4th Meeting of the Platform for Coal Regions in Transition
Breakout session on “Sustainable heating”

GŁÓWNY INSTYTUT GÓRNICTWA

COAL MINE WATER HEATING SOLUTIONS

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Brussels, 09.04.2019 r.

TRANSITION PATHWAY

Mines Restructuring Company
12 non-perspective mines or parts of mines

2000
42 operating coal-mines in Silesia region

2000/2002
10% share of mining in GDP
38,7 thousand of tons/year – emission of dust pollution

2016
7% share of mining in GDP
9,1 thousand of tons/year – emission of dust pollution

2018
20 operating coal-mines in Silesia region

2040?

Goal: Zero emission economy in Europe in 2050

ADVANTAGES OF THE POST-MINING ASSETS

MINE WASTES
circular economy

MINING VOIDS

MINE WATER
geothermal energy

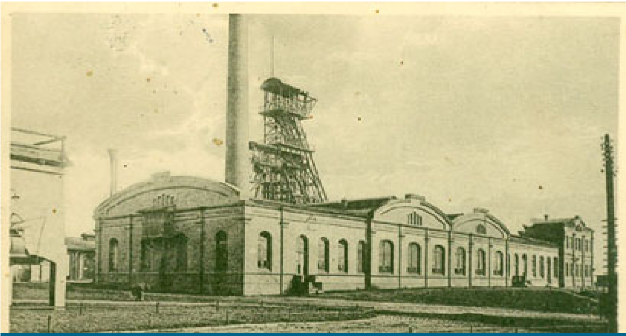
HEAP & DUMPS
ecosystem services

METHANE
(CBM, AMM, VAM)

POST-MINING INFRASTRUCTURE

MINING ASSETS
cultural heritage, leisure, education, services

REHABILITATION&RECONVERSION STRATEGIES



„Eminenzgrube" postcard dated 1915

Silesia City Center

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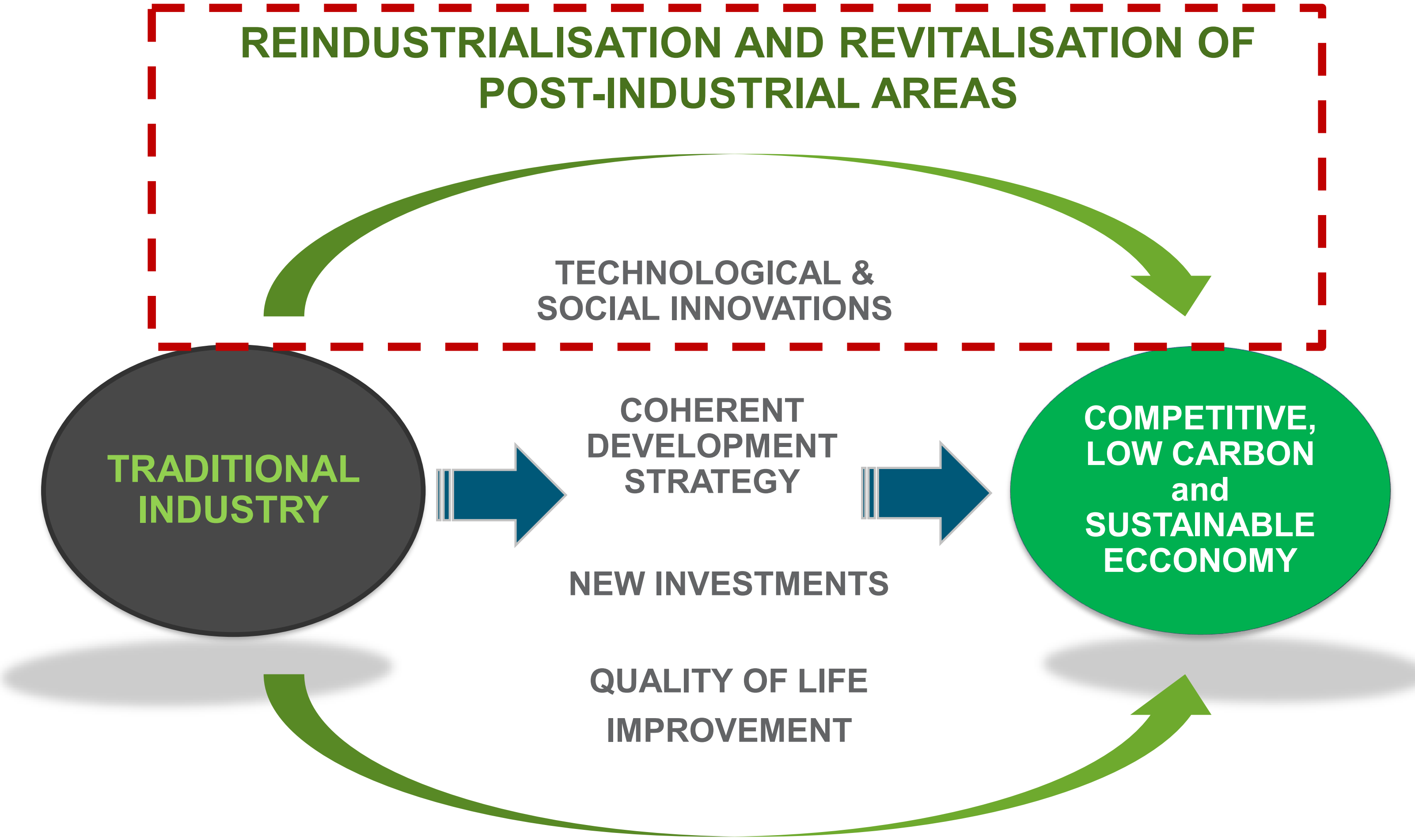
TRANSITION COMPOUNDS



