GŁÓWNY INSTYTUT GÓRNICTWA

Post-mining research and coal mine re-use

CoalTech2051

International strategic workshop on European coal research in light of EU policy objective to 2050 and future global trends in coal use

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ALTERNATIVE OPTIONS TO THE CLASSICAL BUSINESS AT COAL MINE SITES

We will focus on the unique aspects of a mine site that allow to take advantage of the former mining activity in order to develop jobs and economic value, especially in relation to coal regions in transition.

After mine closure the options for valorisation and re-use of coal mine sites can be apportioned in two categories:

1. Sustainable energy generation
2. Other circular mining contributions

SUSTAINABLE ENERGY GENERATION

- Geothermal energy recovery from mine water.
- Energy production from abandoned coal mine methane (AMM).
- Underground coal gasification (UCG).
- Coalbed methane (CBM) and enhanced CBM recovery.
- Energy storage and power generation from underground pumped storage plants.

OTHER CIRCULAR MINING CONTRIBUTIONS

- Energy and material recovery from mining wastes, including trace elements.
- Supply of mine water for potable, agricultural and industrial uses and as sought-after resource of distinct trace elements.
- Alternative uses of mine spoil heaps and voids.
- Heritage tourism and new business uses.
- Eco-industrial parks.

GEOTHERMAL ENERGY RECOVERY FROM MINE WATER

- Underground mine waters have a high potential for ground source heating and cooling via the use of heat pumps.
- The main advantages for implementation of heat pumps are:
  - Economy: consumption of approximately 1kW of electrical energy to produce approximately 4 kW of heat energy.
  - Low maintenance: systems are reliable, compact and silent.
  - Long term of work up to 30 years without overhaul.
  - Environmentally friendly and safe during exploitation.
  - Short term of self-repayment.

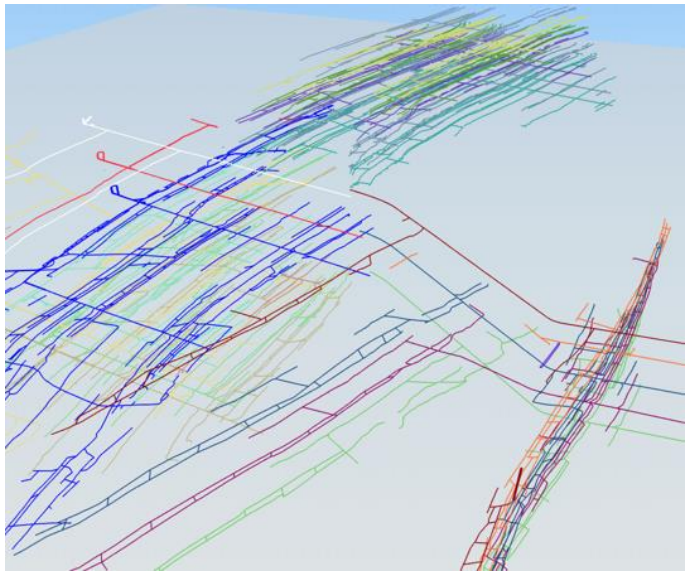
GEOTHERMAL ENERGY RECOVERY FROM MINE WATER

- Factors that affect geothermal energy recovery potential:
  - The size and proximity of local communities that can use the produced energy.
  - Local climatic conditions.
  - Size and type of the geothermal resource: production enthalpy and achievable mass flow rates.
  - The need or not to pump water in order to maintain a safety level as well as the pumping depth.
  - The price of purchasing alternate energy sources.
  - The existence of policy incentives: carbon offset credits, renewable energy credits and/or tax and royalty benefits.

