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Session – Coal Mine Methane as a Valuable Energy Source
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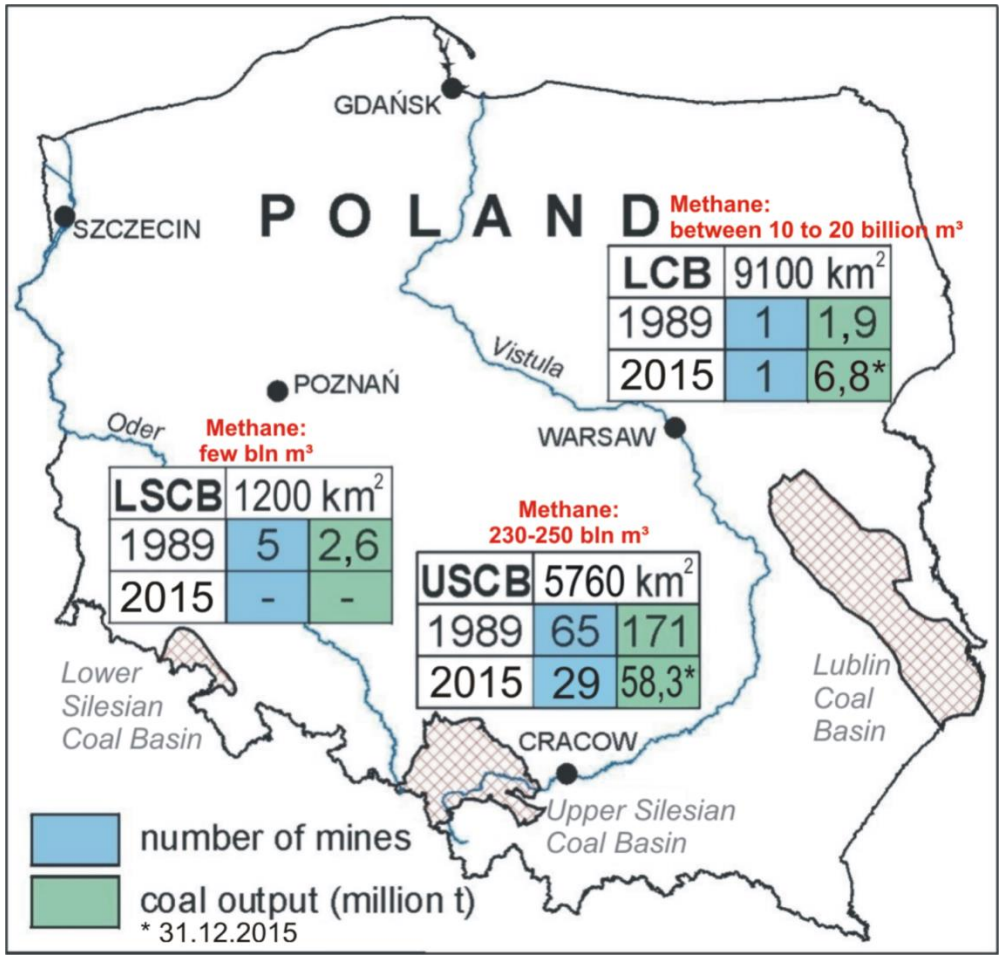
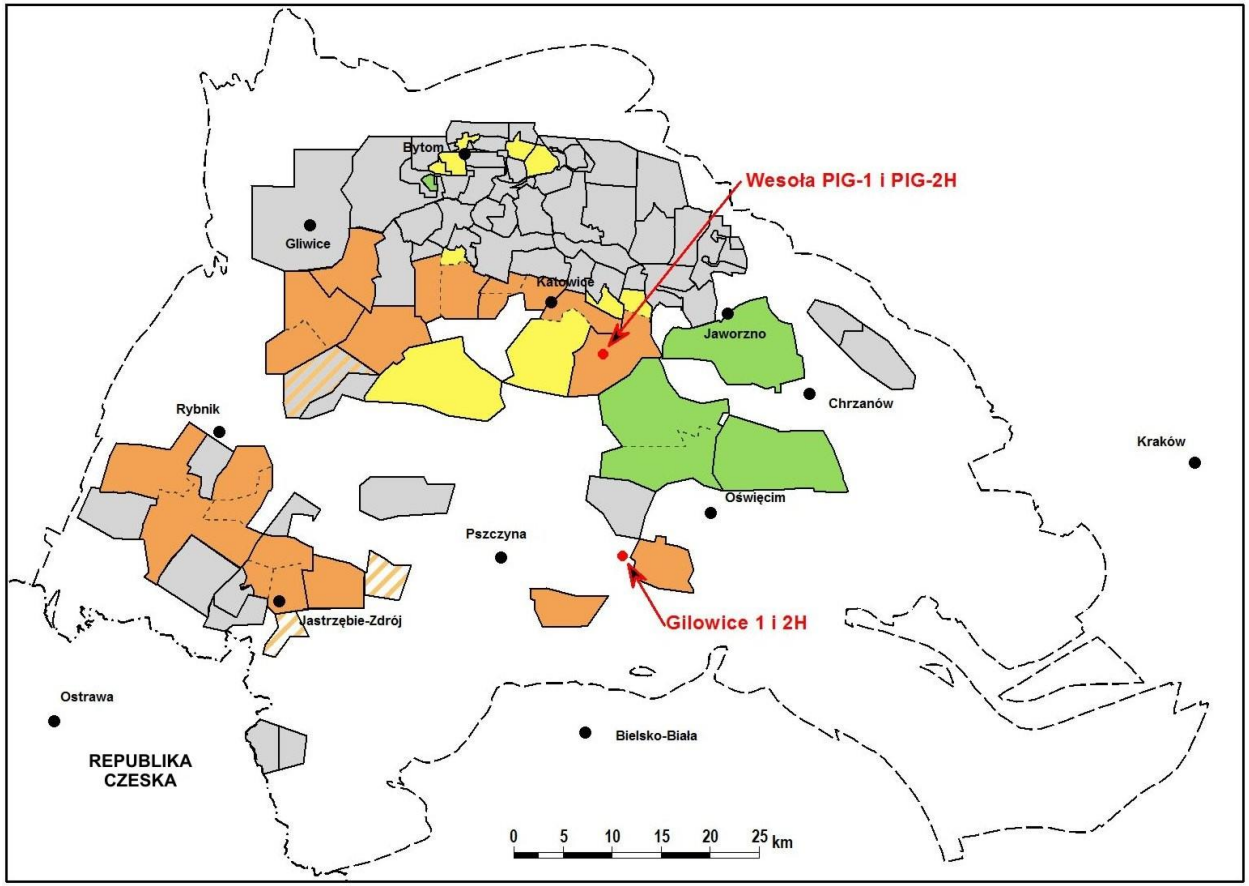
Pre-mine Drainage of Methane from Coal Seams in the USCB – Geo-Methane Program