MULTI-LEVEL MANAGEMENT AND PARTNERSHIP

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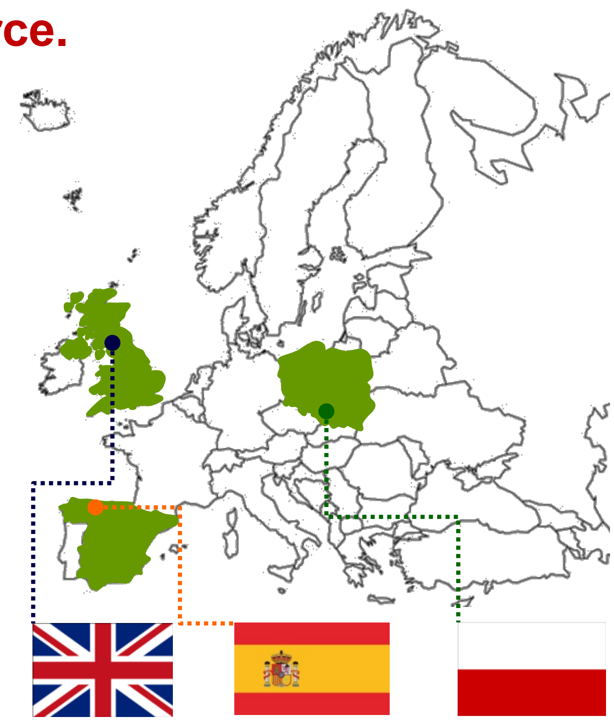
Low-Carbon After-Life (LoCAL): sustainable use of flooded coal mine voids as a thermal energy source – a baseline activity for minimising post-closure environmental risks

LoCAL project brings together the state-of-the-art in modelling & management of abandoned coal mine workings for use the mine water as a heat source.

LOw Carbon After Life: sustainable use of flooded coal mine voids as a thermal energy source - a baseline activity for minimising post-closure environmental risks

LOCAL

- **Główny Instytut Górnictwa (GIG)**
- **ARMADA DEVELOPMENT S.A.**
- **University of Oviedo (UOVE)**
- **Hulleras del Norte S. A. (HUNOSA)**
- **University of Glasgow (UoG)**
- **ALKANE Energy**



