



INNOWACYJNA GOSPODARKA
NARODOWA STRATEGIA SPÓJNOŚCI



CTW
CENTRUM CZYSTYCH
TECHNOLOGII WĘGLOWYCH



UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ
ROZWOJU REGIONALNEGO



The new Clean Coal Technology Centre and underground coal gasification in Poland

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Główny Instytut Górnictwa (Central Mining Institute)

4th European Coal Days, 13th November 2013

General goal

Improvement of competitiveness of the Polish economy through application of modern technology solutions rated among clean coal technologies (CCT), allowing assurance of national energy safety and limiting degradation of the environment

Objectives:

Founding a centre for clean coal technologies that will allow effective competition with modern European and world centres in performance of projects aimed at developing and elaborating new clean coal technologies

Clean Coal Technology Centre



The aim of the investment was to build the experimental area for research and development in the laboratory as well as semi-pilot and pilot (PDU) scale for efficient and Clean Coal Technologies

➤ Research Laboratories

➤ Technological installations

➤ Engineering group for process modelling

➤ Process Development Units

CCTC- Katowice



Katowice – research laboratories

Leading interdisciplinary works i.e. in the line of:

- **Identifying the resources of coal and accompanying fossil fuels**
- **Analysing the basics of coal processing and of the properties of the products**
- **Preparing coal for various application technologies, and especially researching coal properties**
- **Process engineering and nanotechnology**
- **Identifying the CO₂ storage potential**
- **Minimising the environmental impact**
- **Environmental research and monitoring**

Research on kinetics and thermodynamics of reaction

Examples of devices:

- **Pressurized thermo-gravimetrics analyser connected with mass spectrometer**
- **Analyser TPR/TPO/TPD**
- **Analyser Autosorb iQ Quantachrome**
- **FTIR Spectrometer Nicolet iS50**
- **Micro-autoclaves**
- **Analyser for chlorine**
- **AXIO Microscope**
- **X-ray diffractometer D8 Discover Bruker**

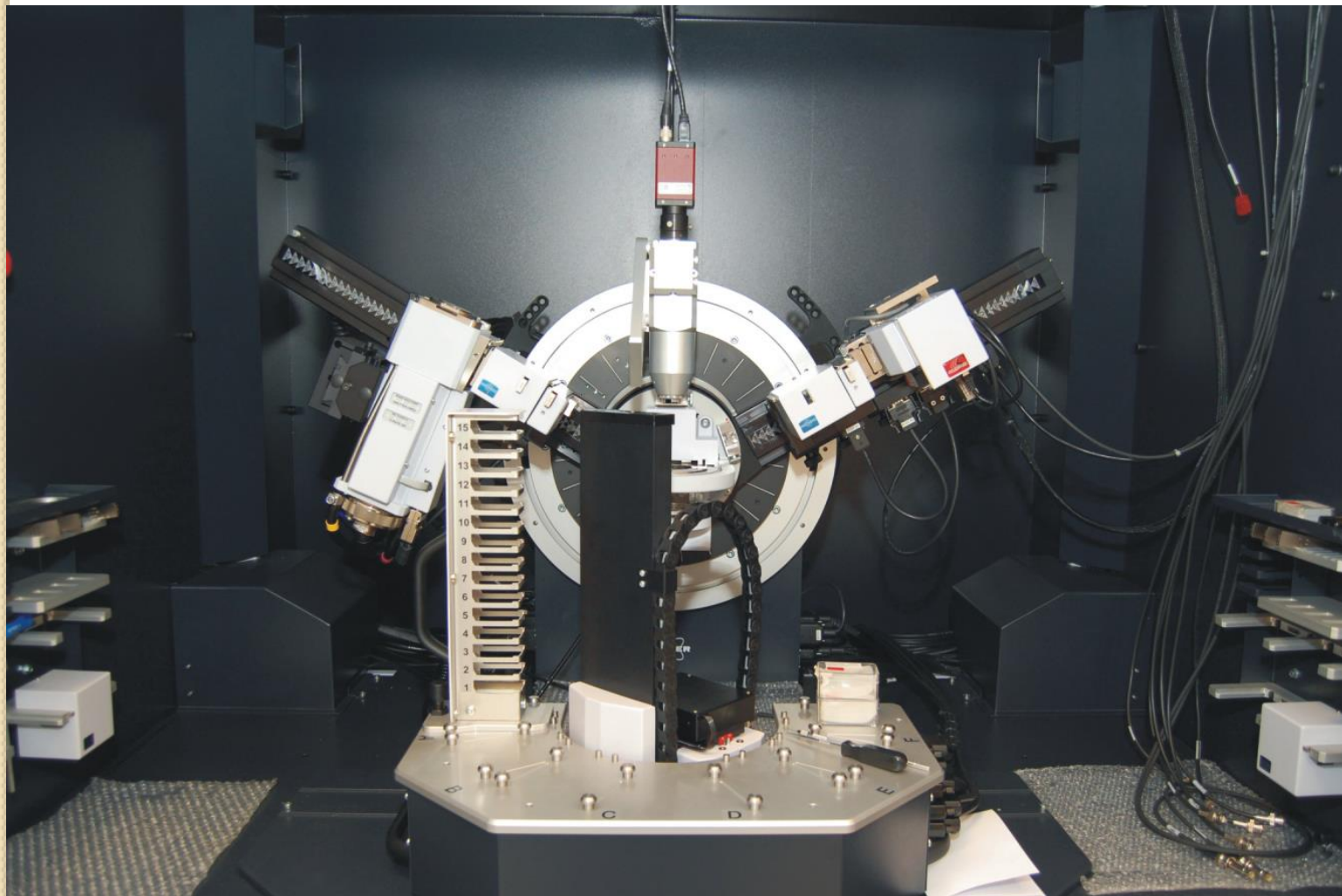
Automatic analyser for chlorine content determining



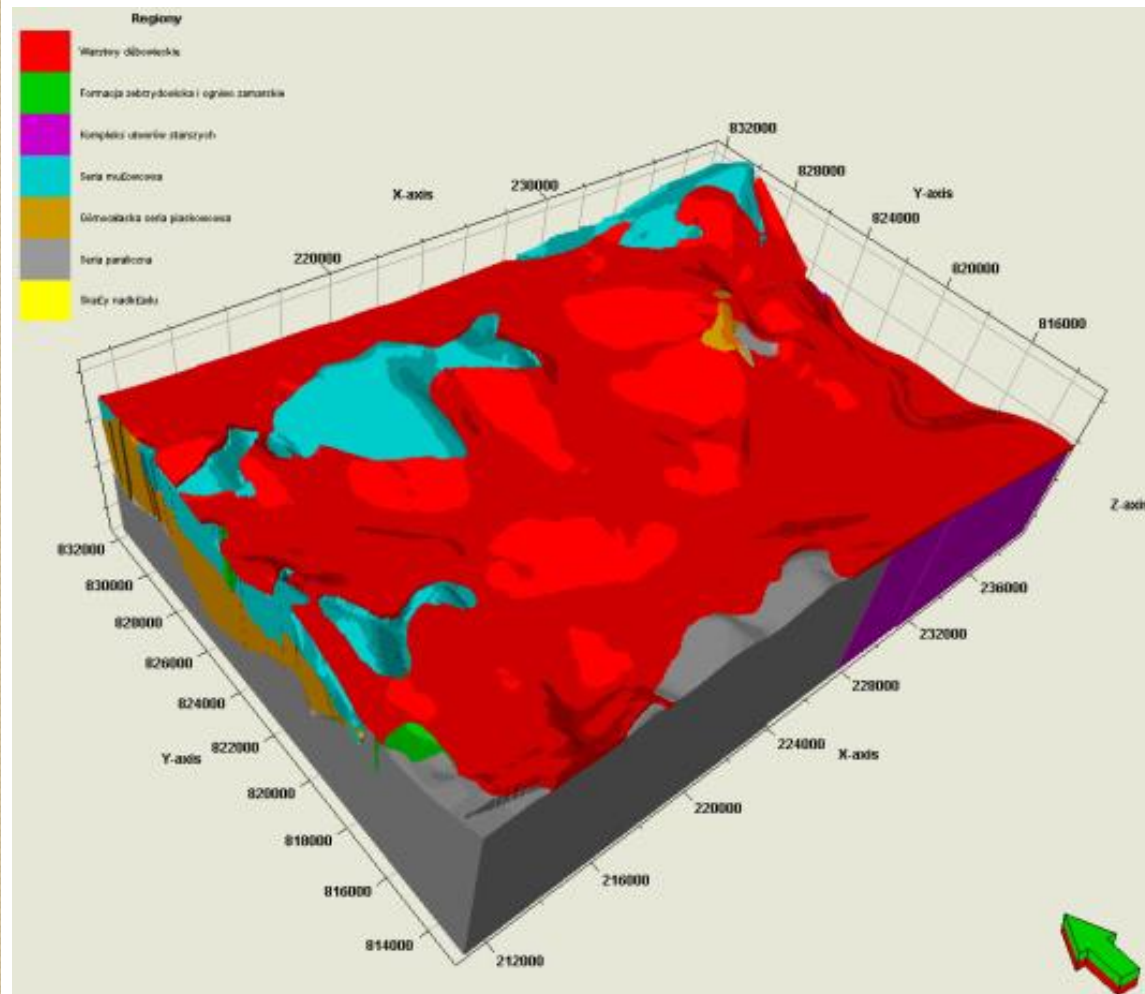
The AXIO Microscope for determination of the reflectance of vitrinite and macerals group composition



