



G Ł Ó W N Y  
I N S T Y T U T  
G Ó R N I C T W A

## CCUS IN REGION WHICH IS TRADITIONALLY ASSOCIATED WITH COAL MINING AND HEAVY INDUSTRY

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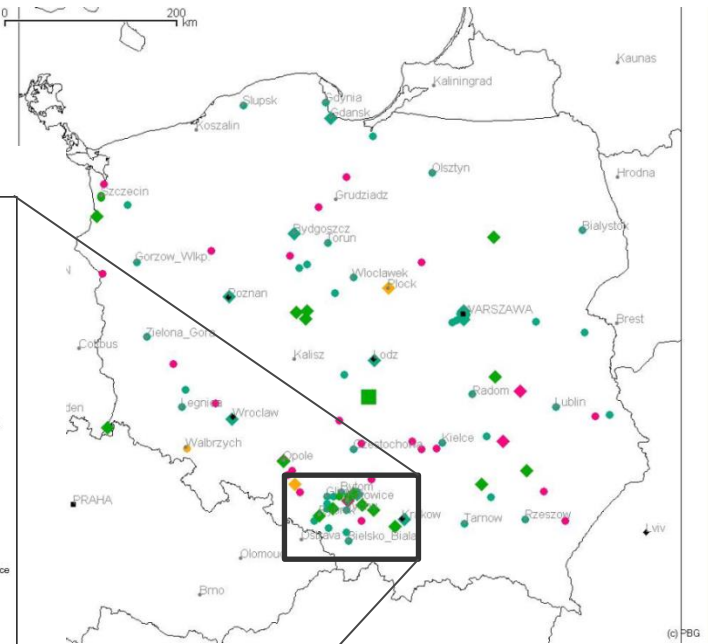
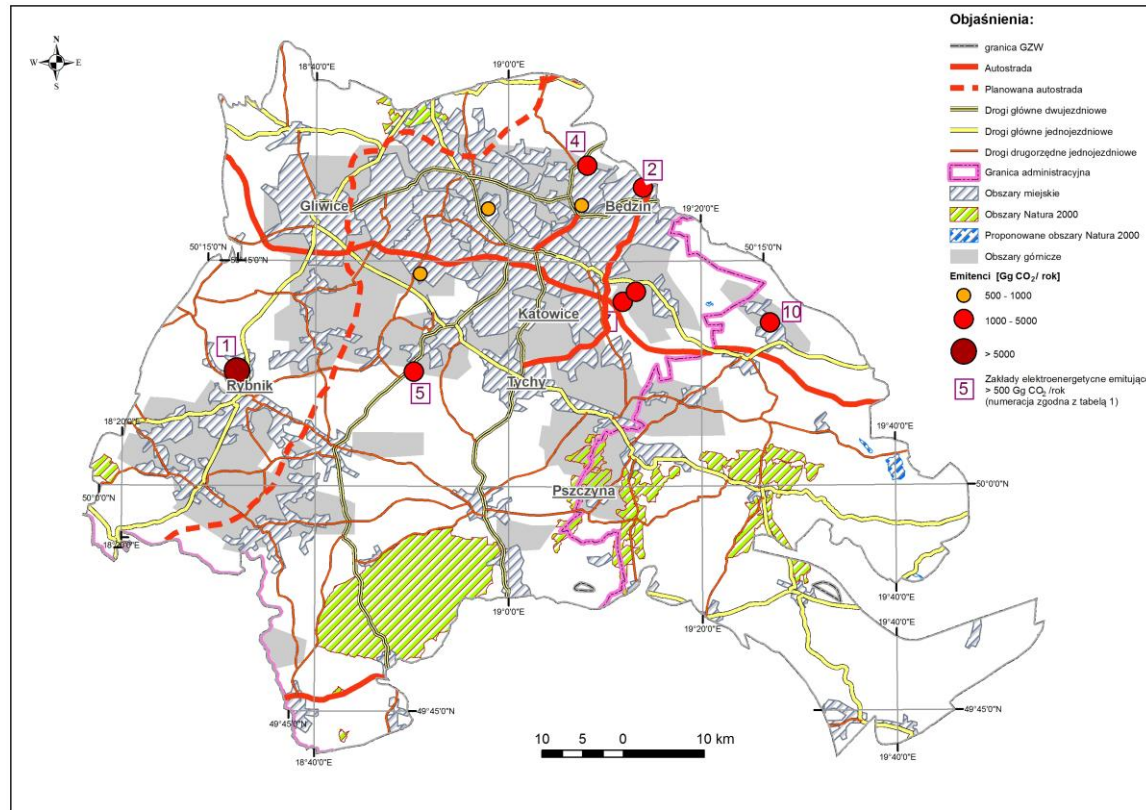
**Laboratory of Deposit Geology and CO<sub>2</sub> Storage**

*Katowice, 23<sup>rd</sup> of January 2019*

# PRESENTATION OUTLINE

1. Upper Silesia region - CO<sub>2</sub> *emission sources*
2. Polish experiences in CCS – examples & main projects
3. Upper Silesia region - *Results of the main projects: Storage possibilities & capacity*
4. Pilot plants of CO<sub>2</sub> capture and utilization

# UPPER SILESIA REGION – CO<sub>2</sub> EMISSION SOURCES



Upper Silesia region is most industrialized region in Poland, where there is strong mining industry (18 coal mines) and strong power sector (about 7 GW of total power capacity).

