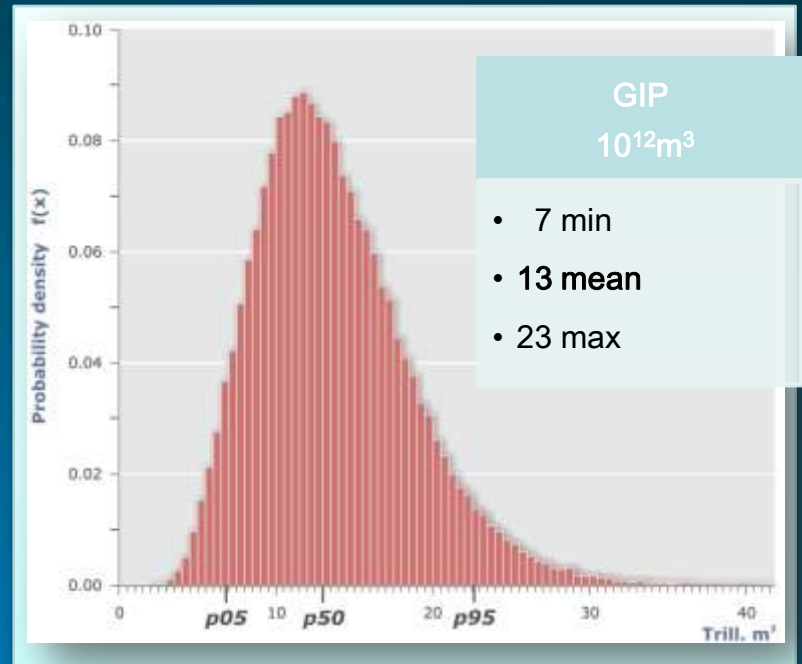
- yellow: granted permits for the **exploration** on hydrocarbons - aiming at unconventional
- green: basins with candidate shale gas formations

## Exploitation of shale gas

- No permits have been granted in Germany for **exploitation of gas from shales**



# German Situation - Shale Gas Potential



## Major unconventional natural gas resources in Europe



The Netherlands

# Netherlands and Shale Gas



## Status on Exploration:

2 exploration licenses granted for shale gas, another 2 pending.

Drilling shale gas exploration wells + awarding new licenses are on hold (MEA, September 2013)

End 2012 MEA decided to base its policy on the outcome of the research on 'Safety of shale gas and CBM Exploration and Production' (conducted by Witteveen & Bos, 2013)

Although conclusions were positive MEA decided (September 2013) that prior to drilling exploration well Environmental Assessment study shall be executed (will take 1-1.5 years)



# Netherlands and Shale Gas



## Potential:

Mapped distribution of prospective shale layers.

Depth cut-off 5km (technical criteria)

Estimations of Technical Recoverable Resources (TRR) still uncertain and currently under review. Shale gas is unproven play in the Netherlands

Current estimations indicate that some **200 – 500 bcm of TRR** may be present

Surface restrictions and notional field development plans are not accounted for.