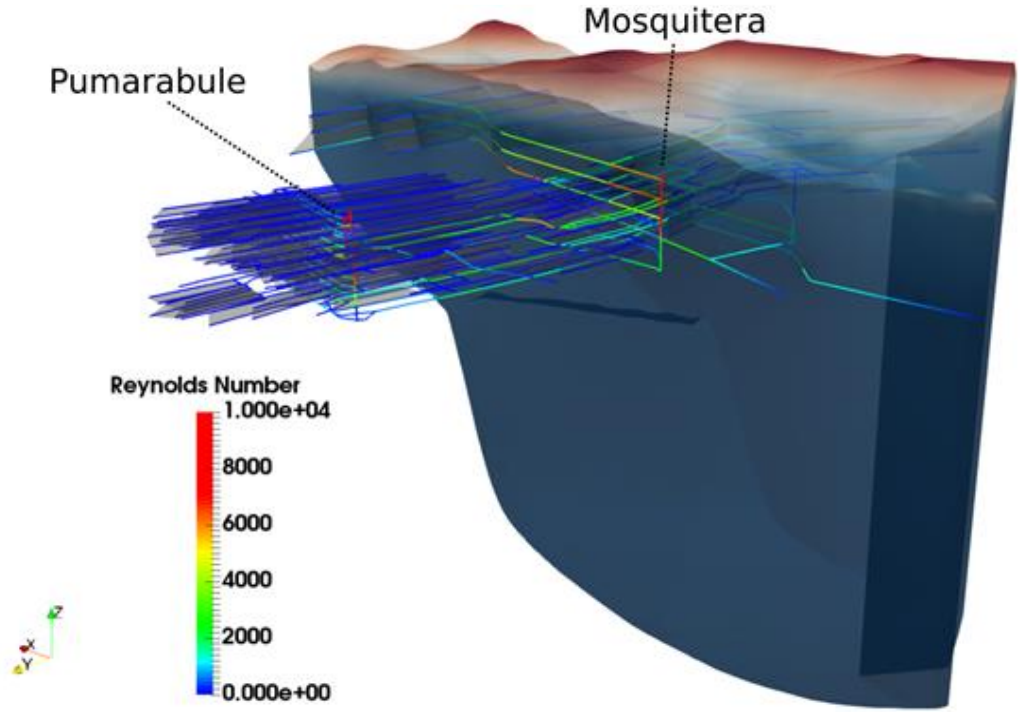
GEOTHERMAL ENERGY RECOVERY FROM MINE WATER

Research Fund for Coal & Steel

- RFCS MERIDA Project: Management of environmental risks during and after mine closure.



Hydraulic/thermal mode



MERIDA
RFCS RESEARCH PROJECT

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ABANDONED MINE METHANE (AMM)

- Capture and extraction of methane from closed coal mines enables to produce energy while limiting release of green house gases in the atmosphere and securing surface from leakage.
- Nevertheless, the presence of methane in a closed mine is not a sufficient reason in order to justify extraction and utilization. A pre-feasibility study is needed as a first step.
- The quantity of AMM available for release depends on various factors including the volume of un-worked coal in the strata disturbed by mining, the residual gas content of the coal still in place, the rate of flooding of the workings, and the quality of the shafts and drifts sealing.
- However, destruction of the gas by flaring may be feasible or convenient in some countries as a carbon offset project or to secure leakages to the surface.

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ABANDONED MINE METHANE (AMM)

- Some factors that affect an AMM project feasibility:
  - Engineering measures taken underground prior to closure to optimize gas accessibility.
  - Options to control water on closure/rate of flooding.
  - The existence of a coal mine methane (CMM) project when the mine was active.
  - The prices for electricity and low to medium heat value gas, existing gas storage and distribution infrastructure, and possible industrial and commercial customers.
  - Policy framework: carbon offset credits, renewable energy credits and/or tax and royalty benefits.
  - Ownership rights and possibility to transfer those rights, and complication and timing of the permitting process.