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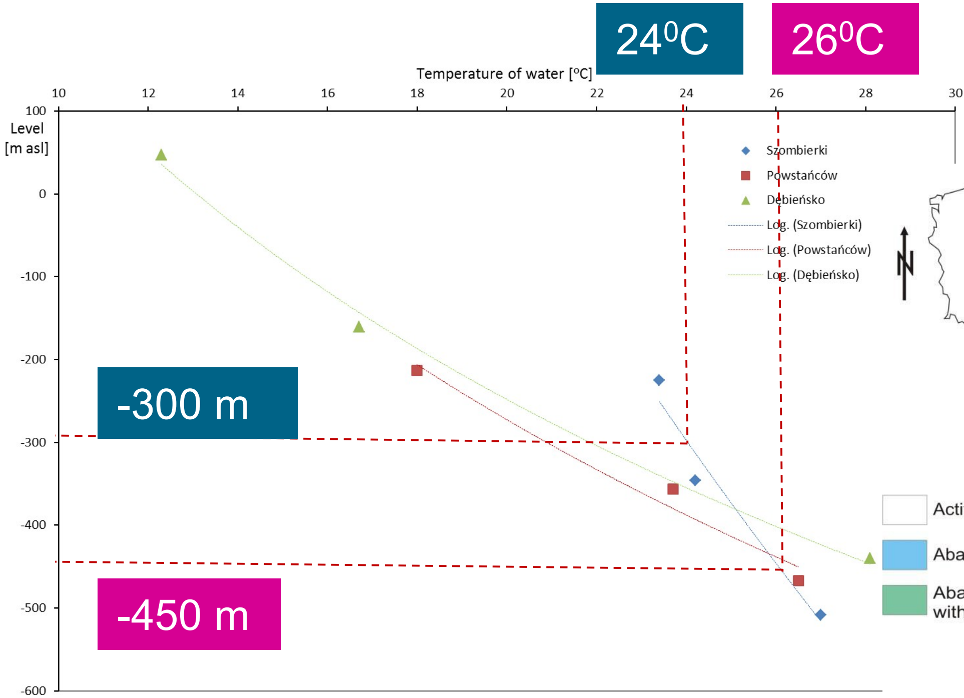
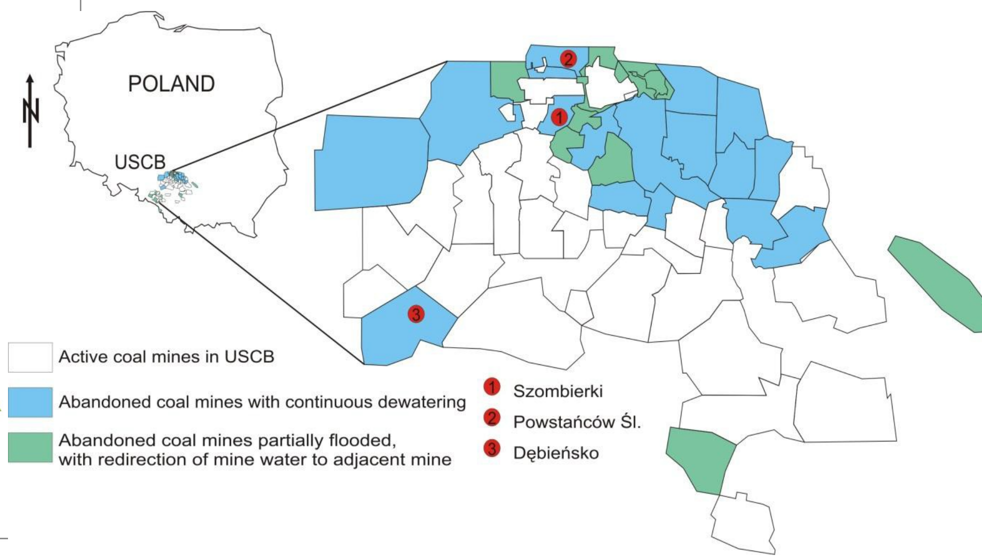
MINE WATER SYSTEMS ADVANTAGES

- A flooded underground mine represents a huge thermal resource and store,
- Mine water temperature is around (or somewhat above, in deep mines) the annual average air/soil temperature.





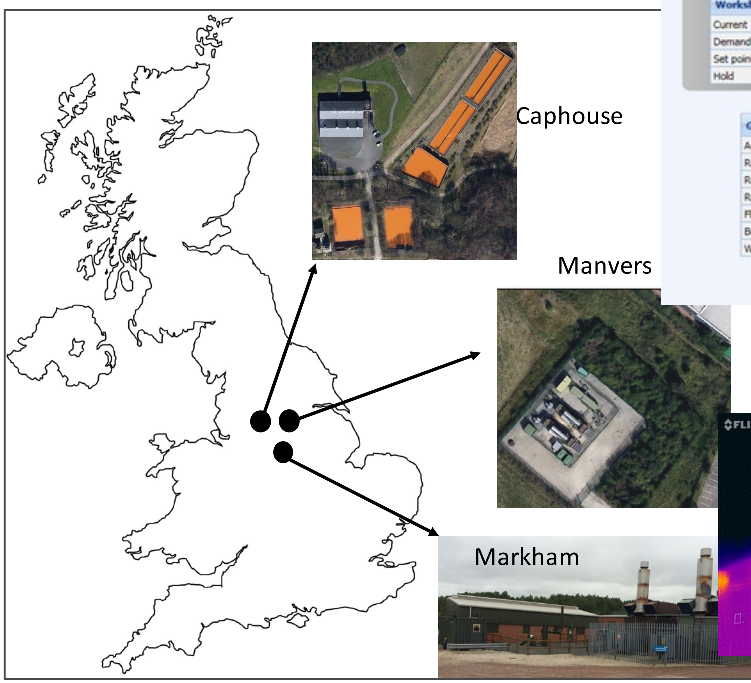
Comparison of temperature of inflow to main levels of the mines Powstańców Śląskich (a), Szombierki (b) and Dębieńsko (c)