## Major unconventional natural gas resources in Europe

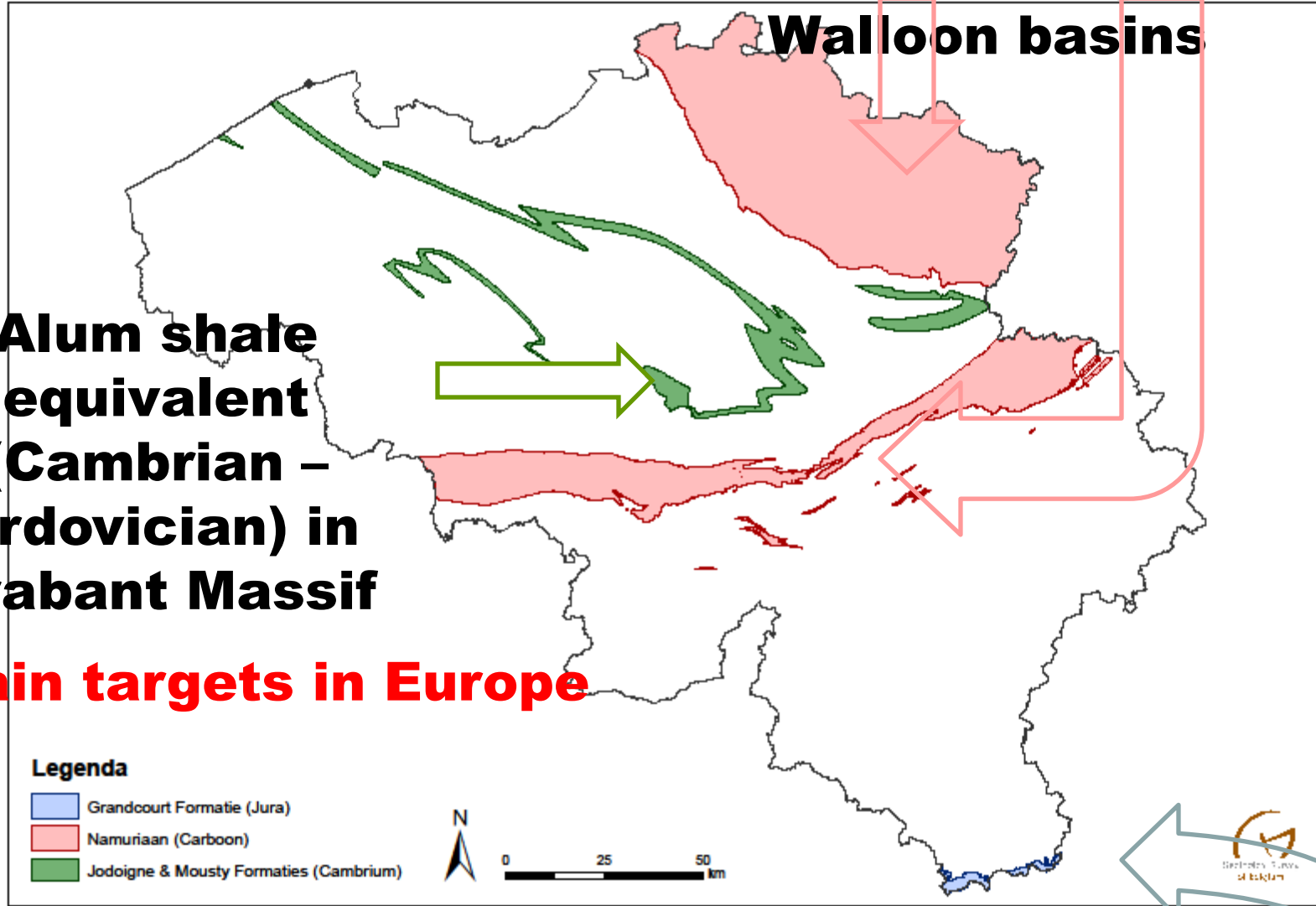


## BLACK SHALES IN BELGIUM

**Namurian in Campine and  
Walloon basins**

**Alum shale  
equivalent  
(Cambrian –  
Ordovician) in  
Brabant Massif**

**main targets in Europe**



**Posidonia (Jurassic) in Paris basin  
(extreme South of Belgium)**

## Major unconventional natural gas resources in Europe

- Shale gas
- Coalbed methane

Ireland

Initial assessments by  
Tamboran - **62 billion cubic  
metres of shale gas** within its  
licence area.

**Currently there is a  
moratorium on further  
development until research  
on environmental impacts  
has been undertaken.**



## Major unconventional natural gas resources in Europe

- Shale gas
- Coalbed methane

From the available scientific knowledge of Italy's geological setting, considering particularly the history of the main basins and consequent geologic conditions, relevant shale gas resources are unlikely to exist in the country.

The Government does not intend to develop projects in sensitive areas offshore or on land; nor does it intend to pursue shale gas extraction.

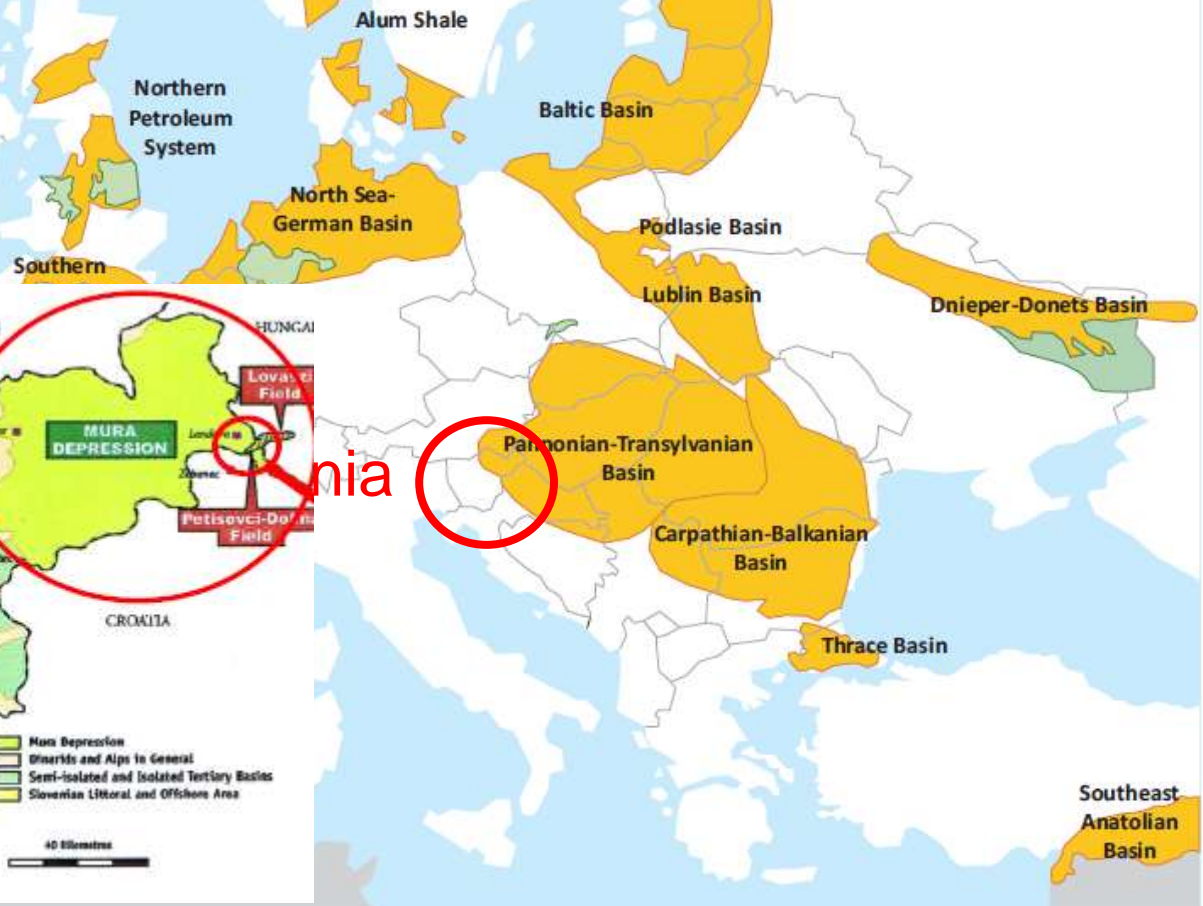




## Major unconventional natural gas resources in Europe

- Shale gas
- Coalbed methane

Deep shales as a gas potential in the Mura-Zala Basin (Pannonian Basin System)  
 $R_o > 0.9$



### Location Map of the Mura Depression



## Major unconventional natural gas resources in Europe

- Shale gas
- Coalbed methane

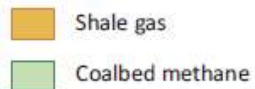
In Greece there are low probabilities to find considerable shale gas resources.