They focus around or in the area of the largest urban agglomerations, and therefore mainly in the northern part of the Upper Silesian Coal Basin.

# UPPER SILESIA REGION – CO<sub>2</sub> EMISSION SOURCES

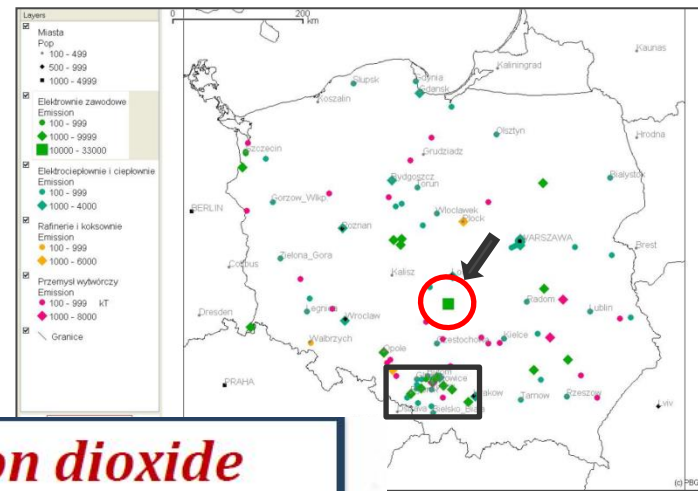
Sources of emissions in the region of Silesia are presented on the basis of ten largest electric power plants in terms of CO<sub>2</sub> emissions.

No.	Name of Powerstation	Emission [million tonnes CO <sub>2</sub> /year]
1.	Elektrownia Rybnik S.A.	~6,5
2.	Elektrociepłownia EC Nowa Sp. z o. o.	1 - 5
3.	Elektrownia Halemba	
4.	Elektrownia Łagisza	
5.	Elektrownia Łaziska	
6.	Elektrownia Jaworzno II	
7.	Elektrownia Jaworzno III	0,5 - 1
8.	Elektrociepłownia Będzin S.A.	
9.	Elektrownia Chorzów S.A.	
10.	Elektrownia Siersza	
The Bełchatów Power Station:		~37.6 million tonnes CO <sub>2</sub> /year

# POLISH EXPERIENCES IN CCS

## – MAINPROJECTS:

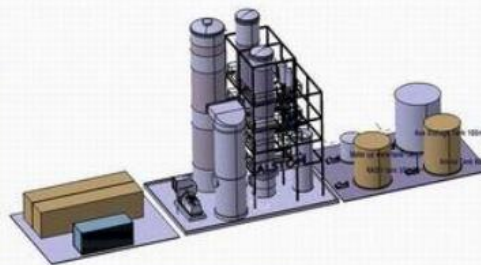
The Bełchatów Power Station is the world's largest lignite-fired power station (nominal power of 5,472 MW) and the largest emitter of carbon dioxide in Poland



- ***Bełchatów, Demonstration plant for carbon dioxide capture, transport and storage (CCS) – co-financed by EU (180 mln euro), lignite power plant: 858 MW, Storage in Saline Aquifer***



Co-financed by the European Union  
European Energy Programme for Recovery



*Visualization of the pilot plant, planned for installation on the block No. 12*



In the beginning of 2013 a decision was made to close the project because of problems with assurance of funding, legal risks, public acceptance and technological risks.

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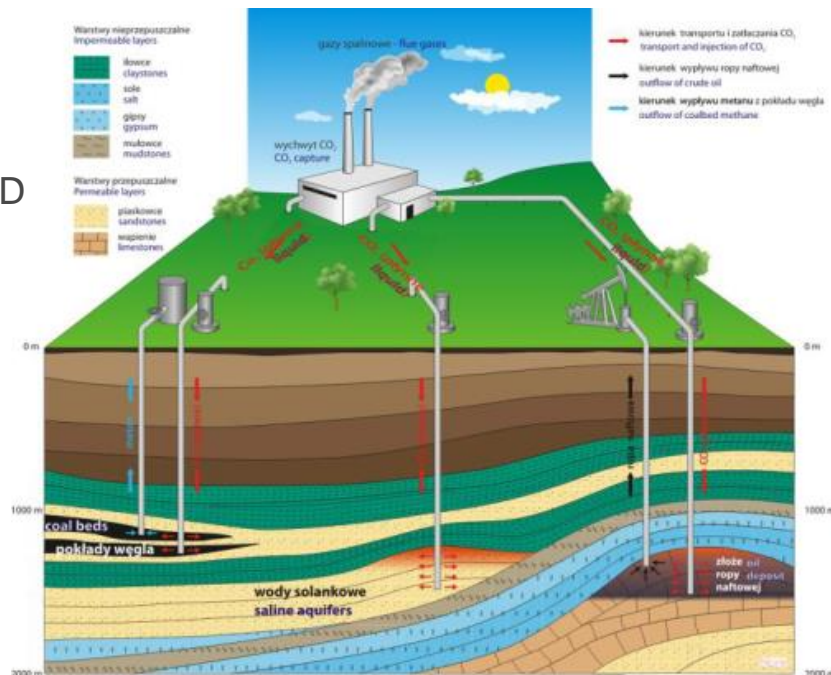