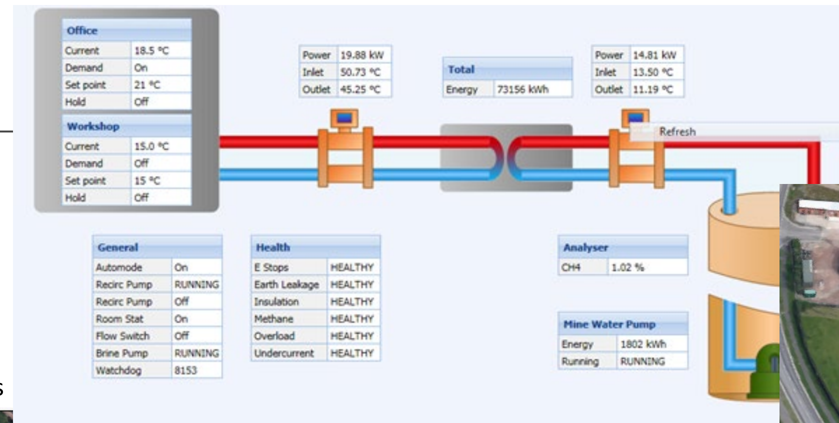
Pilot implementation at Markham site (UK)

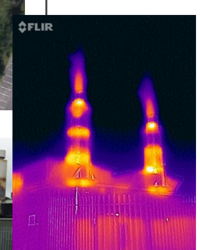
Pilot applications in UK have been implemented in:

- Markham Colliery, Bolsover, Derbyshire – **open loop system**
- Caphouse Colliery, Overton, near Wakefield, Yorkshire – **both open and closed loop systems have been installed**

TRL=9







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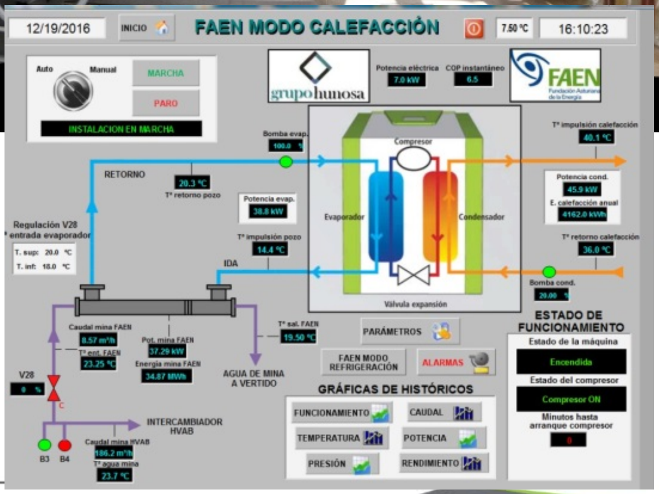
Pilot implementation at pilot site in Asturias (ES)

Spanish pilot implementation at Barredo shaft in Mieres, Asturias included:

- Hospital and University (optimization of **existing open loop** instalations)
- **newly built open loop** instalation for FAEN (Asturian Energy Foundation)



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Pilot implementation at pilot site in Bytom (PL)

Armada Development, a golf course club and housing developer has built the **pilot open loop instalation** based on mine water discharge from abandoned but still dewatered Szombierki mine in Bytom