X-ray diffractometer D8 Discover Bruker



Static model of CO₂ tank located in Dębowiec layers in the area of Upper Silesia Coal Basin



Mikołów Experimental mine Barbara

– technological unit



Leading R&D works in laboratory, large laboratory and PDU scale i.e. on the following stands:

- **Stand for research on ambient pressure and high pressure coal gasification applying reactors simulating the coal bed**
- **Stand for researching coal gasification in fixed and moving bed systems**
- **Stand for researching direct coal hydrogenation**
- **Stand for research on gas separation methods applying PSA and membranes**
- **Stand for testing gas combustion in turbines and gas engines**
- **Stand for analysing various aspects of UCG in real conditions in generators constructed in the coal bed**



CCTC Mikotów -
Technological hall

CCTC Mikołów - Technological hall



Installation for pressured simulation of ucg



Installation for pressured simulation of ucg



Installation for pressure swing adsorption gas separation



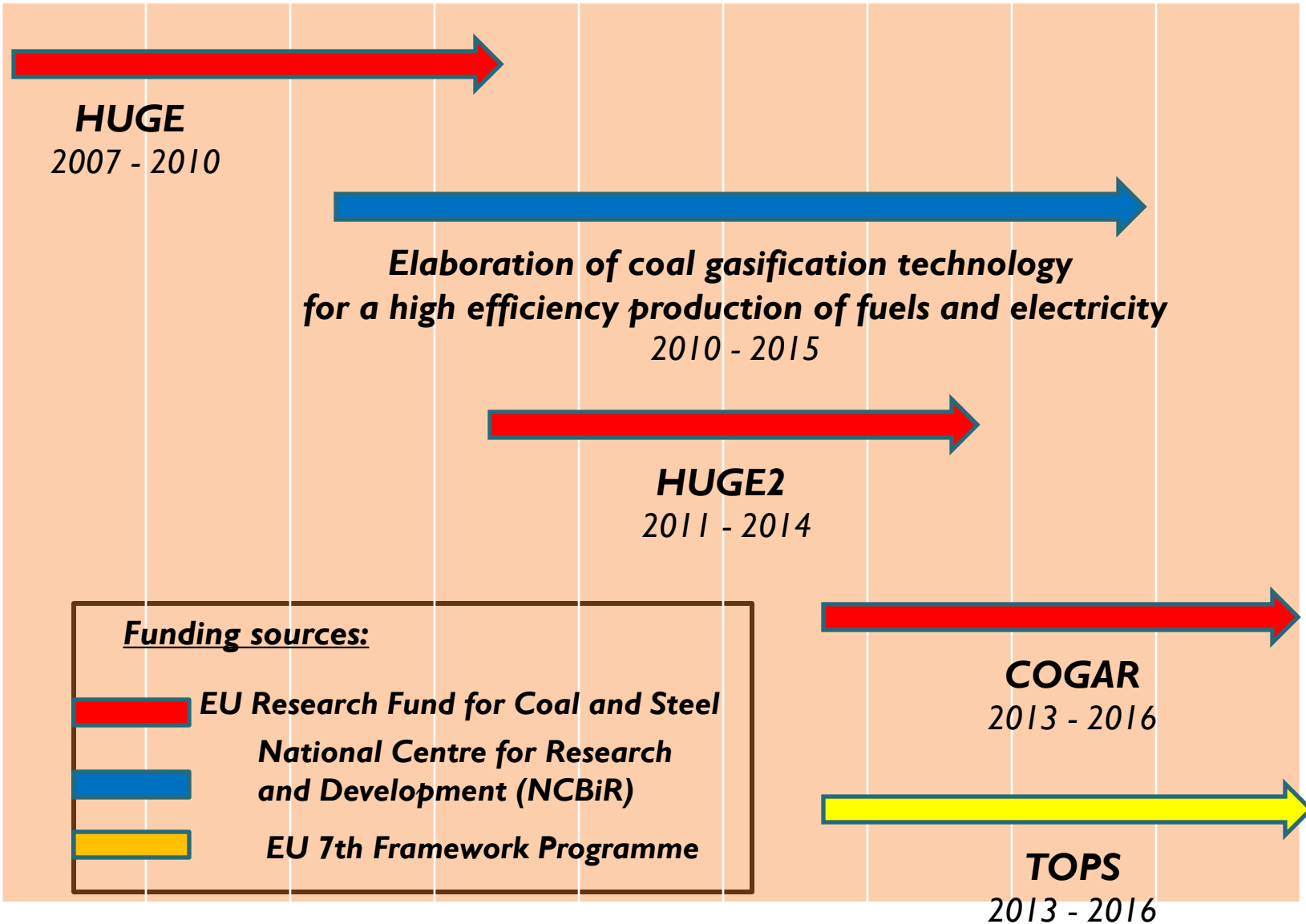
An installation for ucg gas cleaning



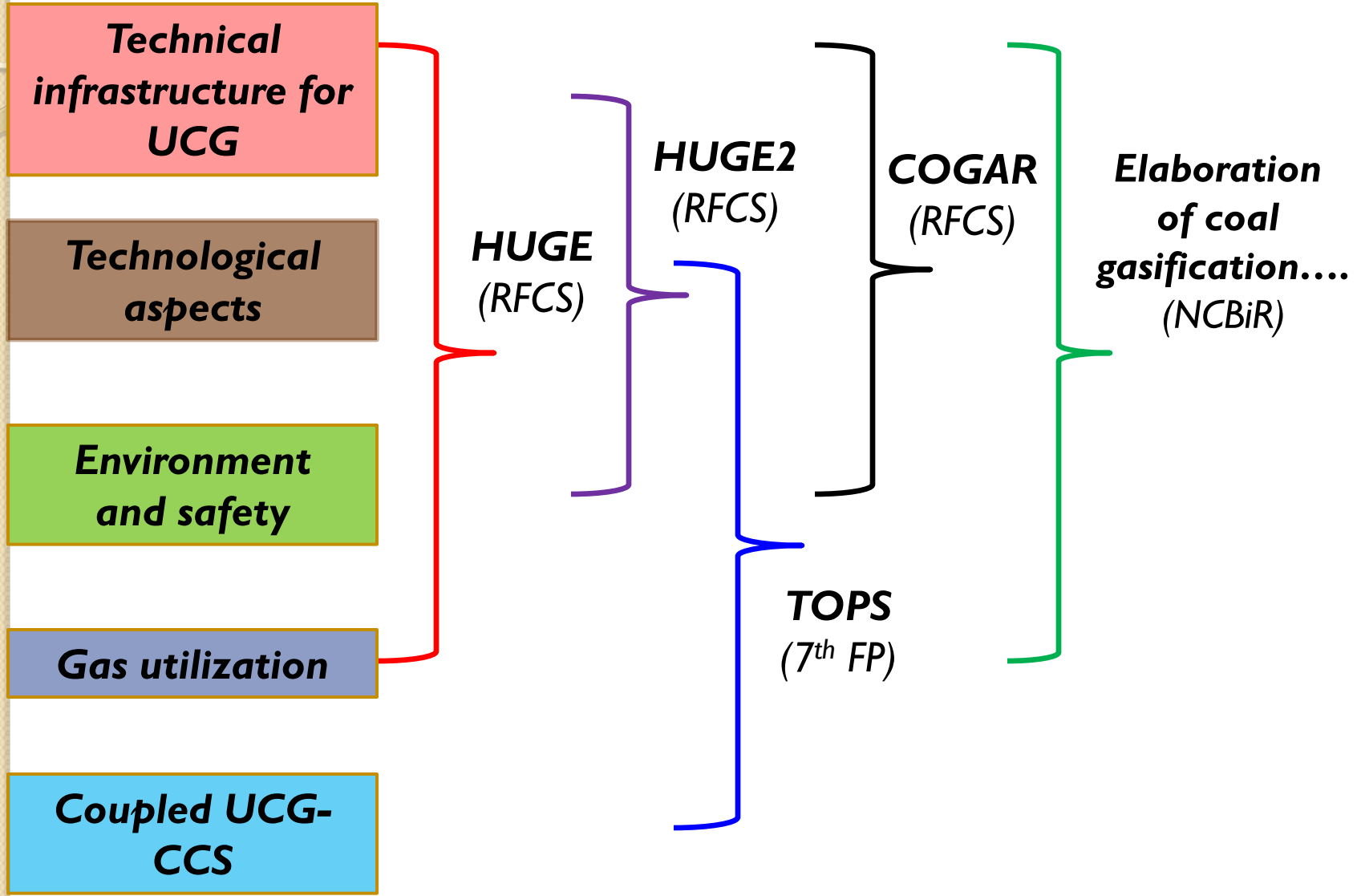


An installation for
ucg gas cleaning

Recent UCG projects in Poland



UCG aspects under study



Projects **HUGE & HUGE2**



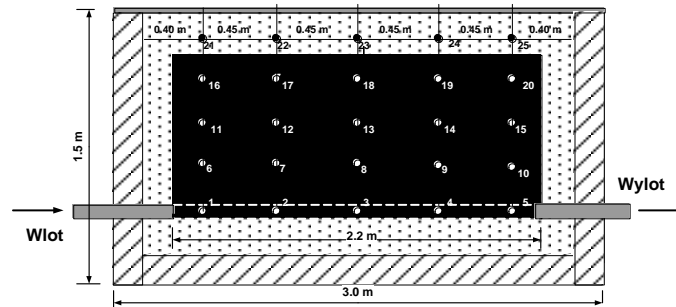
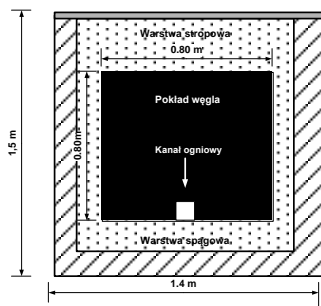
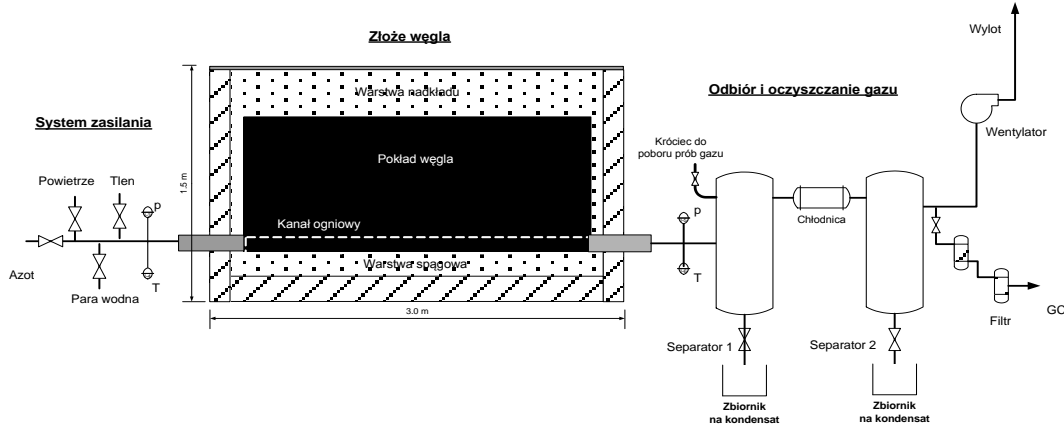
Hydrogen Oriented Underground Coal Gasification for Europe

Aims:

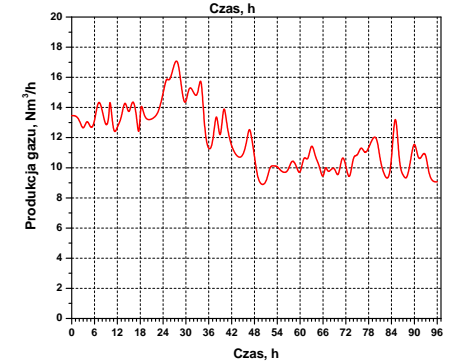
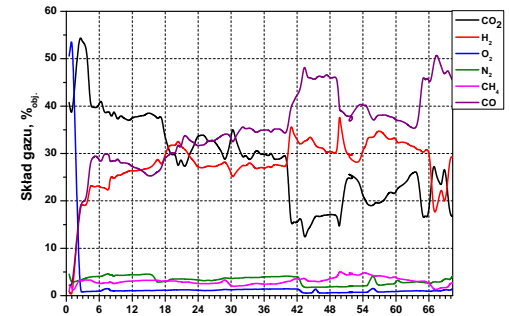
Theoretical and experimental exploration of the possibilities of in-situ production of hydrogen-rich gas through the underground coal gasification (UCG) technique