Any case, the areas most probable to host shale gasses are:

1. The Thraki - Limnos area
2. The Kavala - Prinos area
3. The Axios - Thermaikos area
4. South Greece mainland area
5. The Meso-Hellenic through (Grevena) area

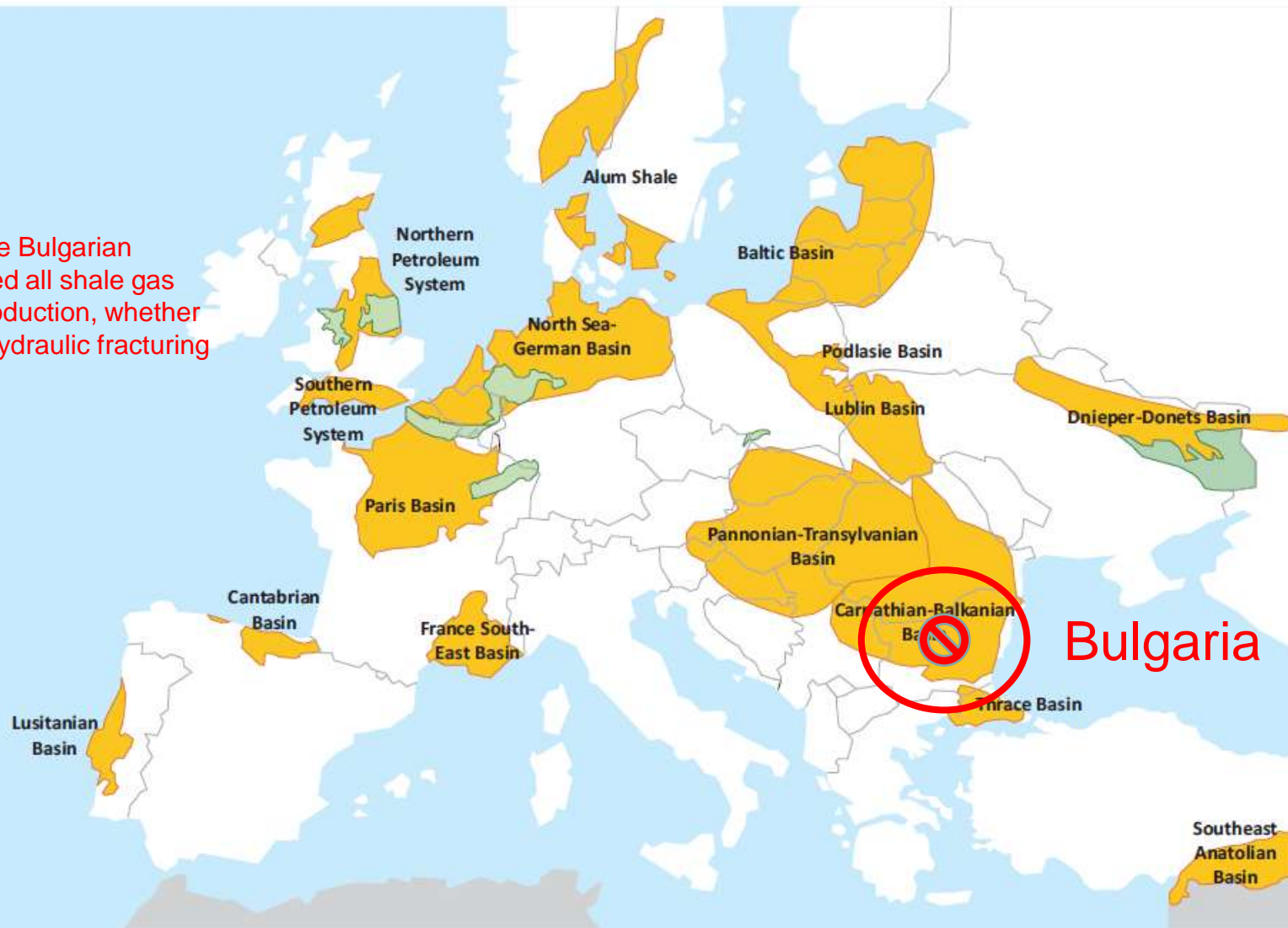


## Major unconventional natural gas resources in Europe



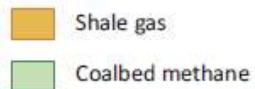
EIA TRR 17 Tcf

In January 2012 the Bulgarian Government banned all shale gas exploration and production, whether or not it involves hydraulic fracturing





## Major unconventional natural gas resources in Europe



EIA TRR 51 Tcf

In May 2012 the Romanian Government began an informal ban on shale gas exploration activities, pending the outcome of EU-level studies on HSE aspects of shale gas development