# POLISH EXPERIENCES IN CCS

## RESEARCH ON POTENTIAL OF CO<sub>2</sub> STORAGE IN POLAND

### – EXAMPLES:

1. **Borzęcin gas field, 1995 – An industrial installation for capturing and depositing acid gases (CO<sub>2</sub>, H<sub>2</sub>S)**
2. **RECOPOL (Kaniów), 2001-2005 – coordinator: TNO, GIG – Reduction of CO<sub>2</sub> emission by means of CO<sub>2</sub> storage in coal seams in the silesian coal basin of Poland (~700 tonnes CO<sub>2</sub> injected into coal seams)**
3. **MOVECBM, 2006-2008 - coordinator: TNO, GIG, *Monitoring and verification of CO<sub>2</sub> storage and ECBM in Poland***
4. **Ponętów, 2004 – University of Science and Technology AGH – Tests of CO<sub>2</sub> storage in saline aquifers**
5. **Jastrząbka Stara – oil field , 2005-2006, *Design and installation work for the geological sequestration of CO<sub>2</sub> on a small oil field***
6. **CO<sub>2</sub>SINK, 2004 - coordinator: GFZ Potsdam, *Developing the basis of CO<sub>2</sub> storage technique by injection of CO<sub>2</sub> into a saline aquifer underneath the city of Ketzin near Berlin (~60000 tonnes CO<sub>2</sub> injected into saline aquifers)***
7. **CASTOR WP1.2, 2004-2006 – coordinator WP1.2: GEUS, *Capture and sequestration of CO<sub>2</sub> associated with cleaner fossil fuel plants***
8. **EU GeoCapacity, 2006-2008, IGSMiE PAN i PBG, coordinator: GEUS, *Assessing European Capacity for Geological Storage of Carbon Dioxide***
9. **CO<sub>2</sub>NET EAST , 2006-2009 - *Carbon Dioxide Knowledge Transfer Network - CO<sub>2</sub> capture and storage networking extension to new member states***
10. **CO<sub>2</sub> ReMoVe (Research, Monitoring, Verification), 2006-2011, coordinator: TNO, IGSMiE PAN - *Monitoring and Verification of CO<sub>2</sub> Geological Storage, Development of a CO<sub>2</sub> leakage biomonitoring methods***



# POLISH EXPERIENCES IN CCS

## – MAIN PROJECTS:

Conducted by:  
Central Mining Institute

- *“Study for the safe storage of carbon dioxide on the example of the Silesian agglomeration”*, under a project of the Minister of Science and Higher Education “Technology Initiative I”

**Timeframe:**  
**2007 – 2011**

### PHASE A ( 2007-2010)

1. Study of potential of CO<sub>2</sub> storage capacity
2. Modeling of underground saline storage complex.
3. Recommended guidelines for the proper infrastructure for transport and injection of CO<sub>2</sub>
4. Developing a surface monitoring system for CO<sub>2</sub> storage in saline formations
5. Comprehensive safety analysis/ risk assessment

### PHASE B (2010- 2011)

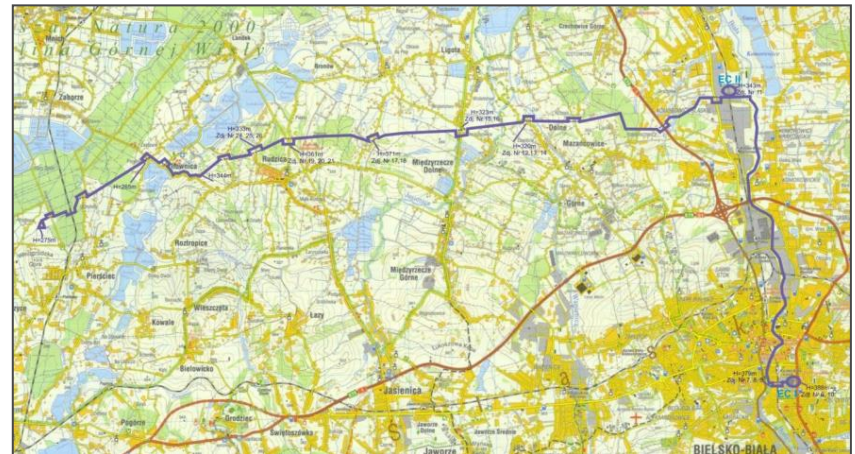
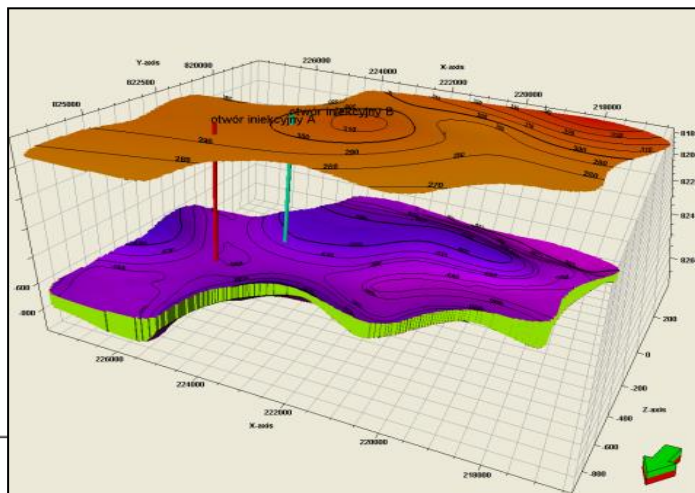
1. Pre-documentation of the installation process for geological CO<sub>2</sub> storage