HUGE 2 – Safety and Environmental Aspects

Ex-situ experimental installation



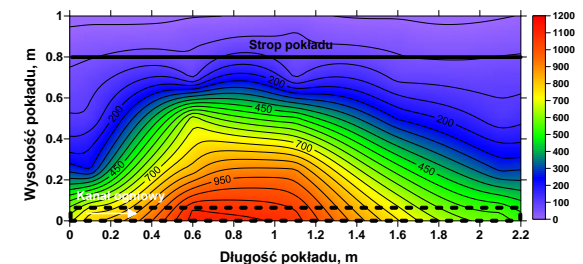
Gas quality control



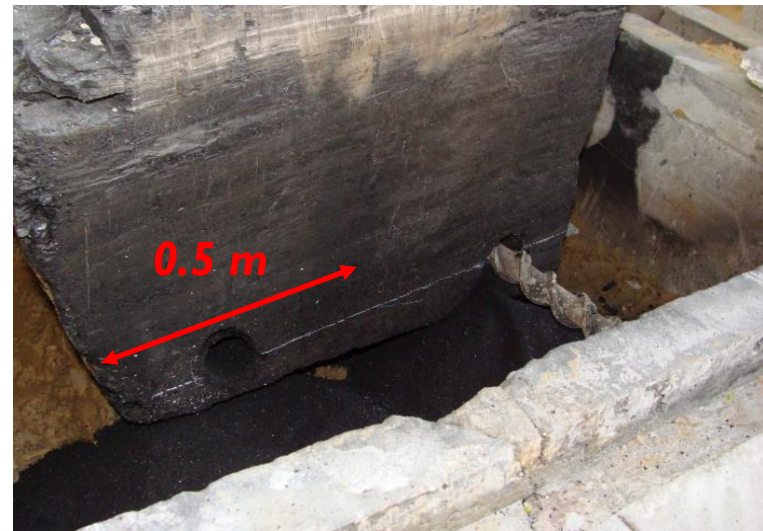
Installation parameters

Coal seam dimensions	2,5 x 0,8 x 0,8 m
Gasification agent	Oxygen, air, steam
Gasification temperature	up to 1600°C
Gasification pressure	atmospheric