## Major unconventional natural gas resources in Europe

- Shale gas
- Coalbed methane

EIA TRR 128 Tcf



## Major unconventional natural gas resources in Europe

- Shale gas
- Coalbed methane

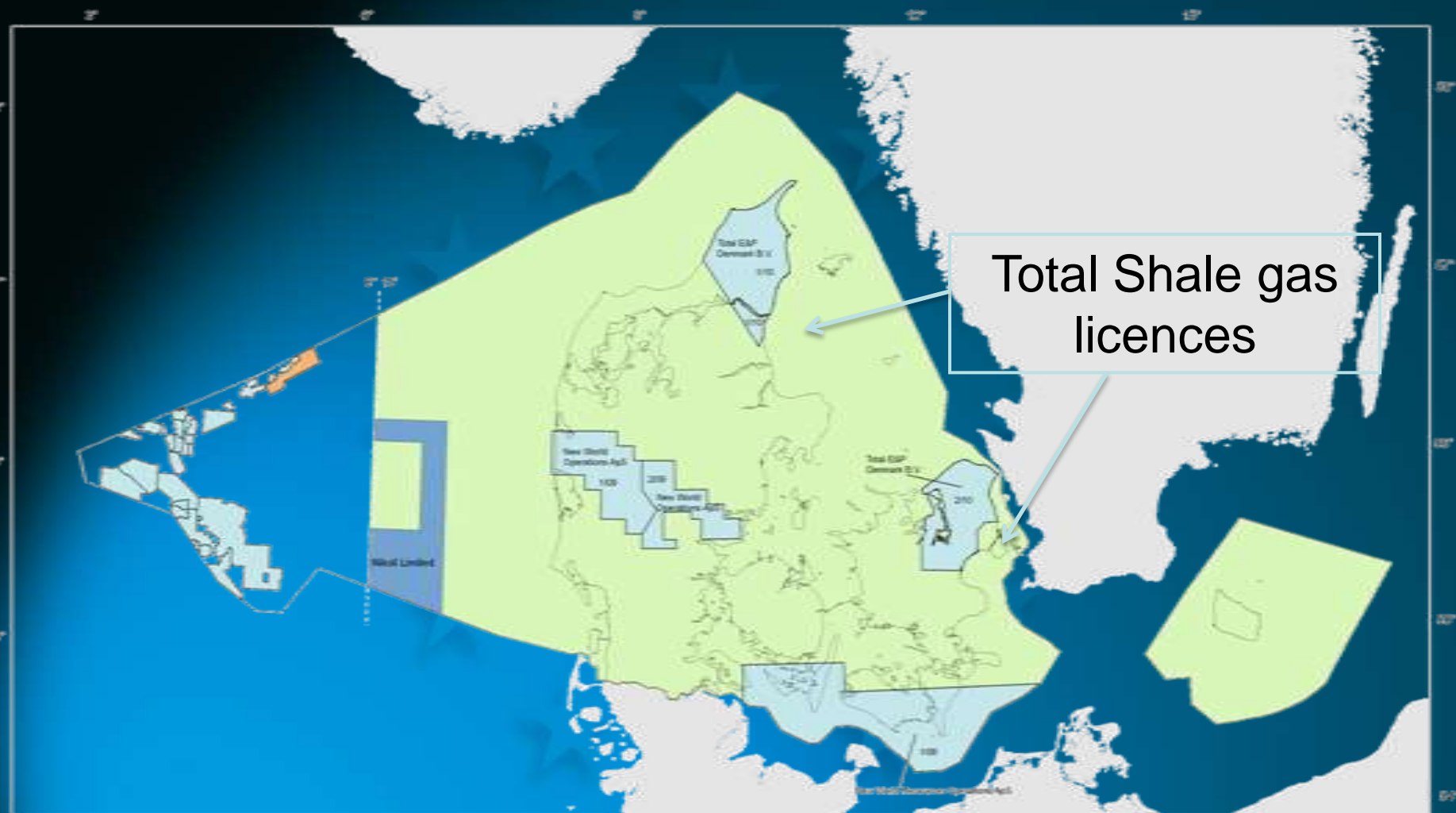
EIA GIP 159 Tcf, TRR 32 Tcf

USGS TRR estimate to be announced 3<sup>rd</sup> December 2013





## Danish licence area - April 2013



Licences awarded 1992-2010

Licences awarded in 2012

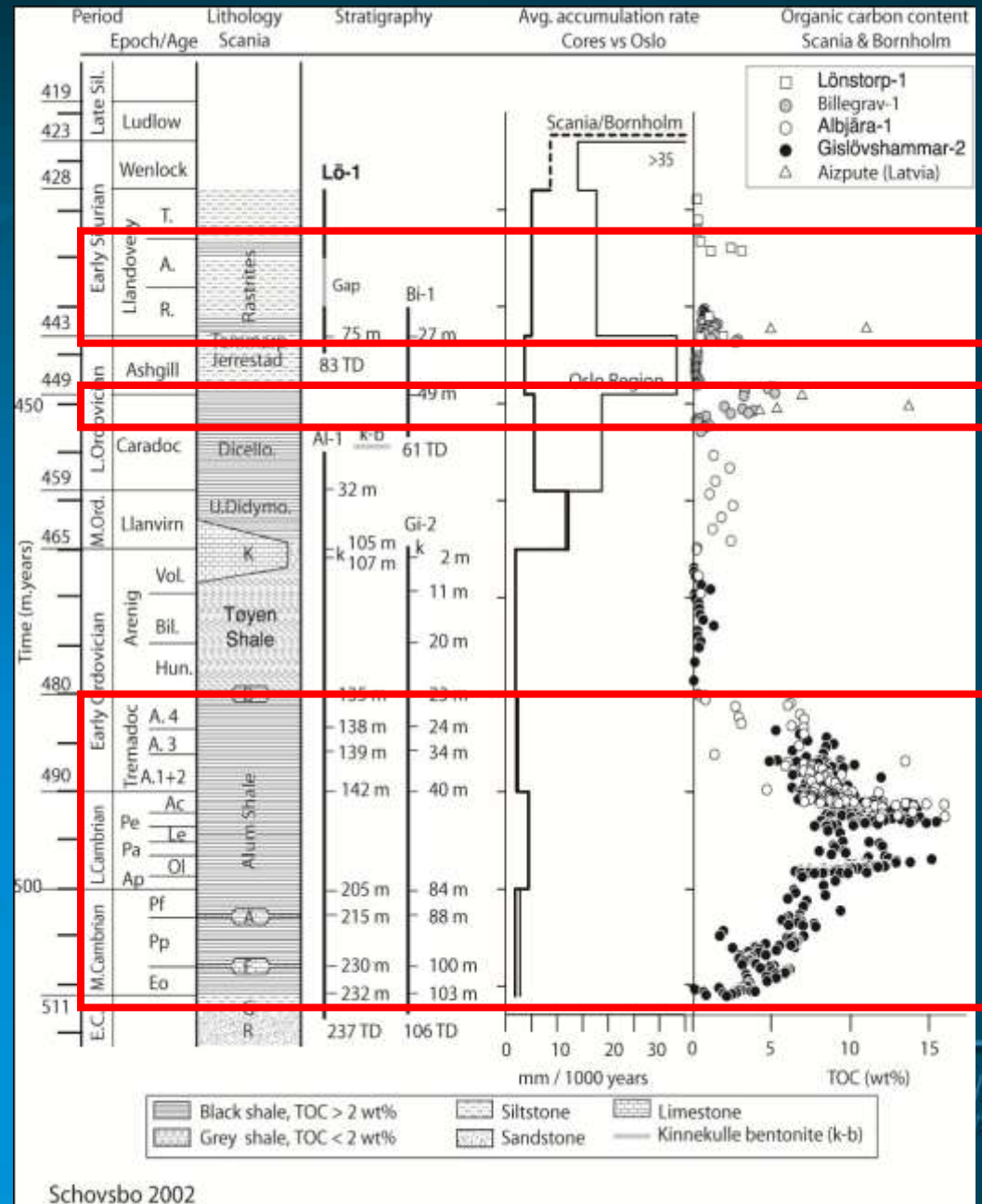
Licence application

Open areas

European  
The Geological Surveys  
of Europe

# Paleozoic Black Shales

- Cambrian-Ordovician Alum Shale
- Upper Ordovician Dicellograptus Shale
- Lower Silurian Rastrites Shale
- Ashgill, Caradoc, and Llandovery are also found onshore in Poland
- Alum Shale is by far the richest in  $C_{org}$