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# CCS – MOST IMPORTANT PROBLEMS FOR SAFETY STORAGE

Based on the results from the “*Study for the safe storage of carbon dioxide on the example of the Silesian agglomeration*”

- localization in the Upper Silesia region: with an urbanization about 78%
- proximity to mining areas
- hazard identification – old, abandoned wells
- occurrence of protected areas:
  - a network of protected areas – the Natura 2000,
  - artificial water reservoir - Goczałkowice Reservoir,
  - therapeutic peat and water,
  - natural gas fields



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# POLISH EXPERIENCES IN CCS

– MAIN PROJECTS:

***“Assessment of formations and structures for safe CO<sub>2</sub> geological storage, including monitoring plans.”***

National Fund project in consortium PGI-NRI, AGH University of Science and Technology, Oil and Gas Institute - NRI, Central Mining Institute, PBG Geophysical Exploration Ltd.

**Conducted by:**



- ***Assessment of formations and structures for safe CO<sub>2</sub> geological storage, including monitoring plans”***

*National Program*

**Timeframe:**

**10.2008 – 09.2012**

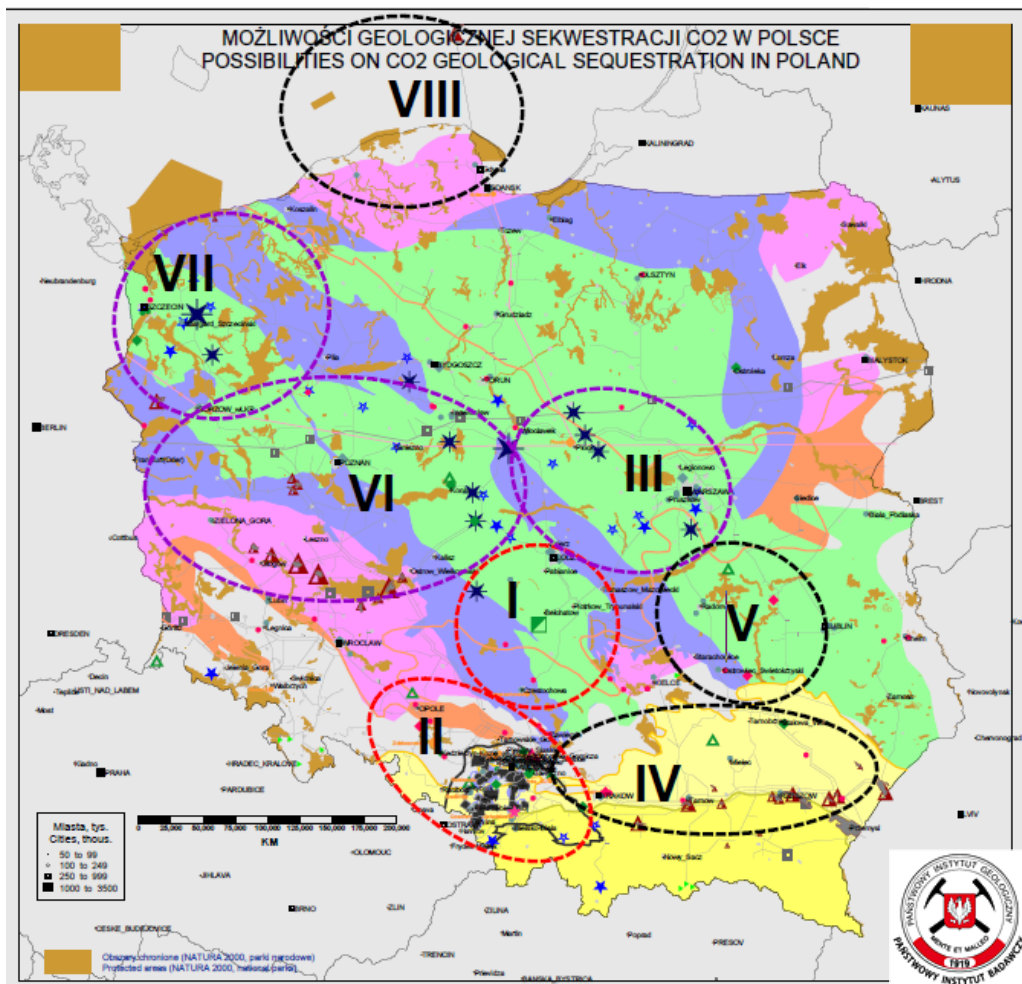
**Ordered by: Polish Ministry of the Environment  
National Fund for Environmental Protection and Water Management**



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# POLISH EXPERIENCES IN CCS – MAINPROJECTS:

*Assessment of formations and structures for safe CO<sub>2</sub> geological storage, including monitoring plans”*



It covers entire territory of Poland and the Baltic economic zone, but is focused on\*:

- regional studies for 8 areas with saline aquifers,
- hydrocarbon fields and coal beds in general,
- case studies for saline aquifer structures (4),
- case studies for hydrocarbon fields (2) and coal beds (1).