Coalbed Methane Resources in the Polish Coal Basins



Methane Emission from Coal Mines in the USCB



Emissions, Recovery and Utilization of Methane in 2016 [MMm^3]			
Methane volume			Emission to atmosphere
total	captured	used	
933.8	342.1	195.0	738.8

Measured volume of methane

(methane released and recorded by mines) – methane contained in ventilation air + methane captured)

933.8 MMm^3

Unmeasured methane sources

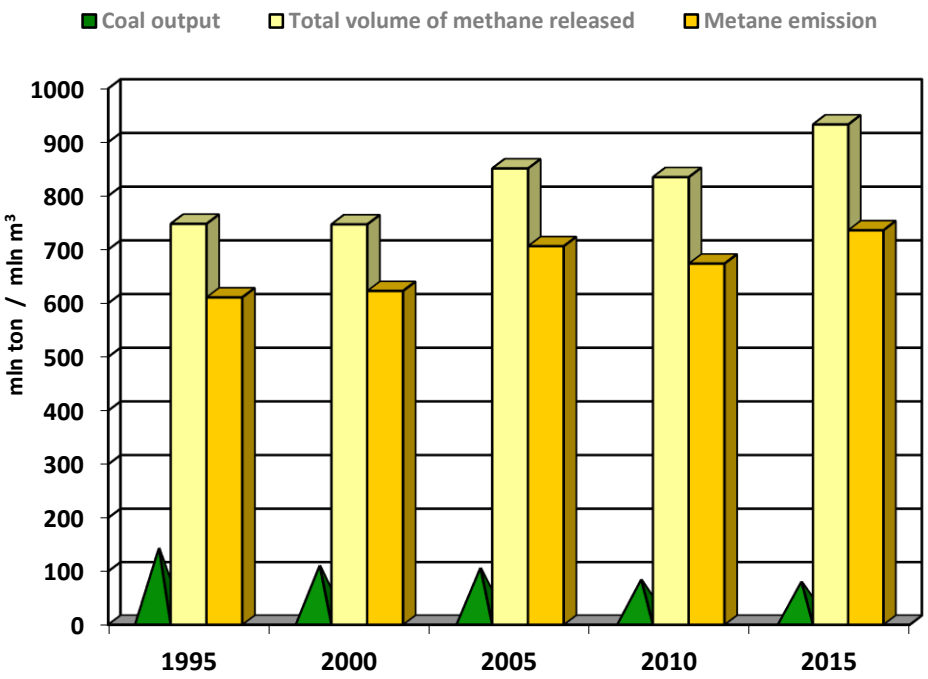
(„non-methane" and „low methane" mines + extracted coal and barren rock consisting of 5–10% of measured methane

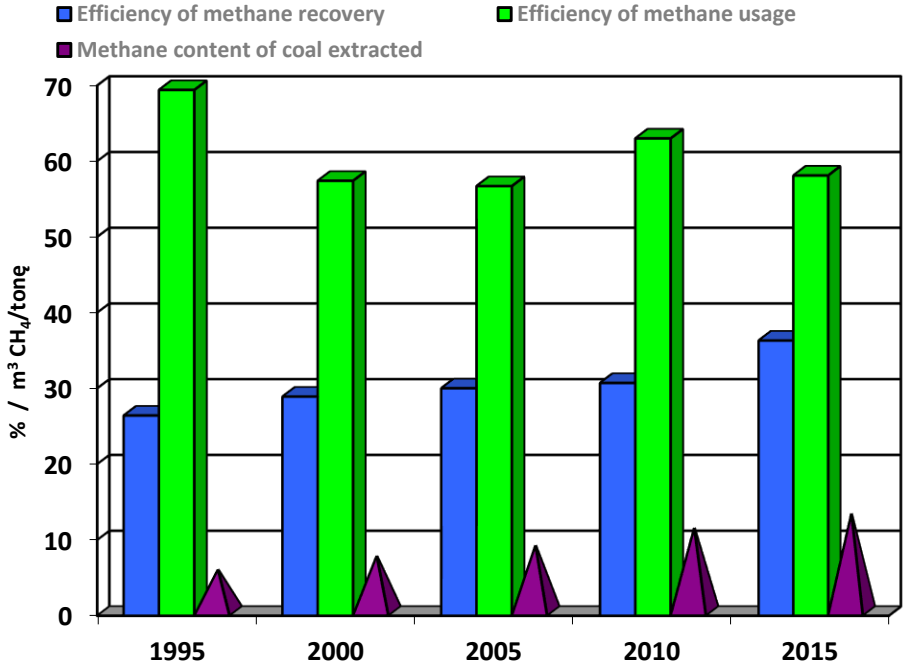
ca. 45–90 MMm^3

gassy coal mines with degasification
gassy coal mines without degasification
non-gassy coal mines
closed mines
mines under construction