TRL=8

The container at Bytom site (PL

Mine water is a valuable and promising thermal energy source

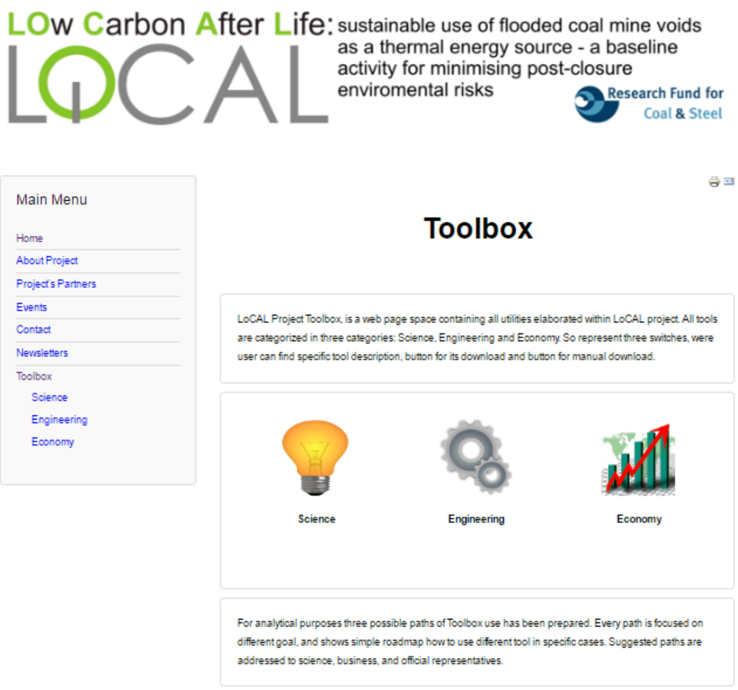
Mine water pipe outlet

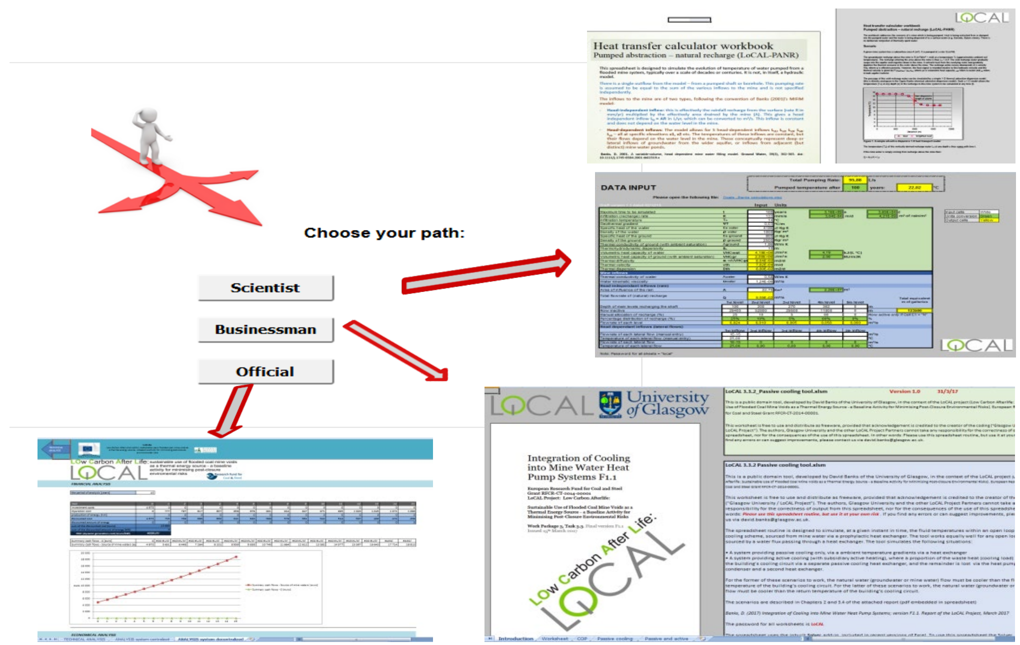
Construction works

TOOLBOX

Toolbox assuring multiplication of the project results

All LoCAL tools and algorithms were combined as a one web-based toolbox gathering all utilities for mine waters heat extraction categorized in three categories: Science, Engineering and Economy. Toolbox is free of charge and it is available at: http://local.gig.eu/index.php/toolbox



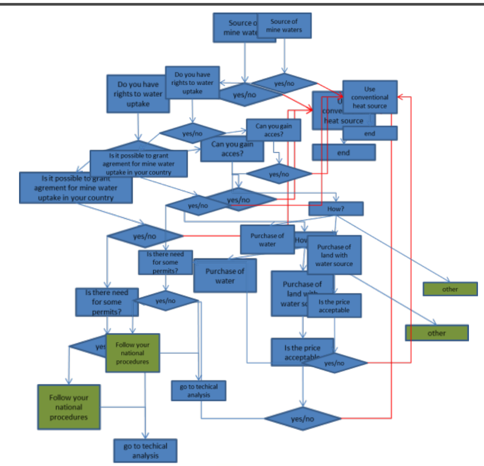


ANALYTICAL TOOL FOR INVESTORS

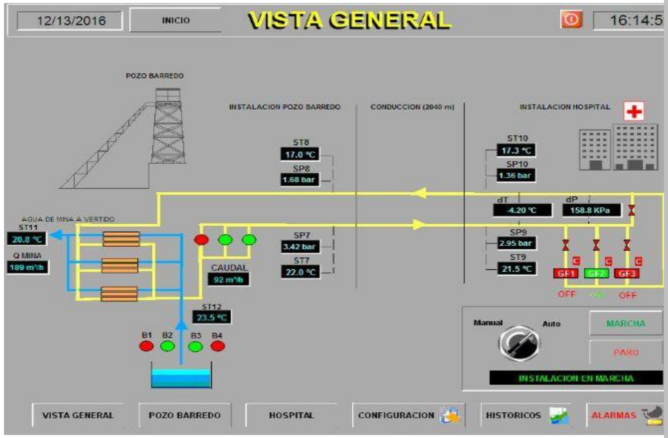
- **Technical, legal and management STEEP/ cost-benefit analysis of various types of decentralised heat pump system, versus centralised plant room system.**
- **Ownership, management and financial models; accessibility to subsidies with different ownership models and responsibility for contamination / licensing aspects with different ownership models.**

Cost-effectiveness of thermal energy use from mine waters.