reinterpretation of archive data, laboratory analyzes

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Over 90% of these structures are located onshore

# POLISH EXPERIENCES IN CCS – MAIN PROJECTS:

*Assessment of formations and structures for safe CO<sub>2</sub> geological storage, including monitoring plans”*

## *Results:*

The estimated capacity of structures for the geological storage of CO<sub>2</sub> is

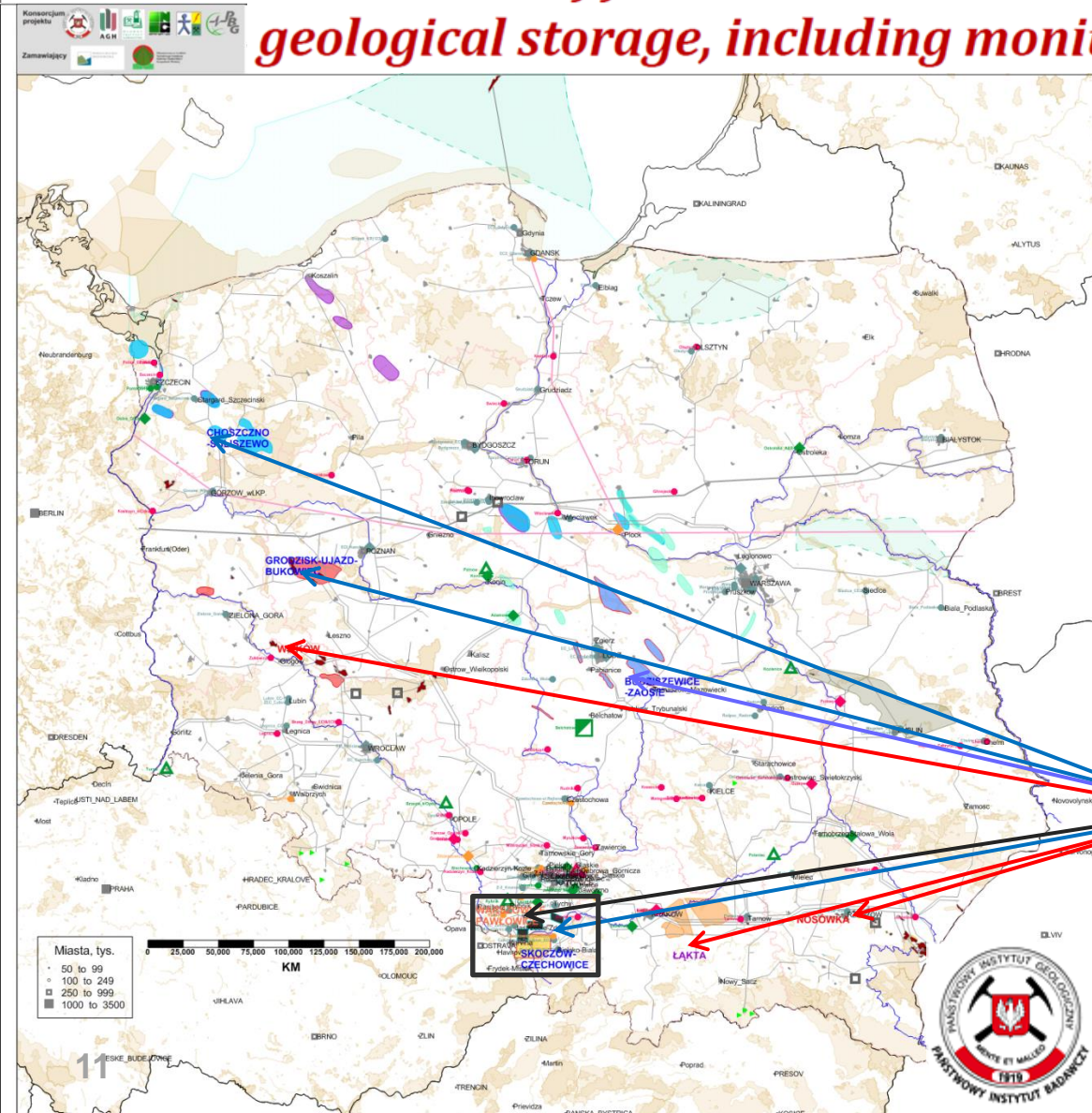
**10-15 billion tonnes CO<sub>2</sub>,**

of which:

- 90-93% - saline aquifers,
- 7-10% hydrocarbon deposits,
- <<1% coal seams.

*Detailed analysis for:*  
**saline aquifers,**  
**hydrocarbon deposits**  
**and coal seams (ECBM)**