Total volume of methane emission per year: ca. 780–825 MMm^3

(1 CH4 = 25 CO_2, → 20 Bm^3 CO_2)



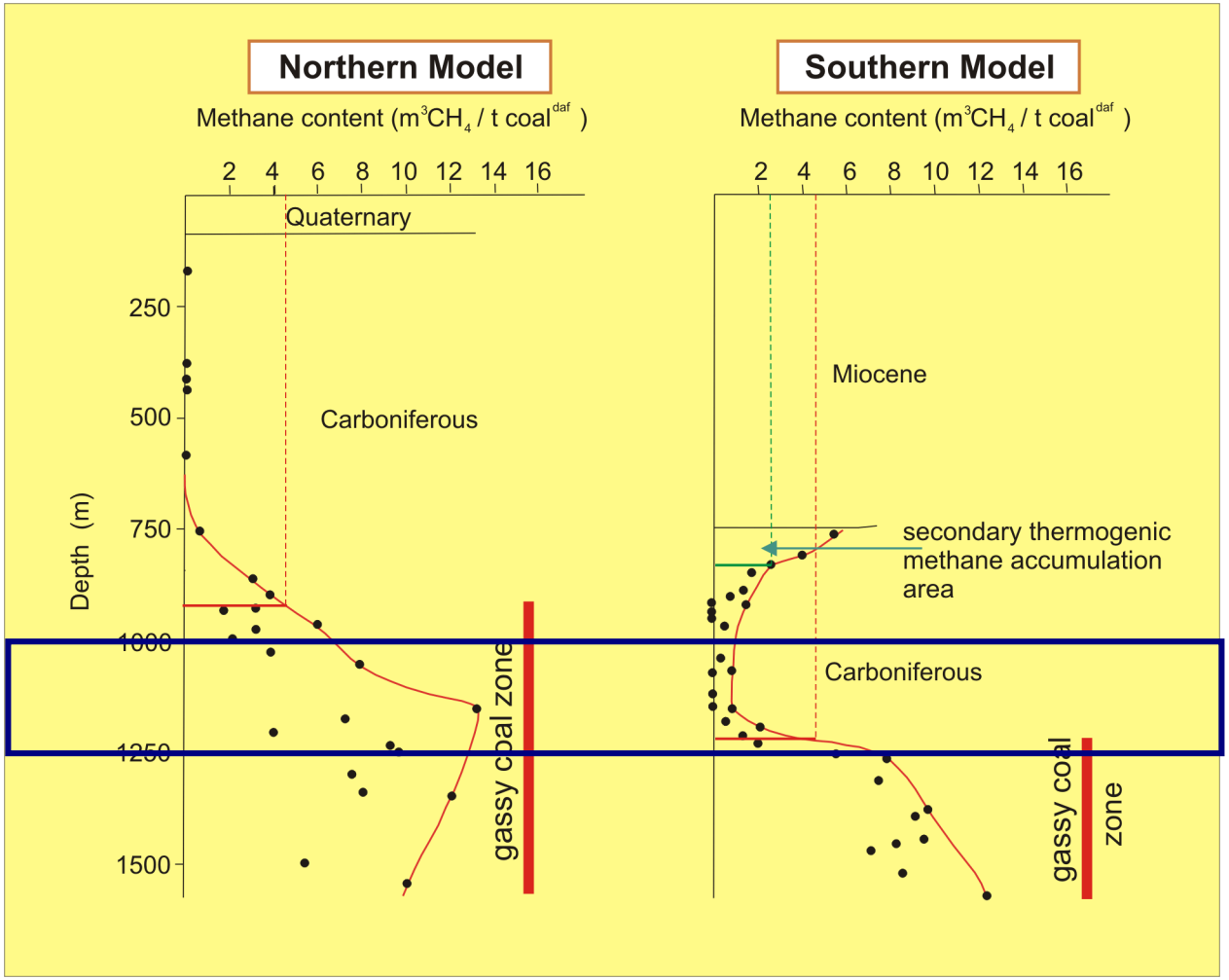


Methane Content, Methane Recovery Efficiency and Methane Emission in 1995–2015

(after State Mining Authority)