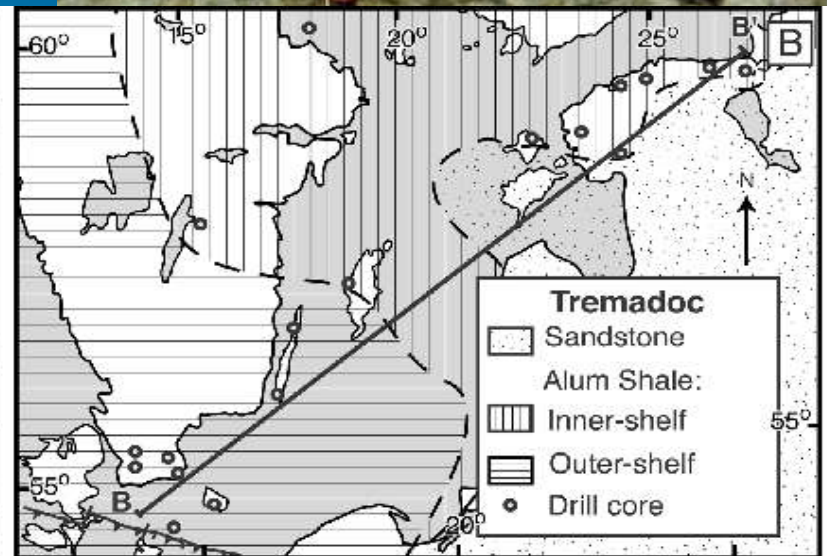
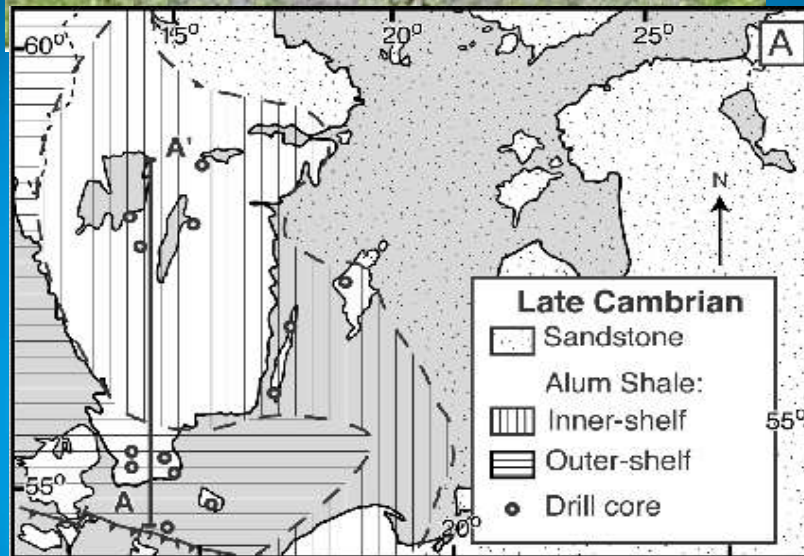