Source: PIG





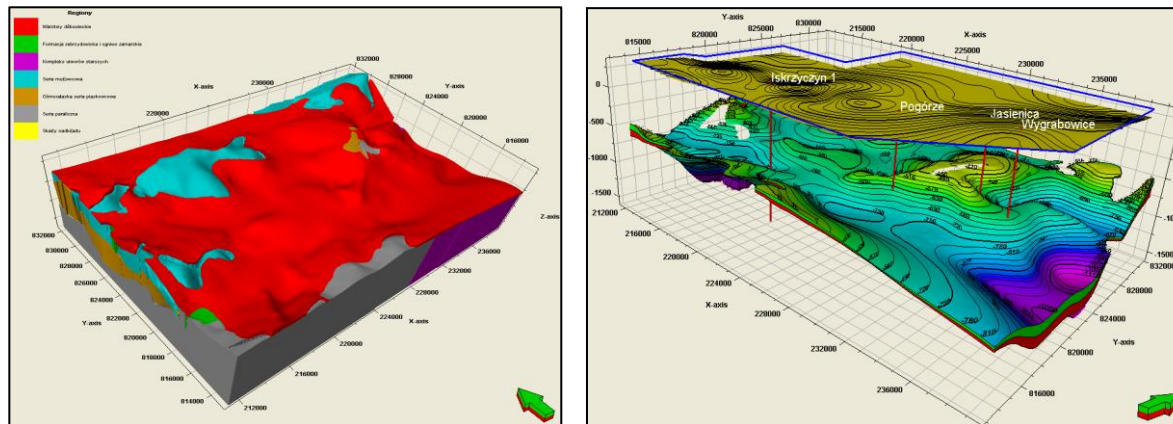
## POLISH EXPERIENCES IN CCS – MAINPROJECTS:

### *Assessment of formations and structures for safe CO<sub>2</sub> geological storage, including monitoring plans”*

In the area of Upper Silesia Coal Basin due to land development, active hard coal mines and environmental elements subject to protection (Natura 2000 sites), three areas associated with aquifers were selected: **the Cracow Sandstone Series aquifer, the Upper-Silesian Sandstone Series aquifer and the Dębowiec Beds aquifer.**

The Dębowiec formation appears to be the most prospective for potential storage of CO<sub>2</sub> out of the three analysed reservoirs. This region is characterized by the most favourable geological and hydrogeological parameters.

### *Numerical model in the Dębowiec Beds aquifer*



Estimated capacity of saline aquifer allows to storage about 44 million tons of CO<sub>2</sub>

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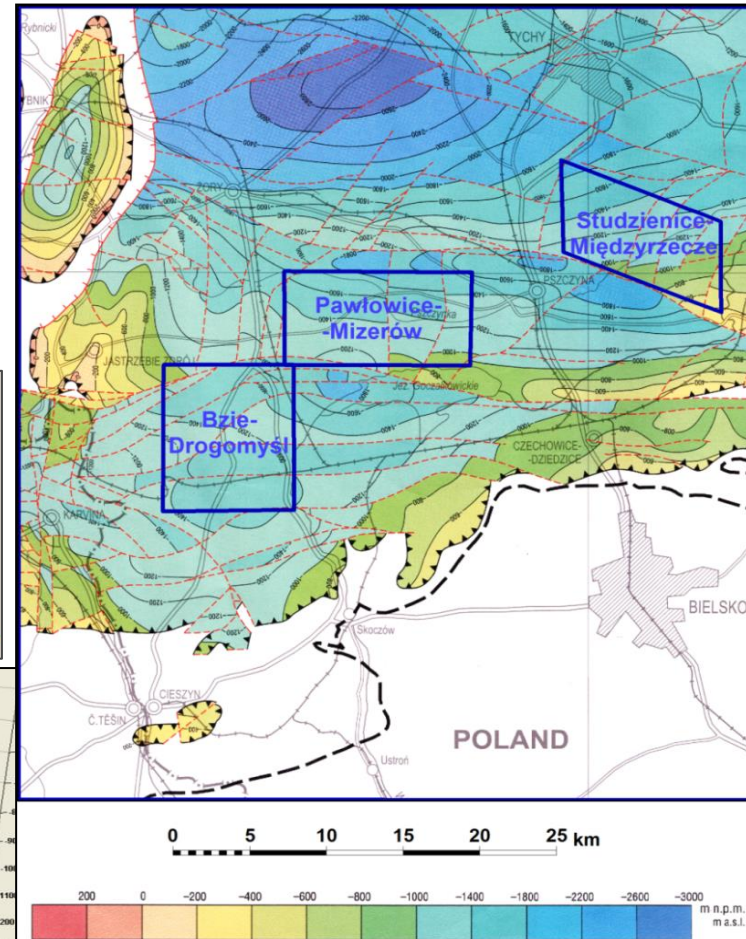
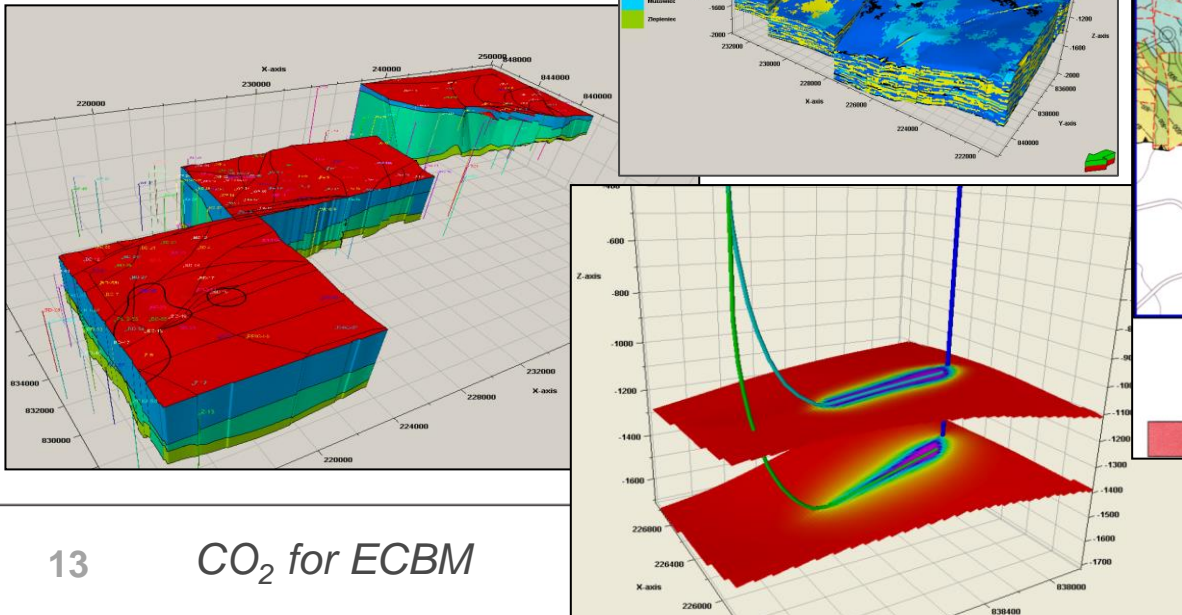
# POLISH EXPERIENCES IN CCS – MAINPROJECTS:

## *Assessment of formations and structures for safe CO<sub>2</sub> geological storage, including monitoring plans*

Deep coal seams with absorbed methane, which can be captured and economically used, and CO<sub>2</sub> can be injected in place of CH<sub>4</sub> (ECBM).

Three potential research areas were identified in the Upper Silesia Coal Basin with similar areas of 55-75 km<sup>2</sup>, which were analyzed to a depth of 2000 m in the area of coal-bearing capacity and methane content of coal seams.

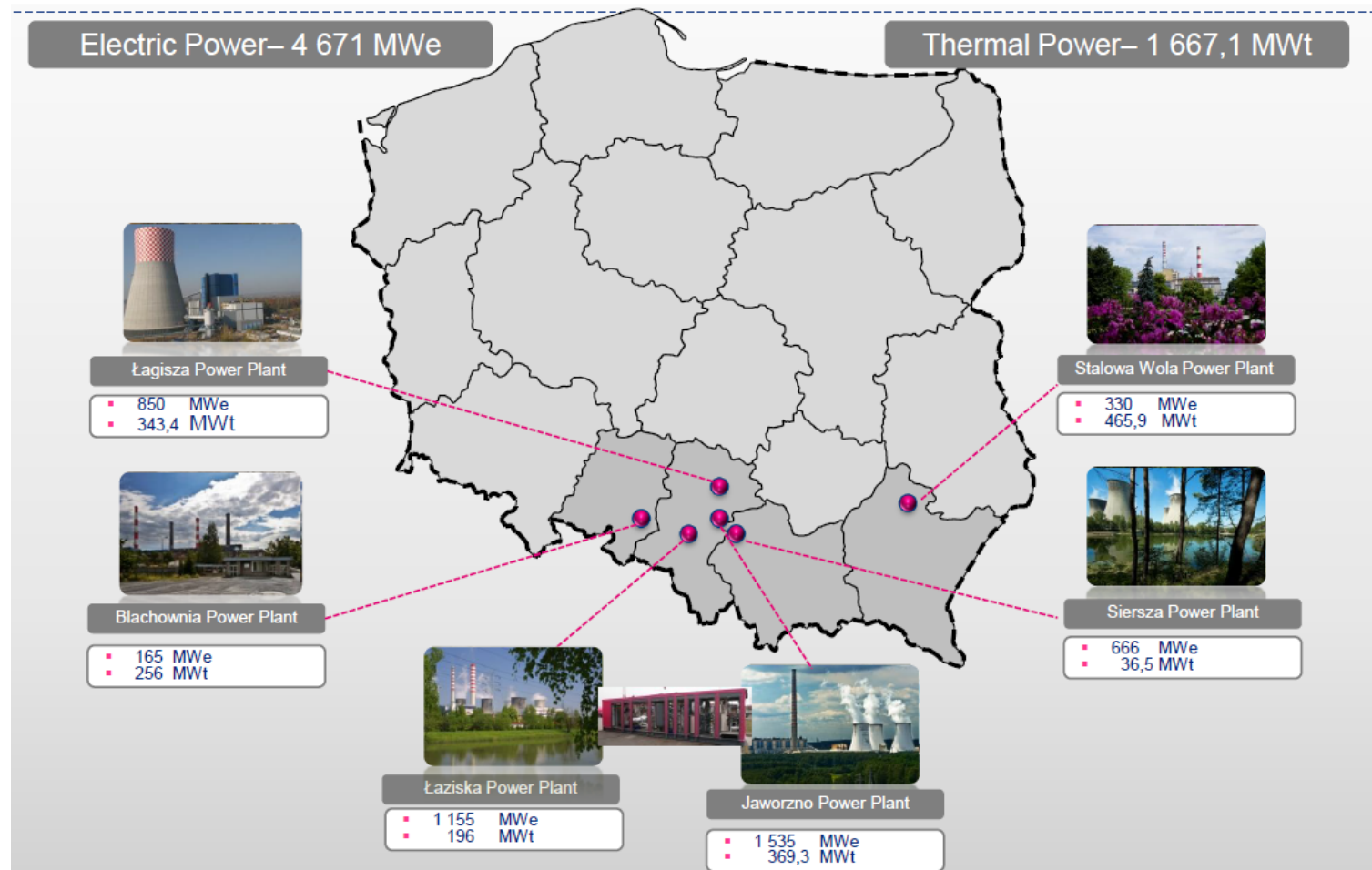
Estimated ECBM potential for CO<sub>2</sub> storage in the area of USCB were estimated at **20,362 mln Mg CO<sub>2</sub>**