Year	Coal output [mln tonnes]	Total volume of methane released [mln m³ CH_4]	Methane content of coal extracted [m³ CH_4/tonne]	Methane volume		Efficiency of:		Methane emission to the atmosphere [mln m³]
				captured [mln m³]	used [mln m³]	Methane recovery [%]	Methane usage [%]	
1995	135,2	748,0	5,5	197,5	137,1	26,4	69,4	610,9
2000	102,5	746,9	7,3	216,1	124,0	28,9	57,4	622,9
2005	98,1	851,1	8,7	255,3	144,8	30,0	56,7	706,3
2010	76,1	834,9	11,0	255,9	161,1	30,7	63,0	673,8
2015	72,2	933,0	12,9	339,0	197,1	36,3	58,1	735,9

Methane Content of Coal with Increasing Depth



It is critical to initiate systematic efforts leading to

a comprehensive solution, or, at least, considerable reduction of coal mine methane problem.

In the light of current and future energy policy of Poland, coal, recovered from domestic resources, will continue to be, over many years, the main source of power supply

It is also important to change the perception of methane,

especially in the coal industry sector:

from a hazardous waste to be disposed of, to a valuable energy commodity

The long-term solution to the problem of gassy mines in USCB

PRE-MINE DRAINAGE OF COAL SEAMS
Methane recovery from coal seams for a few or several years before mining:

- **early recovery of valuable energy source** (1.0–1.5 Bm^3, increasing domestic gas production)
- **extraction of coal in more favorable mining and economic conditions**
  (reducing methane hazard, improved work safety, significant reduction of coal extraction costs)
- **reduction of methane emissions to the atmosphere**
  (mitigation of the greenhouse effect, reducing the cost of emission fees, especially in case of EU ETS)

The Main Features of Pre-mine Drainage in the USCB

1. **Methane recovery from coal seams planned several years before mining operations** (using surface wells) **–** difference in relation to the current in-mine demethanization systems.

2. **It is not possible to recover all methane from coal seams using pre-drainage with surface wells.** Pre-mine drainage will supplement the existing demethanization system.

3. **A Recovery factor of 50-70% of the total coal seam gas is possible**, the recovery of 30-50% of methane from coal seams would essentially change the conditions of coal mining (reducing category of methane hazard, eg. from IV to II).

4. **Activity identical to virgin coalbed methane operation,** applied to coal in the vicinity of active mining operations (new, deeper levels of mines, newly available fields).

5. **Future cost reduction in mining of partially demethanized coal seams should be included in the coal mine economics** – safer mining with lower financial investment.

6. **Application of modern technologies (Surface-to-in-Seam drilling) and well-stimulation technique –** prospects for a commercial recovery of coalbed methane.

Key Issues for the Development of Pre-mine Drainage in Poland

Implemetnation of pre-mine drainage demonstration pilot projects:

(in new coal fields or mining levels, at least 3-5 years before mining operations):

- **The first pilot project run by PIG-PIB (2013–2015)** – wells: Wesoła PIG-1 and Wesoła PIG-2H (done)
- **The second project run by PGNiG and PIG-PIB (2016–2018)** – wells: Gilowice 1 and Gilowice 2H (ongoing)
- **Further development of experimental projects** – surface wells or in-mine boreholes.

Evaluation of coal as a reservoir for CBM:

- **Present understanding of the CBM reservoir –** limited to methane content of coal seams.
- **USBM method –** measurement of residual gas is and estimation of desorbed gas.
- **Reservoir parameters of coal –** insufficient data on reservoir properties, eg.: permeability, geomechanical properties.

