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Revitalization of post mining areas: circular economy contributions

Post-Mining Perspectives: Capture and Use of Abandon Mine Methane and Mine Reclamation and Revitalization of Post Mining Areas

Alicja Krzemień
Pedro Riesgo

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ALTERNATIVE OPTIONS TO THE CLASSICAL BUSINESS AT COAL MINE SITES

Focusing 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**: geothermal energy, abandon mine methane (AMM), underground coal gasification (UCG), coalbed methane (CBM) and enhanced CBM, energy storage, energetic valorisation of mining wastes, etc.
2. **Other circular economy contributions**

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OTHER CIRCULAR ECONOMY CONTRIBUTIONS

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

MATERIAL RECOVERY FROM MINING WASTES, INCLUDING TRACE ELEMENTS

- Mining waste is more and more considered as another natural resource:
  - 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, etc.
  - Void backfilling, etc.

- Relevant ongoing projects:
  - Co-processing of coal mine and electronic wastes.
  - Recovery of rare earth elements.

SUPPLY OF MINE WATER FOR DIFFERENT 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.
- 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.
- Research projects focus on the improvement of its quality with biological or chemical processes, membrane technologies or passive treatments, and in the recovery of critical raw materials, as in the case of mining wastes.

ALTERNATIVE USES OF MINE SPOIL HEAPS

- Ecosystem restoration.
- Commercial forestry plantations and/or biomass production.
- Agriculture and/or livestock.
- Wind and solar power production.

ALTERNATIVE USES OF MINE VOIDS

- Use of voids to store fine-grained waste from mines and power plants or other sources.
- Use of voids for flood prevention.

ALTERNATIVE USES OF MINE SPOIL HEAPS

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

- 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

www.recoveryproject.eu

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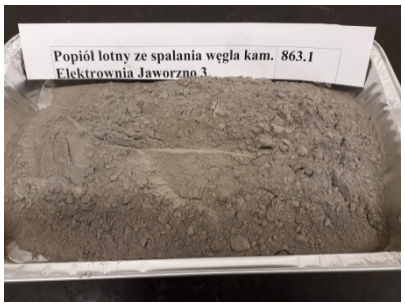
Libiąż spoil heap, Poland

Artificial substitutes for soils in difficult terrains

Fly ashes:

from coal combustion



Sludges:

from coal processing

Aggregate:

from coal processing

Organic matter:

sewage sludge

Set of components for soil preparation

Four types of soil in different combinations

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Business plan: Overall budget of the project

	Concept	Euros
1.	**OVERALL BUDGET**	108,575
1.1	Staff costs (22 person-months)	46,500
1.2	Indirect costs	16,275
1.3	Direct costs	45,800
2.	**BUDGET financed by the EU**	65,145
3.	**DIFFERENCE (1-2)**	**43,430**

- The EU finances 60% of the overall budget of the project.
- Indirect costs represents the 35% of personnel costs and they will be dedicated to cover the travels of the personnel in relation with the project development as well as general expenses.

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Business plan: Direct costs

	Direct costs	Euros
1.	**RAW MATERIALS**	27,000
1.1	Geotextile	1,200
1.2	Material from wastewater treatment plants	250
1.3	Dolomite aggregate 31-63 mm	8,400
1.4	Wild flower and grass seeds (meadow plant)	1,500
1.5	Perennial seedlings (xerophyte and wetland plant)	8,600
1.6	Tree and shrub seedlings (bush communities)	5,500
1.7	Overburden clays	1,550
2.	**Transportation of raw materials for construction of pilot investment (geotextile, coal wastes, ashes, material from wastewater treatment plants, dolomite aggregate, plants)**	8,000
3.	**Preparation of a protective layer for the test polygon against acidification and contamination from stored mine wastes**	3,800
4.	**Preparation of anthropogenic soils on the basis of various types of gangue providing optimal habitat conditions for the plant communities**	3,000
5.	**Planting, maintenance and care of the plants on a stage of vegetation**	3,000
6.	**Dedicated workshop organisation**	1,000
	TOTAL	**45,800**

Business plan: Operating & capital expenses

	Operating expenses	2019	2020	2021	2022	2023	TOTAL
1.	Staff costs	5,812.5	11,625	11,625	11,625	5,812.5	46,500
2.	Indirect costs (travel and general expenses)	2,034.38	4,068.75	4,068.75	4,068.75	2,034.38	16,275
3.	Raw materials, transport, preparation and planting	-	41,800	-	-	-	41,800
4.	Maintenance and care of plants	-	1,500	500	500	500	3,000
5.	Dedicated workshop	-	-	-	-	1,000	1,000
	Total OPEX (Euros)	**7,846.88**	**58,993.75**	**16,193.75**	**16,193.75**	**9,346.88**	**108,575**

Capital expense	%	2019	2020	2021	2022	2023	TOTAL
Own expense	40%	(18,211)	58,994	(9,864)	16,194	(3,682)	43,430
RFCS financing	60%	26,058	-	26,058	-	13,029	65,145
TOTAL CAPEX (euros)	100%	7,847	58,994	16,194	16,194	9,346.87	108,575

Business plan: Incomes estimation (conservative)

- Net benefits from the selling of substrates: 40,000 €/year.
- Avoiding losses from restoration projects failures: 10,000 €/year.
- Avoiding to pay for acid waters contamination: 4,500 €/year.
- Saving for the elaboration of the project: 15,000 € in year 2024.

Concept	2024	2025	2026	2027	2028
Net benefit selling substrates	40,000	40,000	40,000	40,000	40,000
Net benefit avoiding losses	10,000	10,000	10,000	10,000	10,000
Savings acid contamination	4,500	4,500	4,500	4,500	4,500
Project elaboration benefit	15,000	-	-	-	-
Income (Euros)	**69,500**	**54,500**	**54,500**	**54,500**	**54,500**

Business plan: Cash-flows calculation

Concept	2019	2020	2021	2022	2023
Expenses	(7,847)	(58,994)	(16,194)	(16,194)	(9,347)
Incomes (EU financing)	26,058	-	26,058	-	13,029
Cash-flow (Euros)	**18,211**	**(58,994)**	**9,864**	**(16,194)**	**3,682**

Concept	2024	2025	2026	2027	2028
Net benefit selling substrates	40,000	40,000	40,000	40,000	40,000
Net benefit avoiding losses	10,000	10,000	10,000	10,000	10,000
Savings acid contamination	4,500	4,500	4,500	4,500	4,500
Project elaboration benefit	15,000	-	-	-	-
Cash-flow (Euros)	**69,500**	**54,500**	**54,500**	**54,500**	**54,500**

Assuming an average **WACC of 10%** during the duration of the project, the following values are obtained:

- **NPV = 113,503 €**
- **IRR = 50%**
- **PP = 5 years**, or the first year after the end of the research.

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

SOCIAL FACTORS

ECONOMIC FACTORS

LEGAL FACTORS

TECHNOLOGICAL FACTORS

ENVIRONMENTAL FACTORS

REUSE?
(Infrastructure and post-mining resources)

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