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# PILOT PLANTS OF CO<sub>2</sub> CAPTURE AND UTILIZATION

The big power production companies like Tauron, try to develop CCUS techniques having some **pilot plants** of CO<sub>2</sub> capture and utilization.



# PILOT PLANTS OF CO<sub>2</sub> CAPTURE AND UTILIZATION

**Project name:** Development of a technology for highly efficient zero-emission coal-fired power units integrated with CO<sub>2</sub> capture.

**Objective:** The main purpose of the project was to demonstrate the post combustion process in pilot plant connected to coal-fired power plant.

**Principal:** National Research and Development Center (Poland)

**Project duration:** 1.04.2010 – 30.11.2015 (67 months)

**Executors:** TAURON Polish Energy, TAURON Production, Institute for Chemical Processing of Coal (IChPW)

- Mobile Pilot Plant for CO<sub>2</sub> capture from flue gases was designed, constructed and operated at TAURON Łaziska Power Plant.
- The carbon capture facility is based on amine post-combustion process technology (amine scrubbing).
- The plant captured its first tonne of CO<sub>2</sub> in August 2013. Since 2013 the pilot plant has been operated for >1400 h and successfully demonstrated reliable operation allowing the removal of over 55 000 kg of CO<sub>2</sub> from flue gases using amine scrubbing process. It gives opportunity to determine the influence of the process parameters on plant's efficiency.
- Key stages of research task are tests on Łaziska power plant in 2013 and Jaworzno power plant in 2014



Łaziska power plant in 2013



Mobile Pilot Plant



Jaworzno power plant in 2014



# PILOT PLANTS OF CO<sub>2</sub> CAPTURE AND UTILIZATION

Conversion of carbon dioxide captured from power units into **synthetic natural gas (SNG)** to be used as a vehicle fuel is the objective of the pilot plant commissioned by TAURON in the Łaziska power plant (**October 2018**).

Methane is generated as a result of reaction of CO<sub>2</sub> with hydrogen coming from water electrolysis.

The CO<sub>2</sub>-SNG pilot has been designed and executed at the Łaziska Power Plant under the project performed by an international consortium led by TAURON Wytwarzanie.

The SNG (synthetic natural gas) produced in the period of electricity surplus may be injected into the existing natural gas network to be utilized in peak periods for energy production e.g. in gas turbines. After compression, it may be also used – already as – **CNG (Compressed Natural Gas)** in vehicle transport.

The project is co-financed by KIC InnoEnergy and EIT InnoEnergy supported by the European Institute of Innovation and Technology – EIT under the EU program in the field of research and innovation – Horizon 2020.





# PILOT PLANTS OF CO<sub>2</sub> CAPTURE AND UTILIZATION

## 2012: Alabama Power Plant Barry – USA

- The same technology was used as in the TAURON's Pilot Plant for CO<sub>2</sub> capture from flue gases in Poland (*post combustion capture – amine scrubbing*).
- In the US this is done on a much larger scale: from June 2011 to May 2013, over 139 thousand tonnes of CO<sub>2</sub> in the capture station were obtained, which gives about **200 tons/day**.

### 25-MW CCS Demo - 2012

"World's largest carbon capture facility on a fossil-fueled power plant"

SOUTHERN  
COMPANY

Alabama Power  
Plant Barry

- 90% CO<sub>2</sub> capture @ 99.97 purity
- Capture operations began in June 2011 with integrated injection operations in August 2012

150 feet

300 feet



## 2017: Petra Nova Plant – Texas, USA

- The world's largest carbon capture facility at the coal-powered power plant.
- Post-combustion carbon capture technology to reduce Petra Nova's carbon emissions by 90 percent.
- An 80-mile pipeline to route the captured carbon dioxide to extends the life of mature oil fields - increase production at the West Ranch oil field (from 300 to 4000 barrels of oil per day) - **helping make an environmental and economical solutions.**
- Within the first 10 months of 2017, the plant delivered more than 1 million tons of captured carbon dioxide, which gives about **3200 tons/day**.

### PETRA NOVA 2017



2017  
POWER Plant of  
the Year

-90%  
emissions

+1300%  
oil production

# CONCLUSION

- The economic use of CO<sub>2</sub> (CO<sub>2</sub>-EOR, CO<sub>2</sub>-EGR) in Poland is **very limited**.
- An executive regulation allows presently **only offshore storage** in Poland as a result of the Transposition of Directive 2009/31/EC into Polish Law
- Performance assessments and projects that have been conducted in Poland have shown that **geologic settings are suitable for long-term storage of CO<sub>2</sub>**.
- Silesia region authorities strongly supports all activity trying to find solutions for **CO<sub>2</sub> capture and utilization**.



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**Thank you for your  
attention**