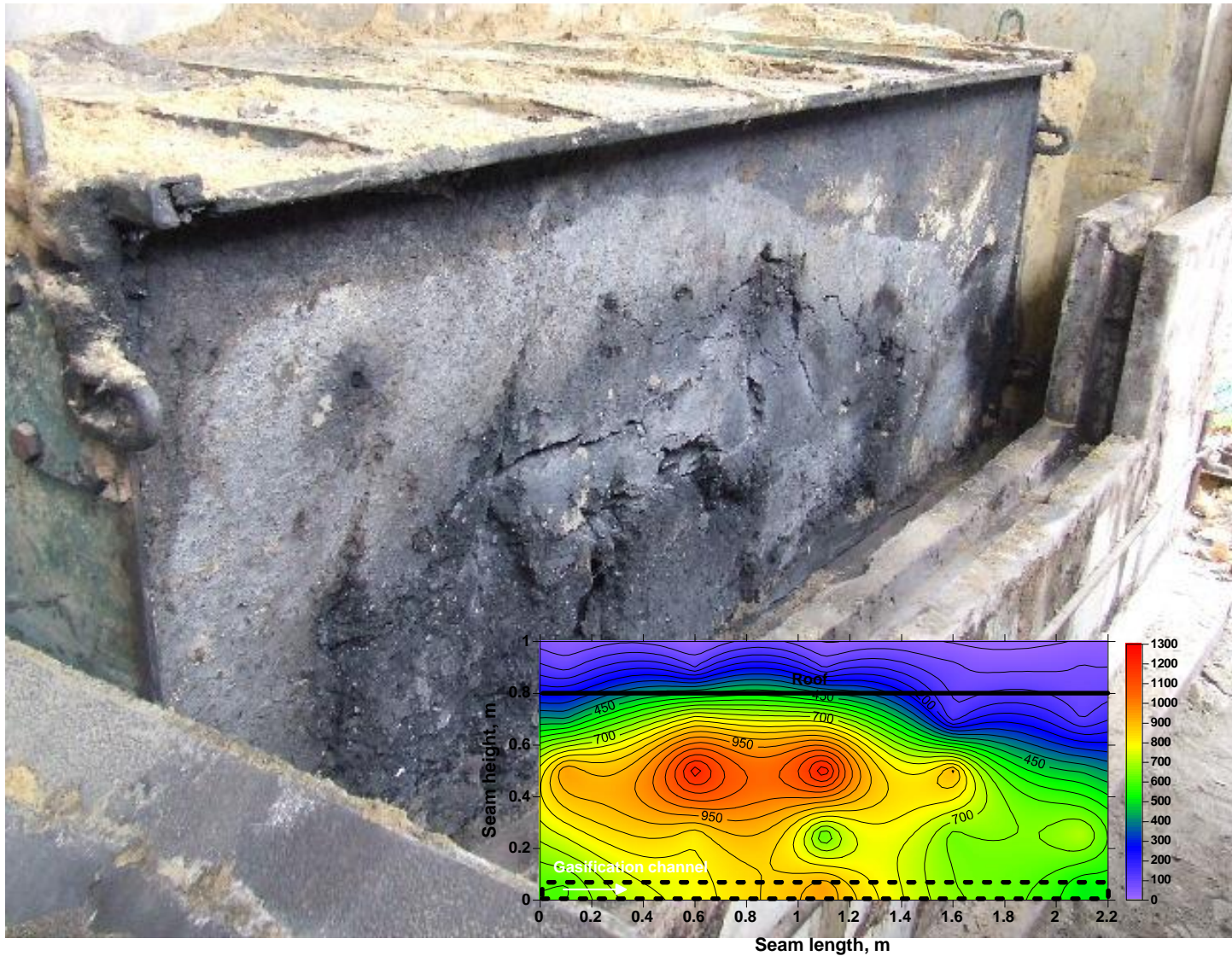
Temperature control



Examples of large coal samples



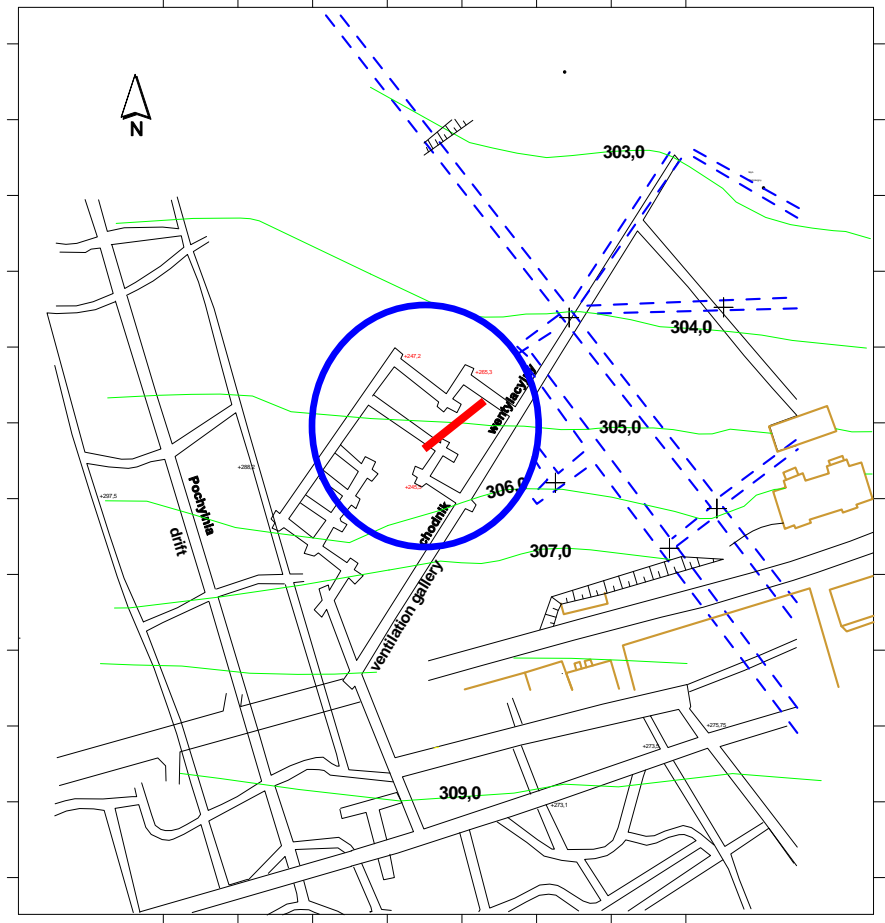
Post-gasification studies



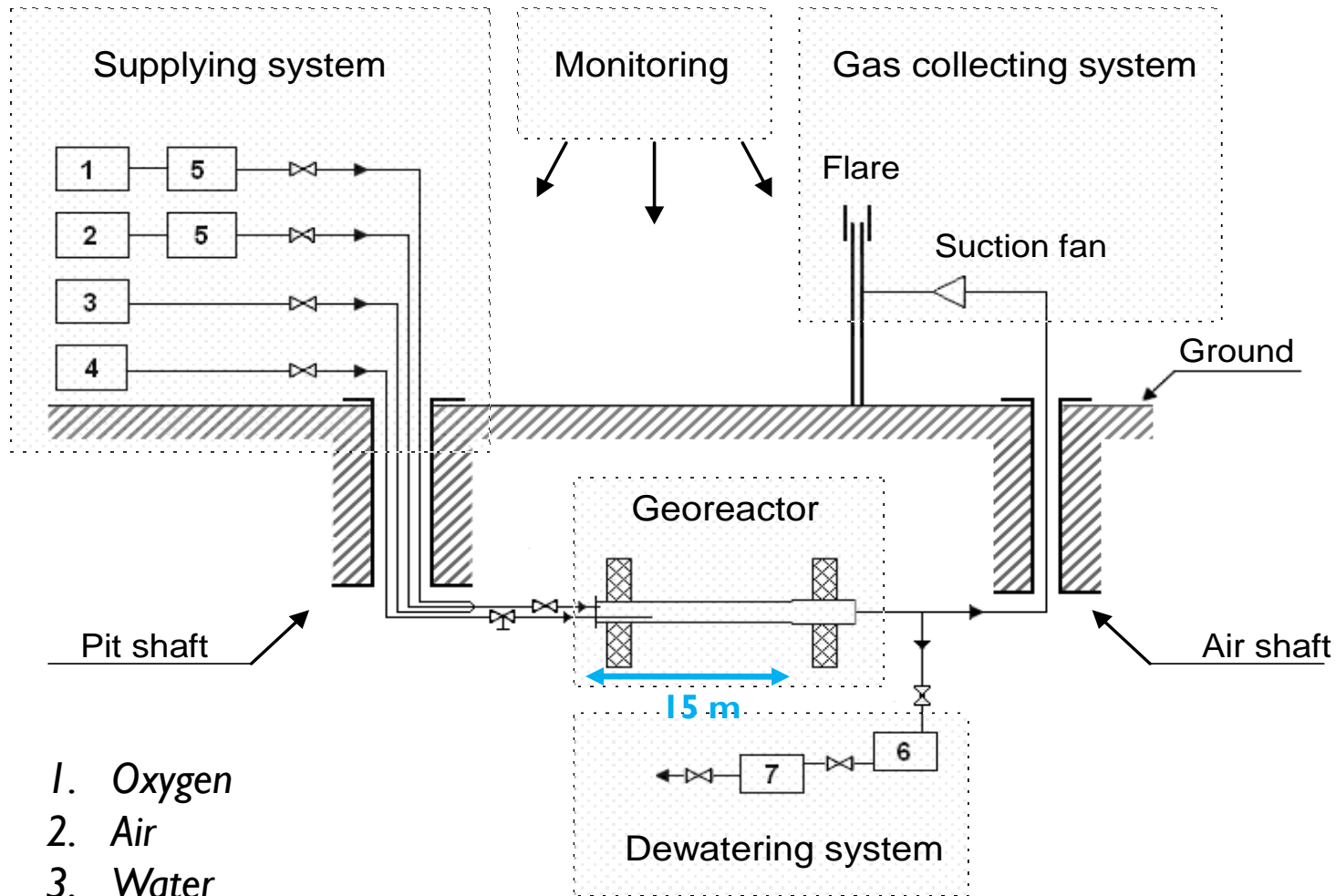
Field-scale UCG experiments at Experimental Mine „Barbara” in Mikołów



Map of mine workings and land surface of the HUGE test site



Scheme of the in-situ installation



1. Oxygen
2. Air
3. Water
4. Nitrogen

Georeactor's input wall and inlet