Economic evaluation of pre-mine drainage using surface wells:

- **Complexity of the issue** – strong dependency on the specific geological, mining and environmental conditions.
- **Long delay in time** - between expenditures and potential profits.
- **Project economics:**
  - Simple on investment side,
  - Difficult to estimate potential revenues and profits, and rate of return of incurred expenses.
- **Revenues and profits – two basic groups:**
  - Direct revenues – from sales of extracted gas or heat / electricity,
  - Indirect revenues – the benefits of the operating in partialy demethanized coal seams.

Overview of the GEO-METHANE Experimental Program: Pre-mine Drainage of Methane from Coal Seams using Surface Wells

Polish Oil Gas & Company + Polish Geological Institute – National Research Institute (PGNiG S.A. + PIG-PIB)

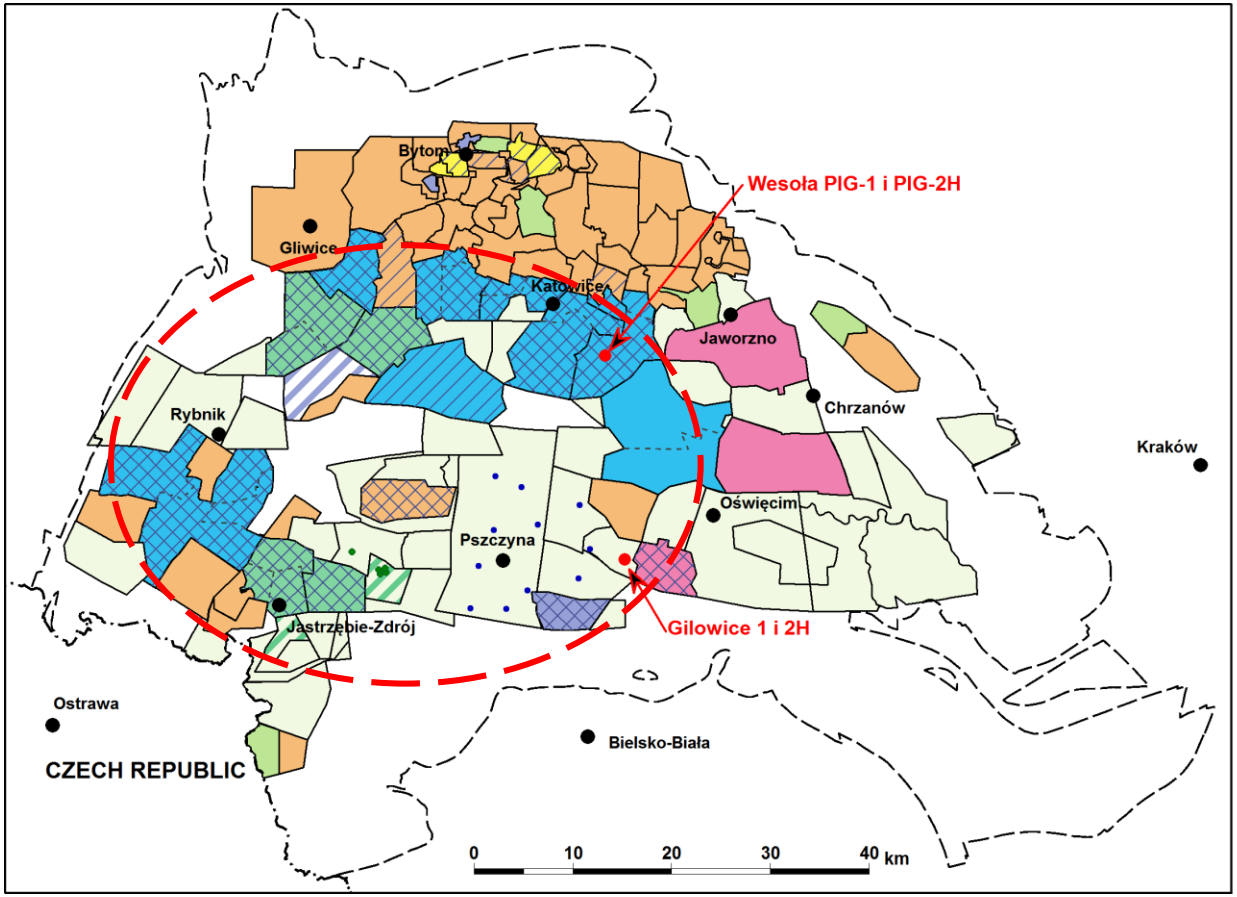
Objectives of Work and Studies

1. **To support development of CBM production technologies** in the Polish coal basins, as well as methane drainage of coal mines:
   - increasing gas production potential in Poland
   - supporting the domestic coal mining industry through providing a comprehensive solution to the problem of methane emissions in coal mines.
2. **Determining, on an experimental basis, the screening criteria** for pre-mine drainage of coal seam gas depending on geological-mining conditions.
3. **Development of directional drilling technologies** and methods of coalbed gas production enhancement suitable for the Upper Silesian Basin conditions.
4. **In case of positive results**, find a trial application in order to demonstrate the feaseability of the pre-mine drainage technology, and subesequenlty its implementation in the selected area.

Phases of work:

- **Phase I – Experimental Project (Gilowice)**
- **Phase II – Pilot**
- **Phase III – Implementation (Production)**

Possible Locations of Pre-mine Drainage Projects



Upper Silesian Coal Basin

- Polska Grupa Górnicza Sp. z o.o.
- Jastrzębska Spółka Węglowa S.A.
- Tauron Wydobycie S.A.
- Węglokoks-Kraj Sp. z o.o.
- other mines
- under construction mines
- suspended mines
- abandoned mines
- undeveloped deposits
- undeveloped deposits within abandoned mines
- gassy coal mines without demethanization
- gassy coal mines with demethanization

CBM exploration wells:

- AMOCO
- TEXACO
- Wesoła & Gilowice

Phase II – Pilot