# Principal Alum Facies

“Outer shelf”:  
low limestone/shale ratio

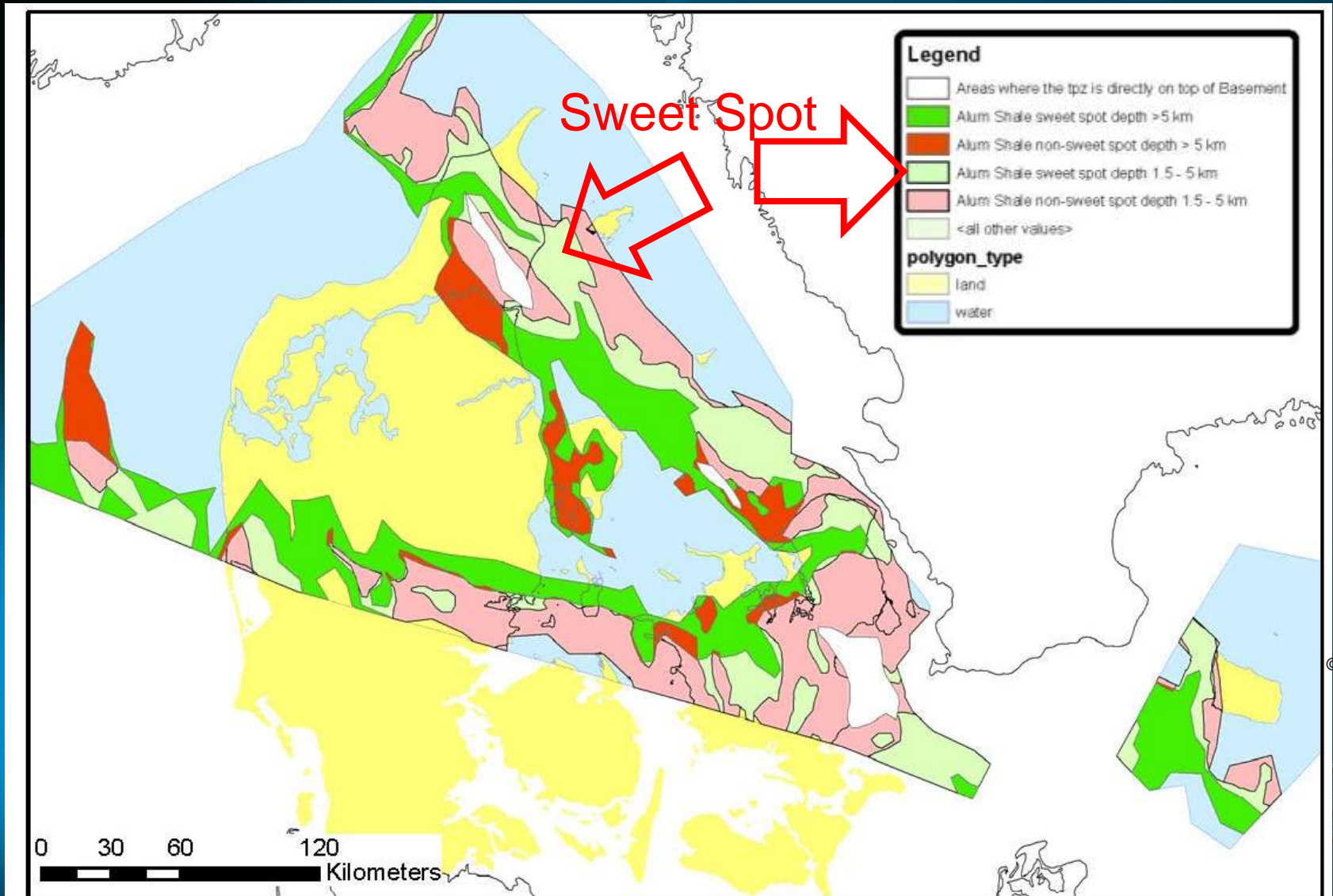


“Inner shelf”:  
high limestone/shale ratio

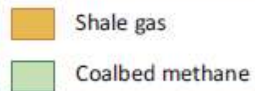




# Proposed assessment units



## Major unconventional natural gas resources in Europe



EIA GIP 49 Tcf, TRR 10 Tcf

Limited areas with deep enough lying potential shale gas targets.

Shell performed during 2009 and 2012 shale gas investigations in Scania, including three deep core drillings. No positive results were reported and the concession was abandoned, partly due to great public opposition.

A few smaller concessions are active regarding biogenic gas in the shallow lying immature Alum Shale



## Major unconventional natural gas resources in Europe

- Shale gas
- Coalbed methane

EIA 2011: TTR 82 Tcf

EIA 2013: TTR 0 Tcf

NPD: 0 Tcf.