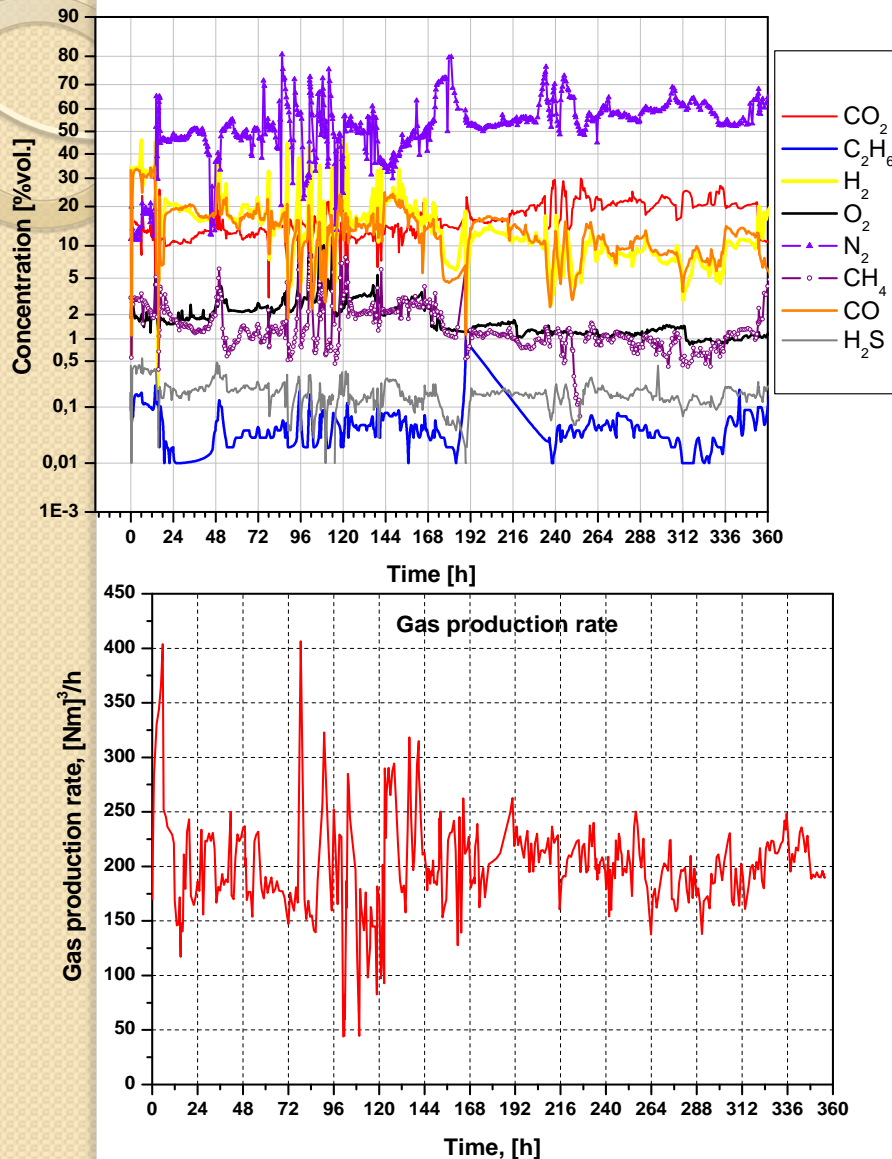
Coal seam ignition





G I G

Operating conditions and general gasification results



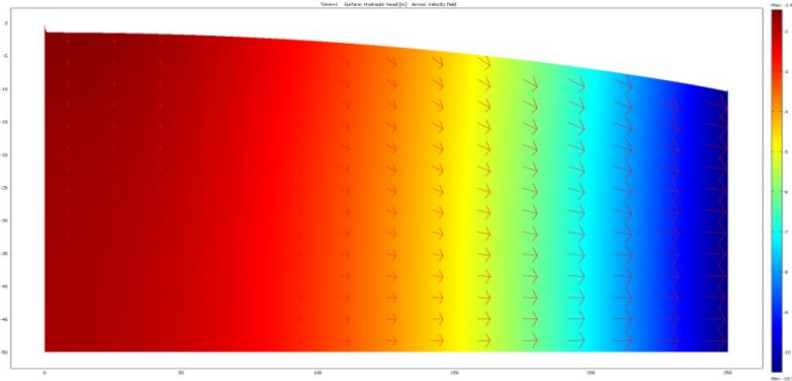
Parameter	Value
Gasification agent	oxygen
Oxygen supply rate, Nm³/h	10 - 40
Experiment duration, hours	355
Average gas production, Nm³/h	202
Average gas composition, %:	
CO ₂	16.4
H ₂	14.7
CH ₄	1.5
CO	13.4
N ₂	52.9
Average gas heating value, MJ/Nm³	3.75
Total coal consumption, kg	22 100
Process energy efficiency, %	56