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ABANDONED MINE METHANE (AMM)

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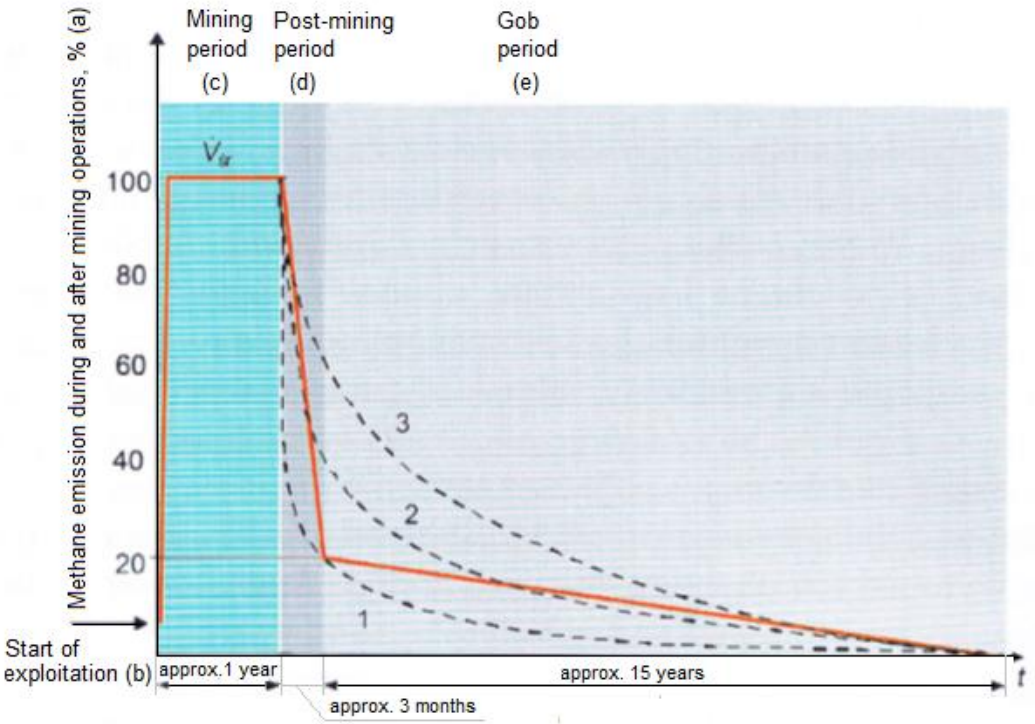