## Major unconventional natural gas resources in Europe

- Shale gas
- Coalbed methane

EIA TTR 0.4 Tcf shale gas  
& 0.3 B bbl shale oil

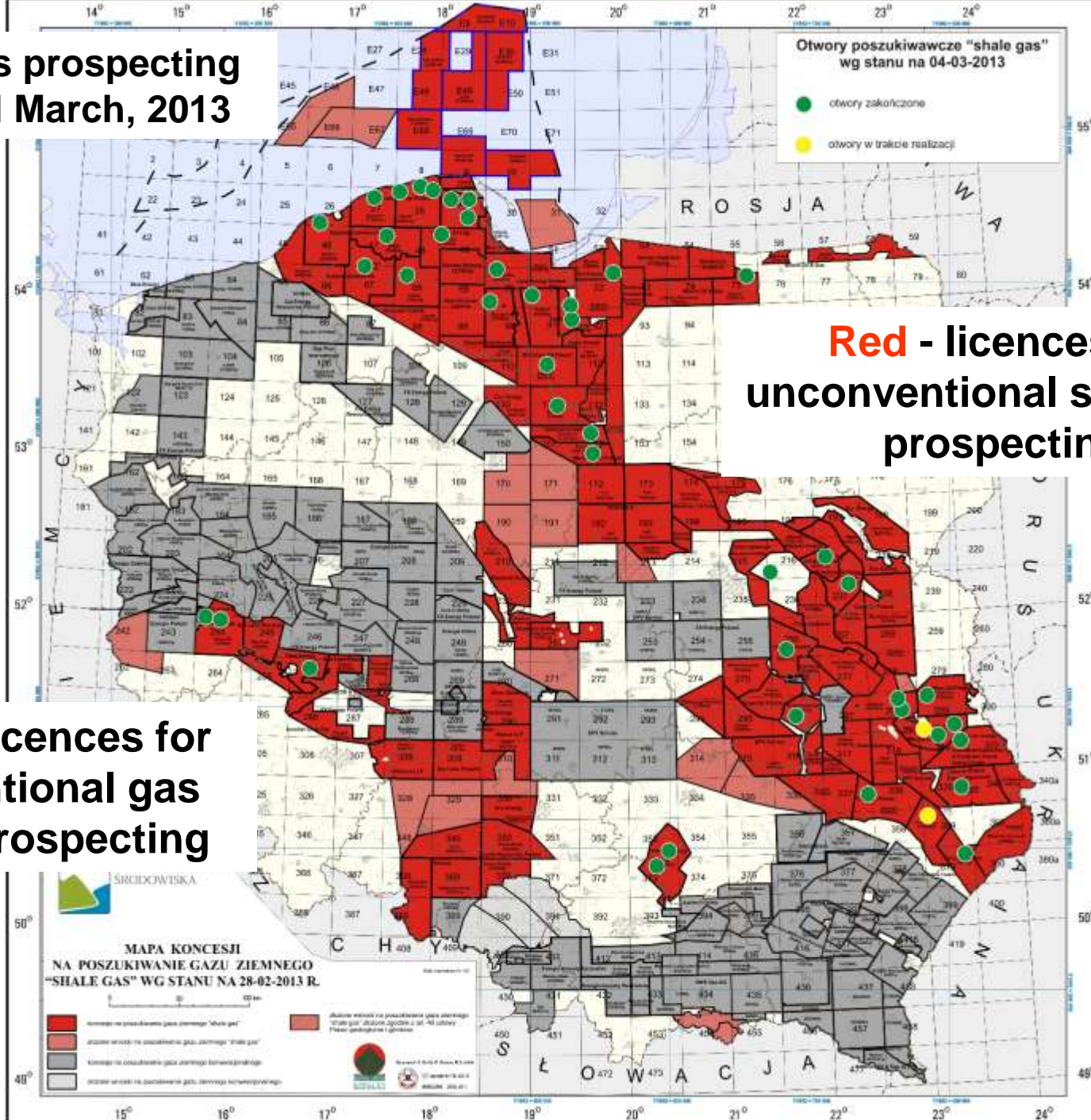


## Major unconventional natural gas resources in Europe





# Shale gas prospecting wells, till March, 2013



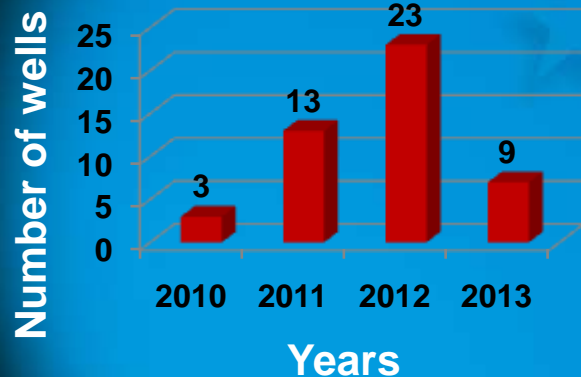


**Table of shale gas well drilled to date (02.10.2013)**

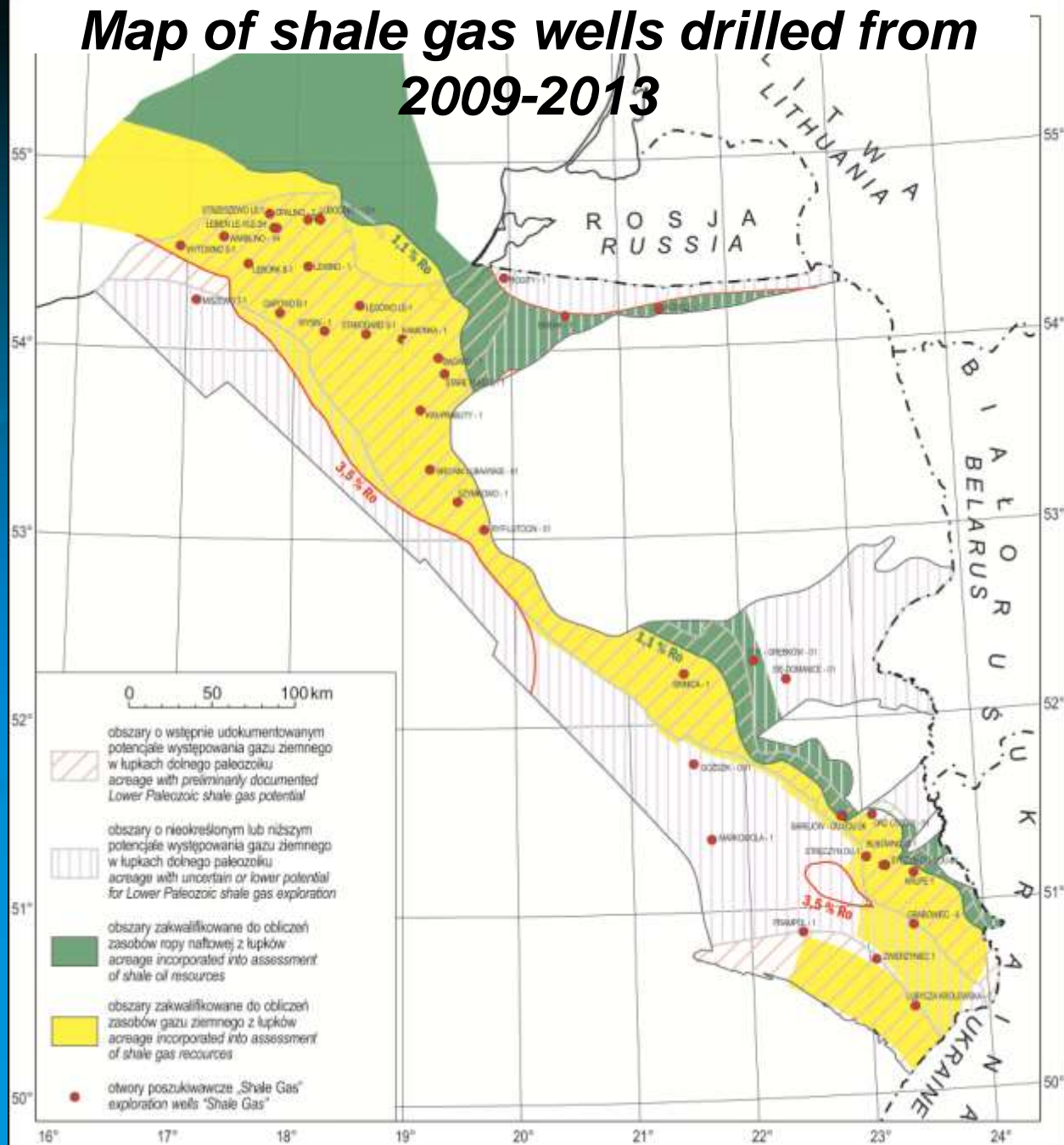
**(source: Ministry of Environment)**

	Vertical wells	Horizontal wells	Sum
Full frac job	13	7	20
Micro frac job / DFIT*	3	0	3
Without frac job	21	4	25
Sum	37	11	48

\*DFIT – Diagnostic Fracture injection Test



# Map of shale gas wells drilled from 2009-2013

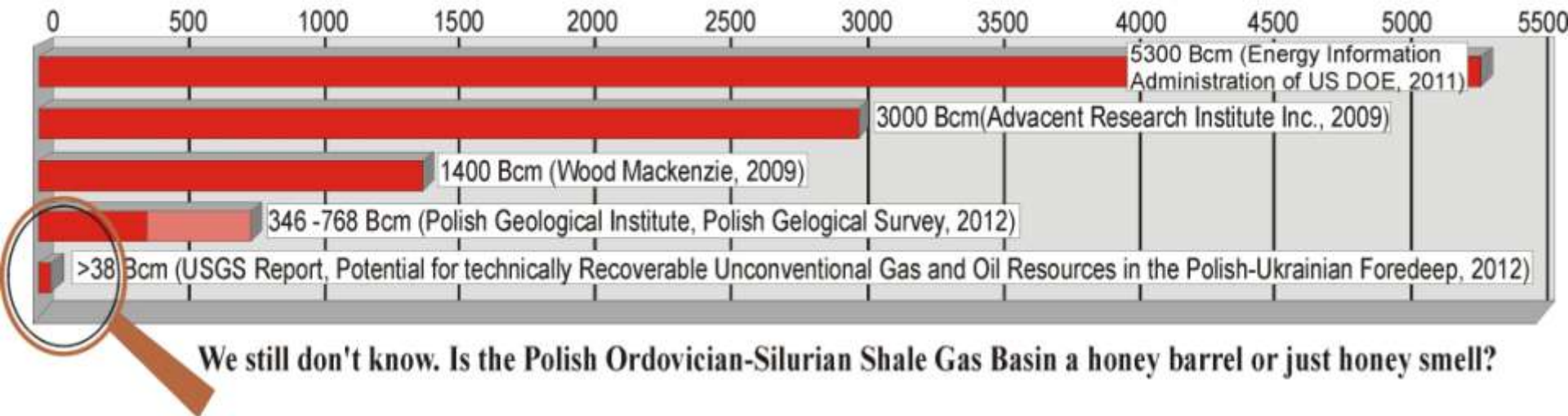


**Dyrka & Janas, PGI, 2013**

# How great are unconventional gas resources in Poland?

No reliable estimate of the resources exists yet...