Investigation of the post-gasification cavity



Numerical modelling of UCG hydrogeology – E Mine

Groundwater flow model (2D)

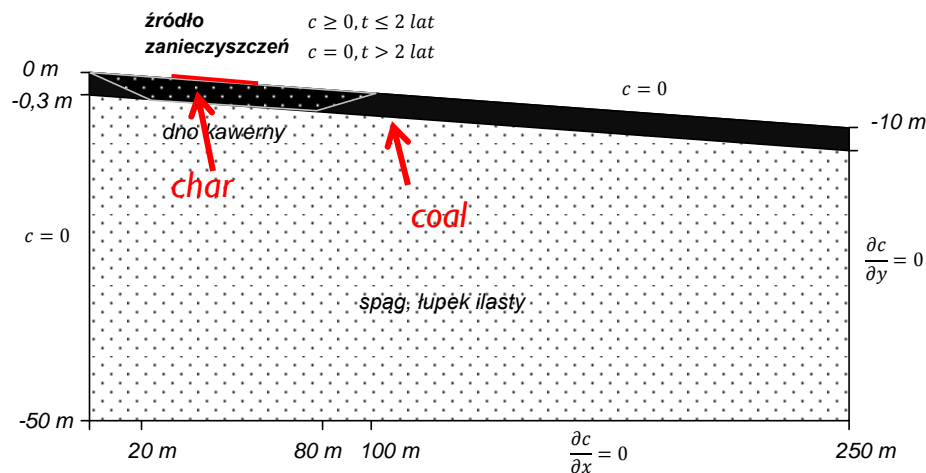


Darcy' law:

$$u = -K\nabla H$$

$$S \frac{\partial H}{\partial t} + \nabla \cdot [-K\nabla H] = Q_s$$

Contaminant transport model



Advective – dispersive transport:

$$\frac{\partial C}{\partial t} + \nabla \cdot (-\theta D \nabla C + uC) - \lambda R \theta C = 0$$

Contaminant transport in coal seam and selected rocks

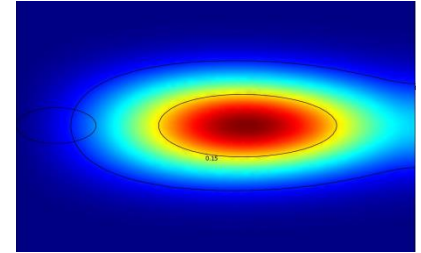
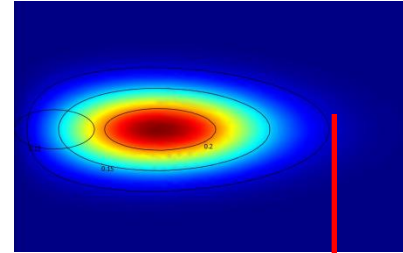
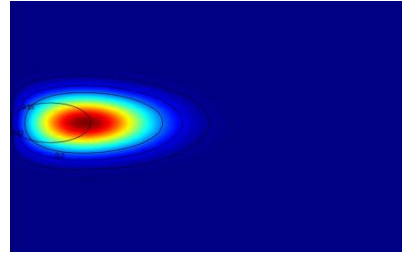
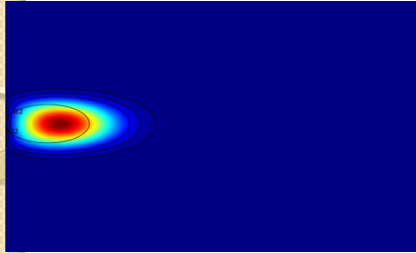
1 year

3 years

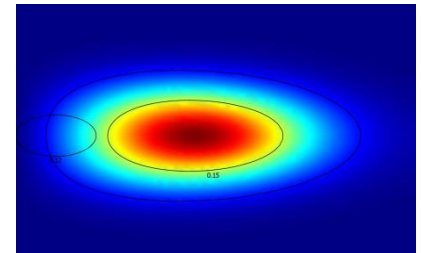
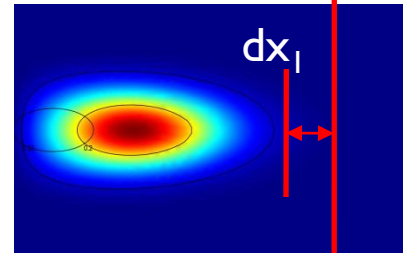
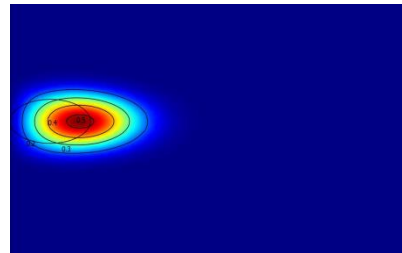
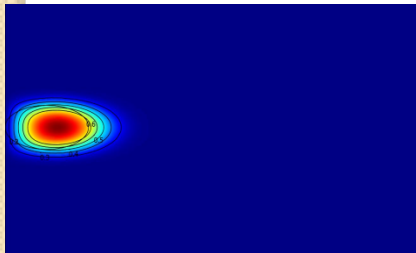
10 years

20 years

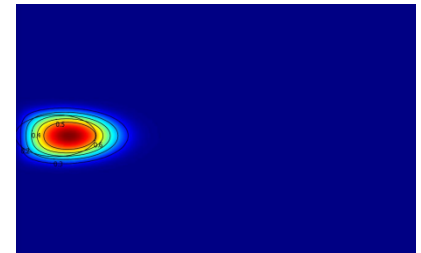
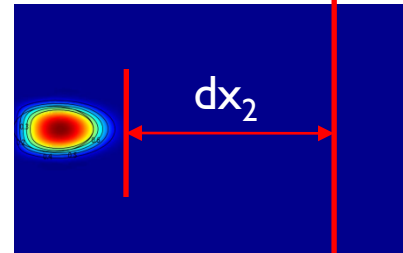
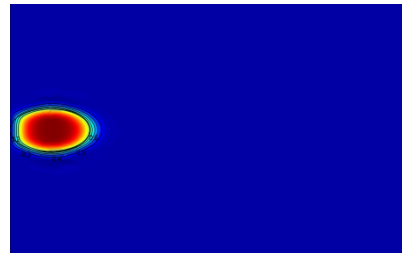
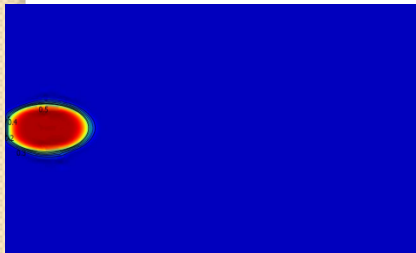
Shale 1