- the operation of Markham installation is expensive as the installation works on a small scale,
- the Barredo installation has much higher investment and operating costs, but the investment is due to larger scale is more profitable.



OUTPUT OF ANALYTICAL TOOL



Geothermal scheme of the hospital project

Heat transfer calculator workbook

Pumped abstraction – natural recharge (LoCAL-**PANR**)

Version 2.0 dated 01/12/16

Input cells	White
Units conversion	Green
Output cells	Yellow

Name of the site	Szombierki

MODEL OPTIONS

Use relative length of galleries to distribute recharge (Y/N)	N	Use Row 41 to manually enter recharge distribution
Use geothermal gradient to distribute temperature (Y/N)	Y	
Calculate head dependent flows (Y/N)	N	Use rows 43 and 44 to manually enter flows and temperatures

DEFAULT HYDRAULIC VALUES

Default static water level (m)	20
Default pumping water level (m)	500

SCENARIO FEATURES

Maximum time to be simulated	t	200	years	6,31E+09	s	7,31E+04	d
Infiltration (recharge) rate	R	110	mm/a	3,01E-04	m/d	3,49E-09	m³ of rain/m²
Infiltration temperature	T_r	10	°C				
Geothermal gradient	∇T	0,024	°C/m				
Specific heat of the ground	Ce ground	800	J/ Kg K				
Density of the ground	ρ ground	2500	Kg/ m³				
Thermal conductivity of ground (with ambient saturation)	λ ground	1,86	W/m K				
Thermohydrodynamic dispersivity	β_L	10	m				
Volumetric heat capacity of ground (with ambient saturation)	VHCgr	2,00E+06	J/m³ K	2,00	MJ/m3K		
Thermal diffusivity	α =λ/VHCgr	8,04E-02	m2/d				

MINEWATER FEATURES

Thermal conductivity of water	λ water	0,58	W/m K		
Water kinematic viscosity	υ water	1,24E-06	m²/s		
Specific heat of the water	Ce water	4186	J/ Kg K		
Density of the water	ρ water	1000	Kg/ m³		
Volumetric heat capacity of water	VHCwat	4,19E+06	J/m³ K	4,19	kJ/(L °C)
Thermal velocity	vth	6,30E-04	m/d		
Thermal dispersion	Dth	8,67E-02	m2/d		

Head independent inflows (rain)

Area of influence of the rain	A	10,27	Km²	1,03E+07	m²
Total flowrate of (natural) recharge	Lo	3,58E-02	m³/s		

	1st level	2nd level	3rd level	4th level	5th level		Total equivalent m of galleries
Depth of main levels recharging the shaft	510	630	790			m	
Row inactive						m	Row inactive
Manual allocation of recharge (%)	23	47	30			%	
Percentage distribution of recharge (%)	23%	47%	30%	0%	0%	%	100%
Flowrate of each level	0,008	0,017	0,011	0,000	0,000	m³/s	

Head dependent inflows (lateral flows)

	1st inflow	2nd inflow	3rd inflow	4th inflow	5th inflow	
Flowrate of each lateral flow (manual entry)	0,045					m³/s
Temperature of each lateral flow (manual entry)	23,20					°C
Flowrate of each lateral flow	0,045	0	0	0	0	m³/s
Temperature of each lateral flow	23,20	0,00	0,00	0,00	0,00	°C

Screenshot of the heat transfer calculation sheet – Input parameters for Szombierki mine

Expenses in mine water pumping from B... Shaft	
Electricicy	
Maintenance Staff	
Equipment	
General Expenses	
Expenses in pumping between the hosp... Barredo Shaft	
Electricicy	
Maintenance Staff	
Equipment	
General Expenses	
Maintenance expenses in hospital instal...	
Maintenance Staff	
Official technice service for machinery	
Guard service	
Auxiliary services	
Materials	
Official audtis	800,00
Correctivo (16 h/mes)	4.754,00
Legionella Prevention	1.600,00
Total expenses	130.087,91

Cost for hospital project

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FEASIBILITY OF MINE WATER SYSTEMS

The technology could be feasible commercially for the short term if some conditions are available:

1. Infrastructure bore hole is available.
2. Water already pumped (for other reasons)
3. Government organisations can absorb the cost of infrastructure.
4. One main user of energy (e.g. hospital, university, shopping center), where preparation phase can be simplified.
5. Water level is high (low energy for pumping).