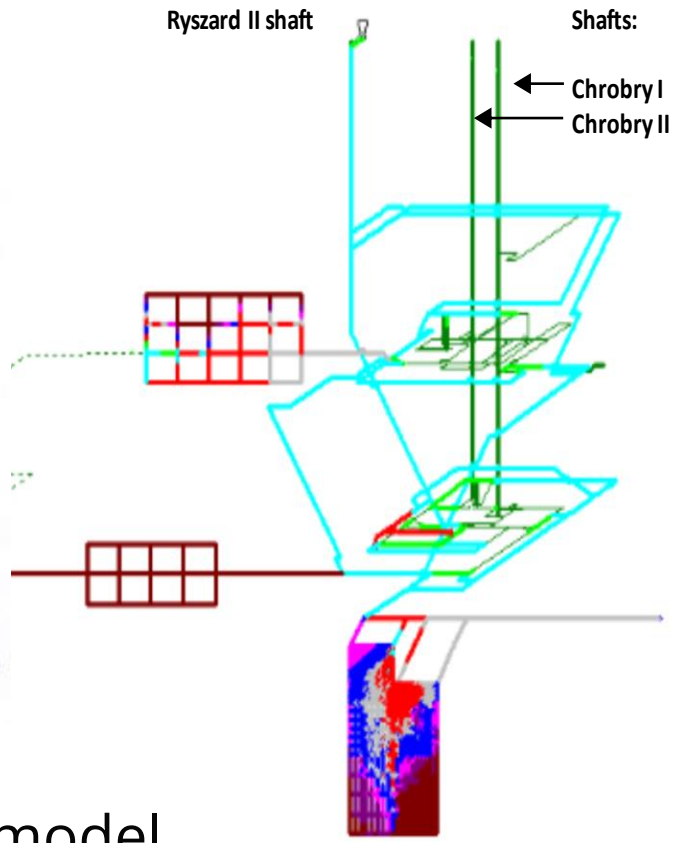

Reservoir model

OTHER TECHNOLOGY OPTIONS FOR SUSTAINABLE ENERGY GENERATION

- Underground coal gasification (UCG): although UCG technology has been basically mature and there is a possibility to combine UCG with CO_2 capture and storage, its industrialization has been slow due to technologies and environmental protection.
- Coal bed methane (CBM) and enhanced CBM recovery: existing (albeit sparse) data suggest that much of the EU CBM resource would require fracking. Simultaneously, land use and water impacts are considerable and abatement practices are limited.
- Moreover, both UCG and CBM are extremely dependent on EU climate policies, as well as on complex permitting processes in Europe.
- Finally, energy storage and power generation from underground pumped storage plants cannot yet be considered a mature technology.

ENERGY AND MATERIAL RECOVERY FROM MINING WASTES, INCLUDING TRACE ELEMENTS

- Mining waste is more and more considered as another natural resource:
  - Energetic valorisation of mining wastes.
  - Extraction/obtention of valuable substances including the recovery of critical raw materials.
  - Obtention of crushed road and construction aggregates.
  - Raw materials for the cement industry.
  - Void backfilling, etc.
- Relevant ongoing projects:
  - Co-processing of coal mine and electronic wastes.
  - Recovery of Rare Earth Elements.
  - Production of bricks and fuel for their burning

SUPPLY OF MINE WATER FOR POTABLE, AGRICULTURAL AND INDUSTRIAL USES AND AS SOUGHT-AFTER RESOURCE OF DISTINCT TRACE ELEMENTS

- Coal mine waters can be strongly acidic and can contain high levels of dissolved salts and heavy metals.
- Others can have a near neutral pH with lower concentrations of heavy metals but with a higher hardness and higher concentrations of silica and sometimes phosphates.
- It is possible to design and construct coal mine water treatment plants that can recover high quality drinking water from all of these different coal impacted waters and which are able to accommodate the quality and the quantity variations that typically occur over time and season by season.
- Also, there is renewed interest in the use of mine water for irrigation as a mean to reduce mine impacted water treatment costs and to create sustainable livelihoods.