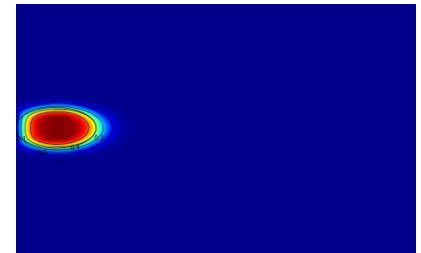
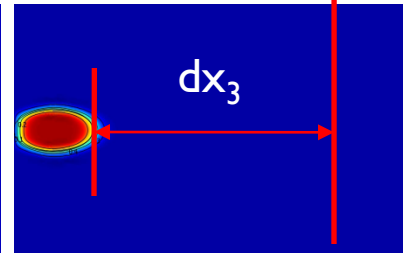
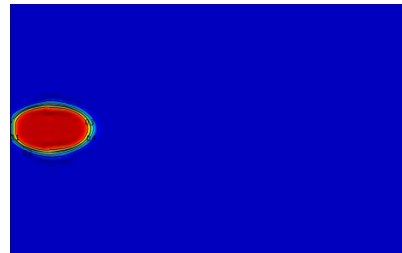
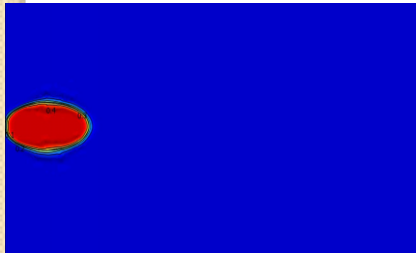
Shale 2



Coal



Char



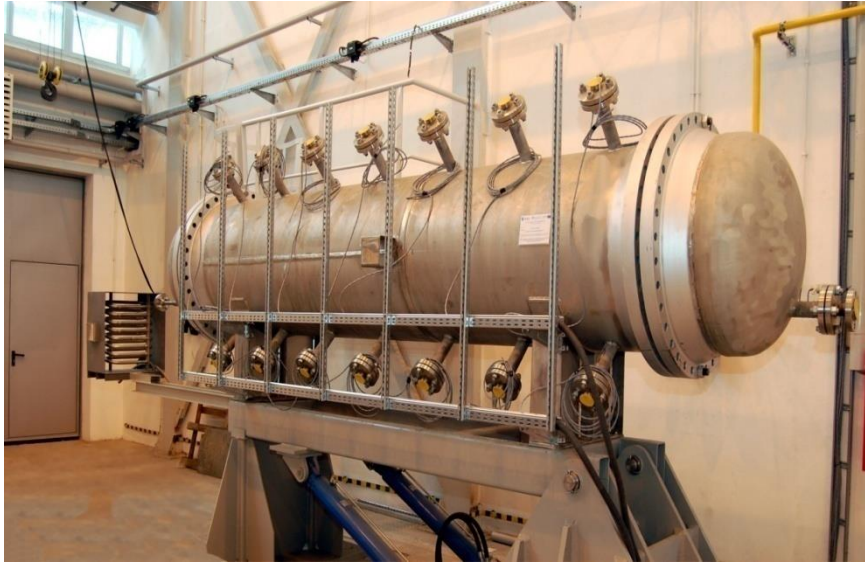
Normalized isolines of naphtalene (c/c_0)

Project TOPS

TECHNOLOGY OPTIONS FOR COUPLED UNDERGROUND COAL GASIFICATION AND CO₂ CAPTURE AND STORAGE (TOPS)

PARTICIPANT NO	PARTICIPANT ORGANISATION NAME	COUNTRY
1 (COORDINATOR)	IMPERIAL COLLEGE OF SCIENCE, TECHNOLOGY AND MEDICINE (IMPERIAL)	UNITED KINGDOM
2	SEAMWELL INTERNATIONAL LTD. (SEAMWELL)	UNITED KINGDOM
3	GLÓWNY INSTYTUT GÓRNICITWA (GIG)	POLAND
4	HELMHOLZ-ZENTRUM POTSDAM DEUTSCHES GEOFORSCHUNGSZENTRUM (GFZ)	GERMANY
5	TECHNISCHE UNIVERSITEIT DELFT (TUD)	NETHERLANDS
6	UNIVERSITY OF GLASGOW (UOG)	UNITED KINGDOM
7	PREMOGOVNIK VELENJE, D.D. (CM-VELENJE)	SLOVENIA
8	THE GEOLOGICAL SURVEY OF DENMARK AND GREENLAND (GEUS)	DENMARK
9	KATOWICKI HOLDING WĘGLOWY S.A (KHW SA)	POLAND
10	SEAMWELL (HONG KONG) LTD (SEAMWELL HK)	HONG KONG
11	GOLDER ASSOCIATES AFRICA (PTY) LTD (GOLDERSA)	SOUTH AFRICA
12	HENAN POLYTECHNIC UNIVERSITY (HPU)	CHINA
13	COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANISATION (CSIRO)	AUSTRALIA
14	MONASH UNIVERSTY (MONASH)	AUSTRALIA
15	UNIVERSITY OF CALGARY (UNICALGARY)	CANADA
16	THE TRUSTEES OF INDIANA UNIVERSTY (INDIANA U)	USA

Workpackages and experimental stand



WP2

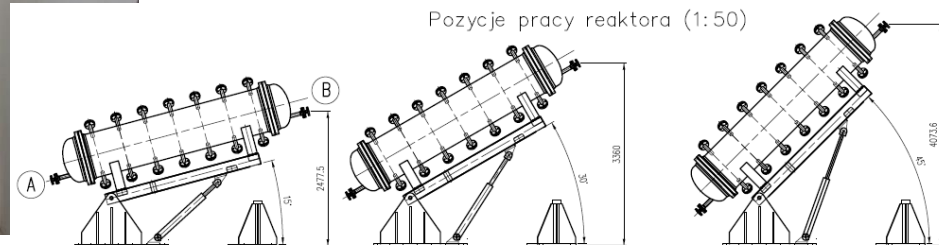
Experimental investigations in thermo-chemical processes involved in UCG – reagent and produced gas quality assessment/optimisation

WP4

Assessment of environmental impacts and risk

WP5

Storage options and coupling the UCG-CCS processes



Polish UCG project supported by The National Centre for Research and Development



**Developing a technology of coal gasification for high efficient production of fuels and electric power
Pilot scale UCG experiment in one of the Upper-Silesian coal mines – KWK Wieczorek**

Industrial UCG installation design

Partners: Central Mining Institute, Katowice Coal Holding, Academy of Mining and Metallurgy, Kraków