Phase objectives:

1. Research focusing on:

- optimal geological-mining conditions for methane drainage and gas content reduction of coal seams which are planned to be mined
- determination of optimal technology for directional drilling and fracture stmulation treatment .

2. Demonstration focusing on:

- pilot, demonstrating instalation for methane recovered by the wells drilled from surface,
- carrying out longterm production tests.

Scope of work:

1. **Drilling of experimental wells** in 3 areas with different geological and mining conditions, with variable patterns of laterals relative to coal seams and type of intersections.
2. **Comprehensive evaluation** of the CBM production parameters (field and lab tests).
3. **Methane production enhancement** – fracture stimulation using different techniques, with a possibility of refracturing.
4. **CBM gas production tests** with determination of gas flow rates in a long period (2-3 years) and the analysis of gas flow variations.
5. **Verification of technical parameters** of gas recovery and transmission and the feasibility of the CBM development project (on a stand alone basis).
6. **Evaluation of the methane recovery effects** for coalbed gas content reduction of the planned longwall panels.
7. **Detailed feasibility study of pre-mine drainag**e of coal seams in the mining industry including underground demethanisation cost analysis.

Completion time of Phase II: 4–5 years

Phase III – Implementation

Phase objectives:

1. **Commercialization of solutions** developed during the first and second phases (execution of this phase will depend on the positive results of the previous phases).
2. **Implementation of gas production** in the area of the selected coal deposit.

Scope of work:

1. **Drilling a number of directional wells**, on a selected location, with special production stimulation treatments and installations for gas recovery and transmission (or local use); 12 multilateral clusters of directional wells in the area of 18-20 km^2 are assumed.
2. **Carrying out gas production** until the flow rates drop to the level predetermined in the previous phases, as justified by geological, mining, and economic conditions.
3. **Report** on the implementation phase and business evaluation of the work performed.

Completion time of Phase III: 5–7 years


Thank you
for your attention
Gilowice, 2017