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

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CCUS locally and at European level
CO2GeoNet and Główny Instytut Górnictwa - GIG (Central Mining Institute) event
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PRESENTATION OUTLINE

1. Upper Silesia region - CO$_2$ 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$_2$ capture and utilization
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 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.
Sources of emissions in the region of Silesia are presented on the basis of ten largest electric power plants in terms of CO₂ emissions.

<table>
<thead>
<tr>
<th>No.</th>
<th>Name of Powerstation</th>
<th>Emission [million tonnes CO₂/year]</th>
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<tbody>
<tr>
<td>1.</td>
<td>Elektrownia Rybnik S.A.</td>
<td>~6,5</td>
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<td>2.</td>
<td>Elektrociepłownia EC Nowa Sp. z o. o.</td>
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<td>3.</td>
<td>Elektrownia Halembla</td>
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<td>4.</td>
<td>Elektrownia Łagisza</td>
<td>1 - 5</td>
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<td>5.</td>
<td>Elektrownia Łaziska</td>
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<td>6.</td>
<td>Elektrownia Jaworzno II</td>
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<td>7.</td>
<td>Elektrownia Jaworzno III</td>
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<td>8.</td>
<td>Elektrociepłownia Będzin S.A.</td>
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<tr>
<td>9.</td>
<td>Elektrownia Chorzów S.A.</td>
<td>0,5 - 1</td>
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<td>10.</td>
<td>Elektrownia Siersza</td>
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The Bełchatów Power Station: ~37,6 million tonnes CO₂/year
POLISH EXPERIENCES IN CCS

– MAIN PROJECTS:

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

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 numerous technological risks.
POLISH EXPERIENCES IN CCS

RESEARCH ON POTENTIAL OF CO2 STORAGE IN POLAND – EXAMPLES:

1. Borzęcin gas field, 1995 – An industrial installation for capturing and depositing acid gases (CO2, H2S)

2. RECOPOL (Kaniów), 2001-2005 – coordinator: TNO, GIG – Reduction of CO2 emission by means of CO2 storage in coal seams in the silesian coal basin of Poland (~700 tonnes CO2 injected into coal seams)

3. MOVECBM, 2006-2008 - coordinator: TNO, GIG, Monitoring and verification of CO2 storage and ECBM in Poland

4. Ponętów, 2004 – University of Science and Technology AGH – Tests of CO2 storage in saline aquifers

5. Jastrząbka Stara – oil field, 2005-2006, Design and installation work for the geological sequestration of CO2 on a small oil field

6. CO2SINK, 2004 - coordinator: GFZ Potsdam, Developing the basis of CO2 storage technique by injection of CO2 into a saline aquifer underneath the city of Ketzin near Berlin (~60000 tonnes CO2 injected into saline aquifers)

7. CASTOR WP1.2, 2004-2006 – coordinator WP1.2: GEUS, Capture and sequestration of CO2 associated with cleaner fossil fuel plants


9. CO2NET EAST , 2006-2009 - Carbon Dioxide Knowledge Transfer Network - CO2 capture and storage networking extension to new member states

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 CO₂ storage capacity
3. Recommended guidelines for the proper infrastructure for transport and injection of CO₂
4. Developing a surface monitoring system for CO₂ storage in saline formations
5. Comprehensive safety analissys/ risk assessment

PHASE B (2010-2011)
1. Pre-documentation of the installation process for geological CO₂ storage
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:
  - Natura 2000,
  - Goczałkowice Reservoir – artificial water reservoir,
  - therapeutic peat and water treatment,
  - natural gas fields
POLISH EXPERIENCES IN CCS

– MAIN PROJECTS:

“Assessment of formations and structures for safe CO2 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.
POLISH EXPERIENCES IN CCS

MAIN PROJECTS:

Assessment of formations and structures for safe CO2 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

Over 90% of these structures are located onshore
POLISH EXPERIENCES IN CCS

MAIN PROJECTS:

Assessment of formations and structures for safe CO2 geological storage, including monitoring plans”

Results:
The estimated capacity of structures for the geological storage of CO2 is 10-15 billion tonnes CO₂, 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
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 and three areas associated with CO$_2$ storage in coal seams were selected.

**Assessment of formations and structures for safe CO2 geological storage, including monitoring plans**
The Dębowiec formation appears to be the most prospective for potential storage of CO$_2$ out of the three analysed reservoirs. This region is characterized by the most favourable geological and hydrogeological parameters.

Estimated capacity of saline aquifer allows to storage about 44 million tons of CO$_2$
Deep coal seams with absorbed methane, which can be captured and economically used, and CO\textsubscript{2} can be injected in place of CH\textsubscript{4} (ECBM). Three potential research areas were identified in the Upper Silesia Coal Basin with similar areas of 55-75 km\textsuperscript{2}, which were analyzed to a depth of 2000 m in the area of coal-bearing capacity and methane content of coal seams, and potential CO\textsubscript{2} capacities were estimated: 20,362 mln Mg CO\textsubscript{2} for ECBM.
PILOT PLANTS OF CO\textsubscript{2} CAPTURE AND UTILIZATION

The big power production companies like Tauron, try to develop CCUS techniques having some pilot plants of CO\textsubscript{2} capture and utilization.
**PILOT PLANTS OF CO₂ CAPTURE AND UTILIZATION**

**Project name:** Development of a technology for highly efficient zero-emission coal-fired power units integrated with CO2 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 CO2 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 CO2 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 CO2 from flue gases using amine scrubbing process. It gives opportunity to determine the influence of the process parameters on plant’s efficiency.
- In the coming years, the pilot plant will be used to evaluate advanced technological innovations.
- **Key stages of research task are tests on Łaziska power plant in 2013 and Jaworzno power plant in 2014**
PILOT PLANTS OF CO₂ CAPTURE AND UTILIZATION

The big power production companies like Tauron, try to develop CCS techniques having some pilot plants of CO₂ capture. Also some attempts have been done in CCU by producing methane from CO₂ in the KIC InnoEnergy programme.

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 CO₂ with hydrogen coming from water electrolysis.

The CO₂-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 CO₂ CAPTURE AND UTILIZATION

2012: Alabama Power Plant Barry – USA

- The same technology was used as in the TAURON’s Pilot Plant for CO2 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 CO2 in the capture station were obtained, which gives about 200 tons/day.

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.
CONCLUSION

• The economic use of CO2 (CO2-EOR, CO2-EGR) in Poland is a 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 CO2.

• Silesia region authorities strongly supports all activity trying to find solutions for CO2 capture and utilization.
Thank you for your attention