The above conditions will allow shorter payback period and enhance the commercialisation process.

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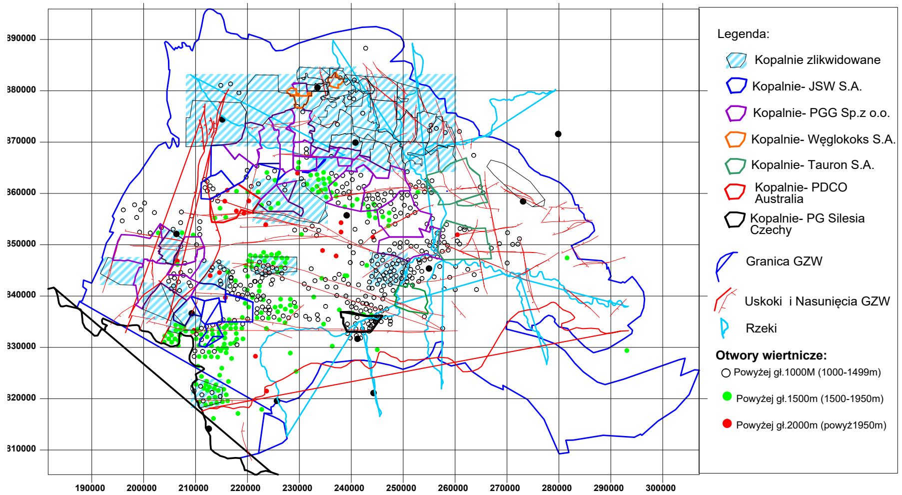
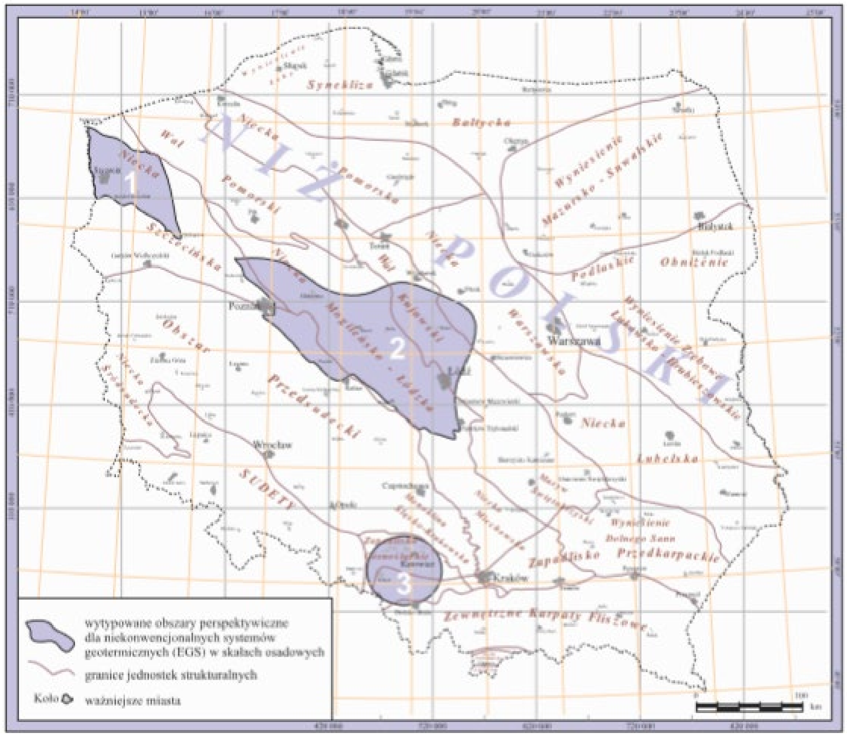
NEXT LEVEL – DEEP GEOTHERMAL POTENTIAL

The Upper Silesia region (area 3) should be considered as prospective for potential geothermal systems (HDR and EGS) in sedimentary rocks, however the majority of deep wells documenting reservoir rocks are located at the border of the area and only 21 wells below 2 km in the Silesian Coal Basin area.