Cost: 20 mln euro



The aim of the project

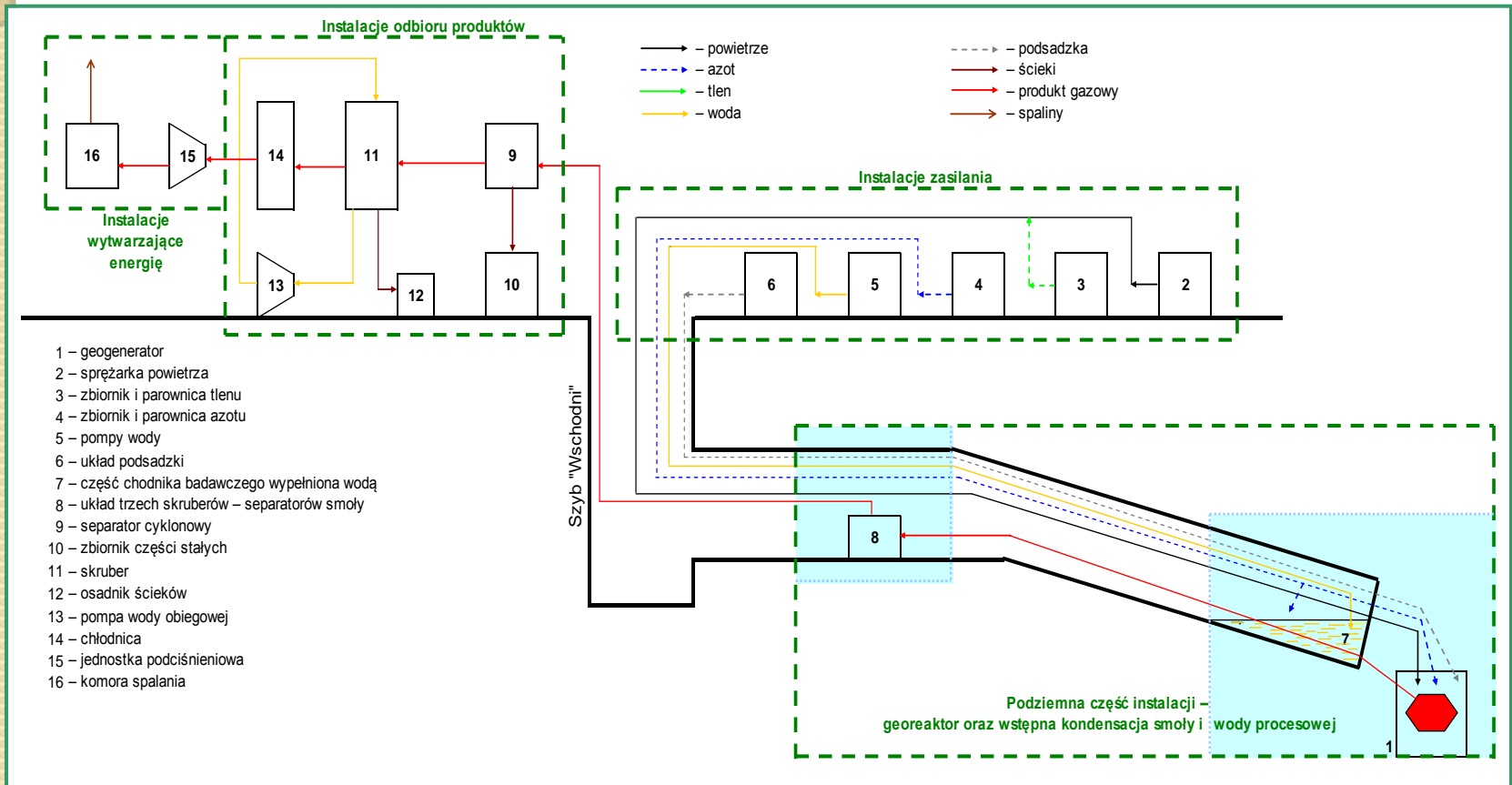
- **Accessibility of coal seam of proper localisation and thickness**
- **Gasification of coal in pilot scale**
- **Demonstration an ability of save ignition, gasification and cooling of the process**
- **Demonstration an ability of using the product of gasification (designing burner, using engine)**
- **Collection of data for technological project scaled up to demonstration size**

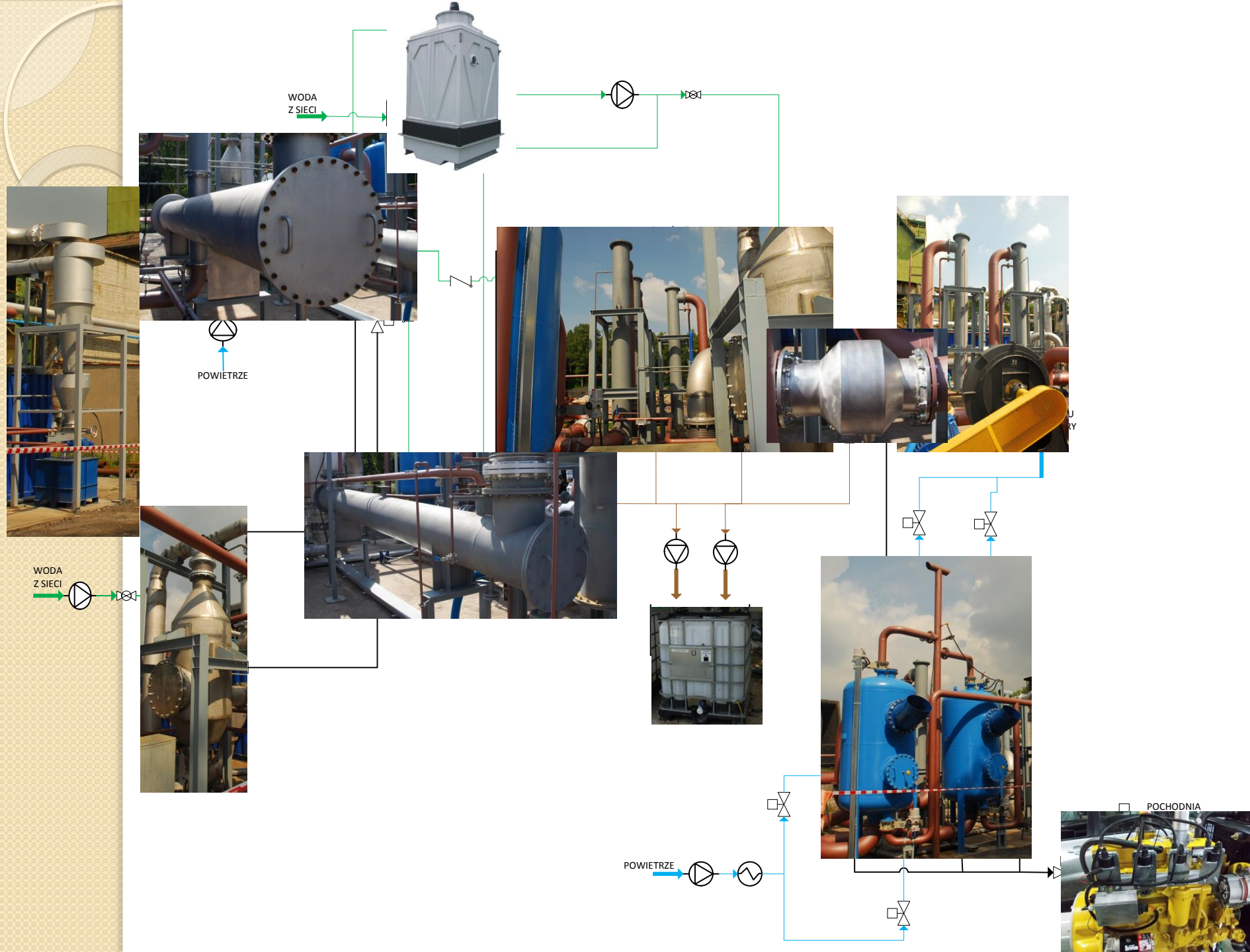


Technical assumptions

Coal consumption:	15 ton / day
Duration of trial:	2-3 months, a F/M of 2014
Gasification agent:	air (oxygen for starting)
Coal seam thickness:	5,5 m
Depths of coal layer:	500 m
Accessibility from galleries	

Infrastructure requirements – Potential to integrate with existing coal mining infrastructure





Main technical and formal problems



- **Choosing the proper place for gasification (Silesia mining area)**
- **Preparation the trial in working mine**
- **Getting special permission for the UCG trial**
- **Fulfilling the regulations of Mining Authorities**

Expected results



- 1. Mathematical model of georeactor**
- 2. Procedures for accessibility of coal seams for UCG**
- 3. Technological project of UCG demonstration installation**
- 4. Feasibility study of UCG demonstration installation**
- 5. Development of optimal system of UCG gas utilisation**



**Thank you very much for your
attention**