## SHALE GAS RECOVERABLE RESOURCES



## SHALE GAS

Shale gas recoverable resources of the **onshore and offshore** Ordovician – Silurian Baltic – Podlasie – Lublin Basin

Basin is estimated for maximum: **1920 Bcm (1.92 Tcm)**. Taking into account constraints on key parameters of the calculations, the higher probability range of **recoverable shale gas resources are: 346 - 768 Bcm**

Source: ASSESSMENT OF SHALE GAS AND SHALE OIL RESOURCES OF THE LOWER PALEOZOIC BALTIC-PODLASIE-LUBLIN BASIN IN POLAND. First Report by P. Poprawa, 2011



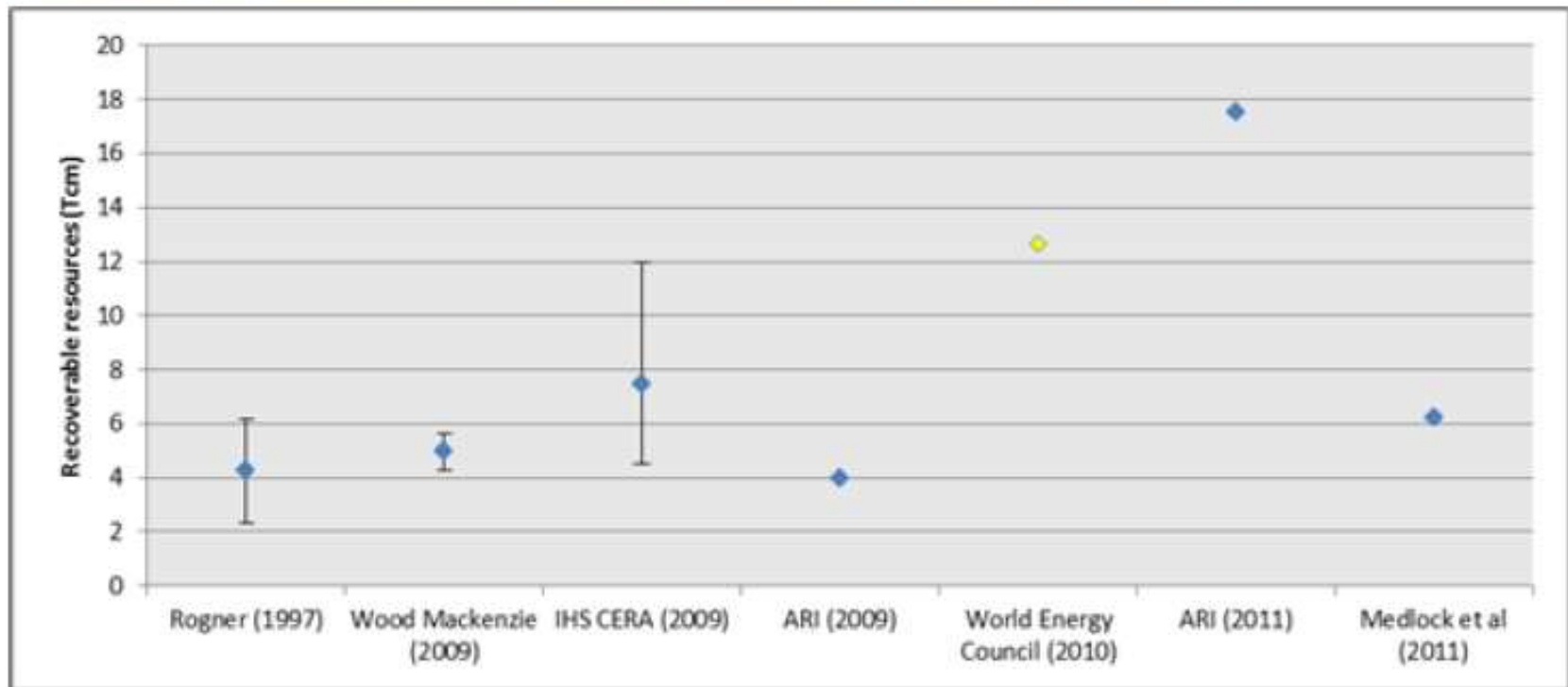
Państwowy Instytut Geologiczny  
Państwowy Instytut Badawczy

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

# Need for coordinated Pan-European assessment

## Potential in Europe

Estimates of technically recoverable shale gas resources in Europe



- Economically recoverable potential unclear  
→ More explorations needed



# Pan-European Assessment

- There is no reliable assessment on the European shale gas resources.
- EU is interested in a reliable assessment of Europe's unconventional oil and gas resources.
- Many geological surveys have made their own domestic assessments, but they are not comparable between countries.
- **The overall goal with a pan-European assessment study is to get an independent, scientific based, coherent assessment of the shale gas resources.**

# Pan-European Assessment cont.

- Pan-European assessment on a basin by basin approach
- The European geological surveys has the data and knowledge on the specific shale stratigraphy, sedimentology, petrography etc.
- By combining the knowledge from each survey into a basin wide synthesis, knowledge is shared and the end product improved.

# Pan-European Assessment cont.

- Many surveys have build up methodologies to estimate the shale gas resources.
  - USGS – TRR
  - BGR – GIP
  - PGI – GIP, TRR
- Pilot study of gas potential of the Lower Paleozoic Shales in the Baltic Basin
- It is hoped that the pilot will develop into a study, that covers the entire Europe, financed by the Horizon 2020.



# Pan-European assessment Basin by Basin

Major unconventional natural gas resources in Europe



# Acknowledgement



# EGS GeoEnergy Expert Group (EGS GEEG)

## Thank you for your attention

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