Location map of boreholes with depth of over 1000m on USCB area



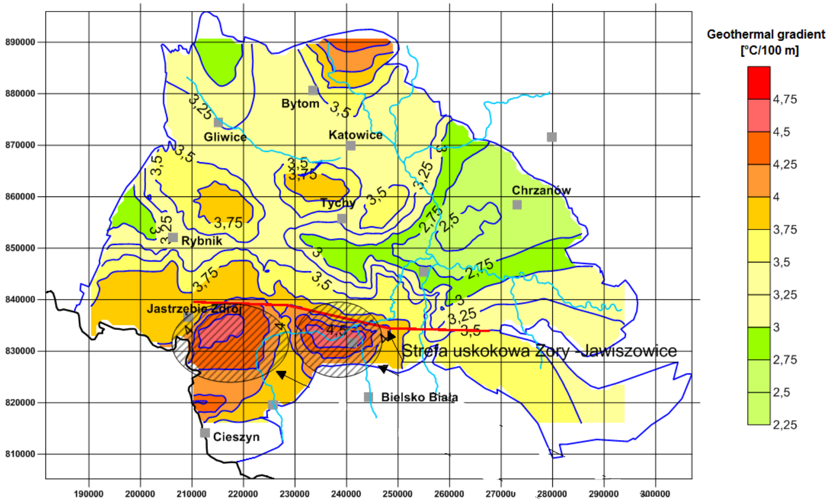
Number of boreholes with depth of over 1000 m - 632 pcs
Number of boreholes with depth of range 1000-1498 m - 411 pcs
Number of boreholes with depth of range 1500-1990 m – 200 pcs
Number of boreholes with depth of over 2000 m – 21 pcs



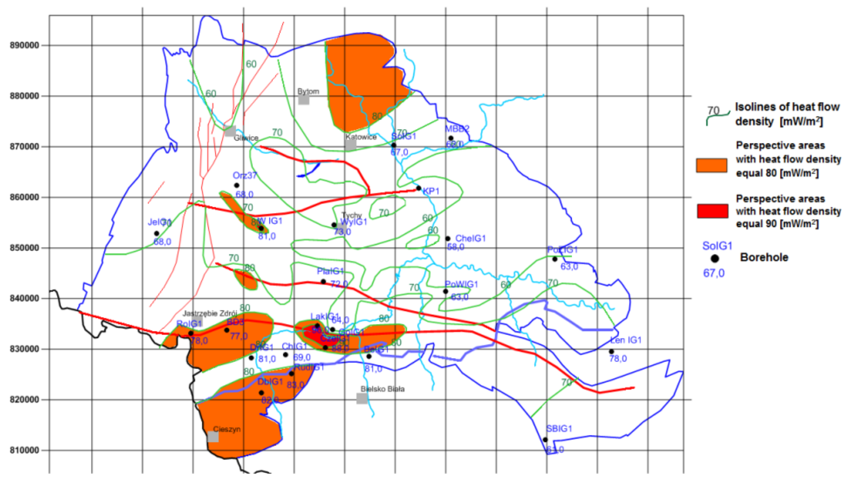
Map of selected prospective areas for the location of unconventional potential geothermal systems (HDR and EGS) in sedimentary rocks

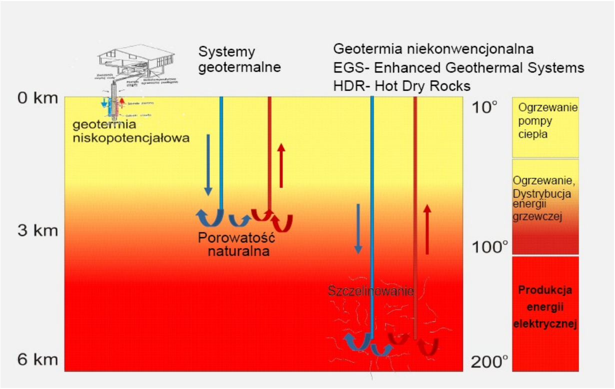
PROSPECTIVE GEOLOGICAL STRUCTURES FOR THE NEEDS OF CLOSED GEOTHERMAL SYSTEMS (HOT DRY ROCKS) - UPPER SILESIAN COAL BASIN (USCB) AREA

Geothermal gradient map on USCB area



Heat flow density map of the Upper Silesian Coal Basin





What has been done in the area of Upper Silesia?

1. **Assessment of the geothermal potential of water tables up to a depth of 4km on USCB area.**

2. **Assessment of rock properties and geothermal gradient on the region of USCB.**

3. **Assessment of the potential, thermal balance and prospective geological structures for the needs of closed geothermal systems (Hot Dry Rocks) on USCB area.**

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REMARKS

Green energy, carbon footprint

- Mine water can be used as a sustainable source of both heating and cooling purposes,
- This would promote the use of „green" energy, helping in decreasing the carbon footprint,
- This would also provide an after-life for the mine,
- Post-mining resources can be effectively combined with other energy systems,
- **There is still more options available to conver former coal mine into energy source such as (HDR, EGS).**

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THANK YOU FOR ATTENTION

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