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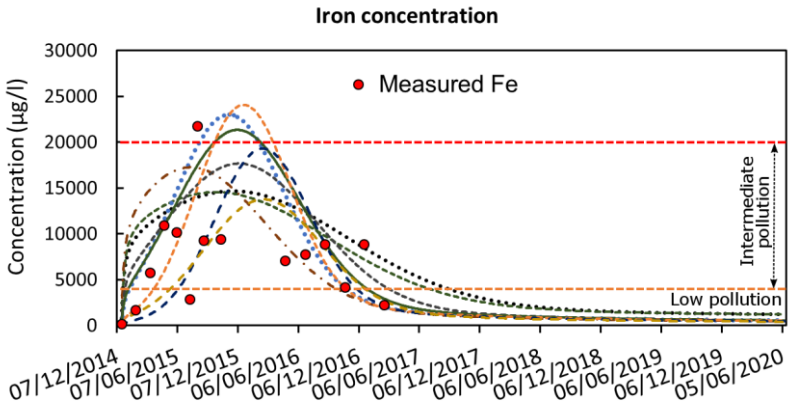
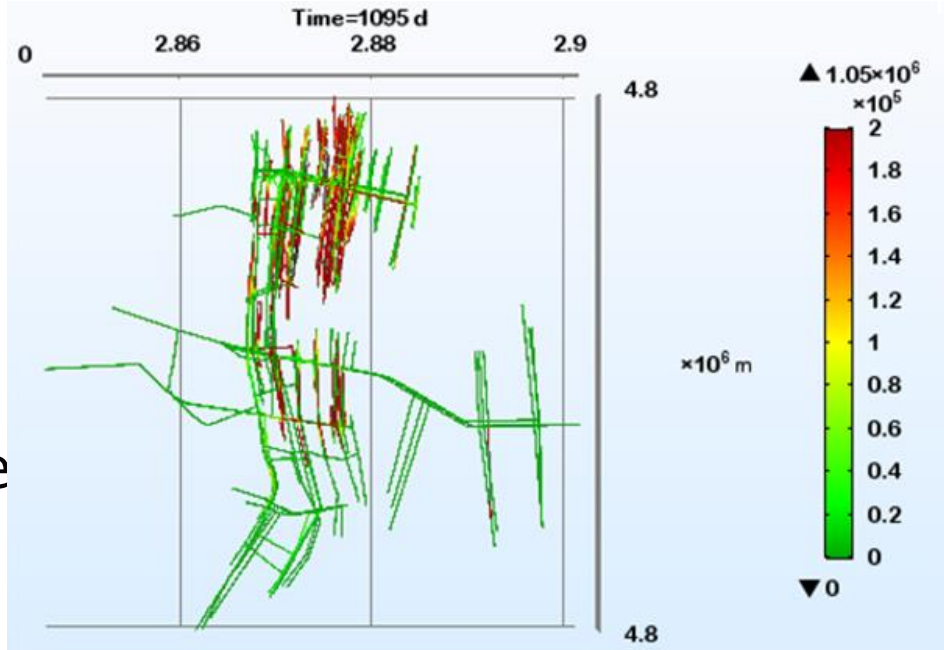


Contaminant transport mode



ALTERNATIVE USES OF MINE SPOIL HEAPS AND VOIDS

- Ecosystem restoration.
- Commercial forestry plantations and/or biomass production.
- Agriculture and/or livestock.
- Wind and solar power production.
- Use of voids to store fine-grained waste from mines and power plants.
- Use of voids for flood prevention.

ALTERNATIVE USES OF MINE SPOIL HEAPS AND VOIDS

- RFCS RECOVERY Project: Recovery of degraded and transformed ecosystems in coal mining-affected areas.

www.recoveryproject.eu

  - To select land rehabilitation and ecological restoration actions that deliver the greatest benefits relative to their costs, based on the ecosystem services concept.
  - To develop artificial substitutes for soils suitable to several types of plant communities, addressing 'difficult terrains' in coal mining waste heaps.

Recovery
RFCS RESEARCH PROJECT

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Libiąż spoil heap, Poland

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Libiąż spoil heap, Poland

HERITAGE TOURISM AND NEW BUSINESS USES

- Heritage tourism commonly involves displays designed to represent and commemorate a valued cultural past. Apart from museums, visitors can 'experience the past' by going underground, being guided by 'real miners' and engaging with material artefacts of mining, not merely observing them.
- On the other hand, the re-use of abandoned buildings may bring bright ideas to once faded facades, and transform them into new industries or business.

ECO-INDUSTRIAL PARKS

- The main objective of industrial parks is to reduce waste and pollution by promoting short distance transport, optimizing material, resource and energy flows within the industrial parks.

CONCLUSIONS

- Key parameters/criteria that make existent technologies for sustainable energy generation and other circular mining contributions a socio-economic success have to be considered.
- Stakeholders' expectations have to be identified, in order to understand their priorities in terms of economic, social, cultural and environmental aspects, as well as problems or obstacles that may be perceived within these areas.

SOCIAL FACTORS

ECONOMIC FACTORS

LEGAL FACTORS

TECHNOLOGICAL FACTORS

ENVIRONMENTAL FACTORS

REUSE?
(infrastructure and Post-mining resources)

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