

CORE POLICY FACTSHEET

Context

Brines, traditionally discharged into the environment, are a source of valuable materials. These highly saline effluents contain significant quantities of salts. The shift from a linear economic model to the circular economy strategy in the industrial sector leads both to environmental protection and to increased revenues for the industries generating brines. By implementing brine treatment, we avoid the need to mine or produce some of the recovered salts, while mitigating the environmental damage caused to land, waterways and oceans by brine discharge. Furthermore, the extraction of salts from brines contributes to lower GHG emissions since their industrial production encompasses high energy consumption and CO₂ production as byproduct.

The LIFE Brine-Mining project targets to eliminate the coal mine brine discharge in the environment and recover clean water and valuable resources from it, such as magnesium, calcium, sulfates, and sodium chloride. Through a combination of membranes, precipitation, and thermal technologies, the brine becomes a source of secondary raw materials and high purity water instead of a harmful byproduct.

This policy brief includes a short description of the LIFE Brine-Mining project, demonstrating its environmental and economic benefits. It also states the project outputs, highlights the points aligned with the existing policy regulations, and demonstrates policy recommendations for the Green Europe Industry.

BRINE-MINING - Closing the loop in the coal mine wastewater treatment

The Brine-Mining project focuses on the implementation of the WFD objectives in Poland, in the Upper Silesian Coal Basin, where coal mine activities occupy 25% of the area's territory.

Coal mine wastewater pollutes the environment, stressing aquatic flora and fauna, potentially leading to their elimination. Coal mine wastewater comprises mine water, which is extracted from great depths through excavation, and sewage water from coal preparation processes, such as cutting and washing. Discharged coal mine wastewaters elevate the salinity of a water body, deteriorating its quality and affecting its ecological status.

Resource recovery: From wastewater to valuable resources

Through advanced treatment technologies, the project pilot system recovers clean water and marketable materials, such as minerals and salts, contributing to the principles of circular economy strategy promoted by European regulations. In specific, the pilot system recovers:

- Clean water for municipal, agricultural, and industrial purposes.
- Mg(OH)₂, CaCO₃, CaSO₄ of market value
- NaCl of high purity for market exploitation.



Environmental benefits

By treating the coal mine wastewater before its discharge in water ways, the pollution load entering surface water bodies is significantly reduced, aligning with European regulations focusing on water protection and biodiversity conservation. The project also ensures that the treated water meets or exceeds the Water Quality Standards set by European regulations, protecting the public health.

The ions recovery (Mg, Ca, Na, Cl, SO₄) achieved by the project implementation lessens the need for mining and processing the corresponding raw materials, mitigating the associated environmental impacts from extraction, processing, and transportation of the minerals, including the generation of greenhouse gases from the significant energy inputs required, often sourced from fossil fuels, like coal and oil. The main environmental benefits of the project implementation are:

- Water sources conservation, since the recovered water from the plant can substitute fresh water for the coal mine needs and it can even be exploited for other industrial and municipal purposes.
- Reduced brine disposal to the environment of more than 90%.
- Mitigation of greenhouse gas releases through energy savings, by the replacement of commercial minerals and salts with the recovered from the wastewater.

Economic benefits

Cost saving: Brine-Mining aims to enable the improvement of the coal mine wastewater management performance, on the whole. Therefore, it addresses to the cost of brine discharge by incorporating the reuse of water and the other resources for mining purposes. The recovery of salts, also results in lower demand for extracted minerals, and in consequence lower required energy. This leads to a significant cost saving in the industrial sector. By **recovering magnesium**, a **critical raw material** for the EU, the project directly supports the EU strategy to reduce the imports of magnesium, promoting a cost-effecting supply chain and Europe autonomy.

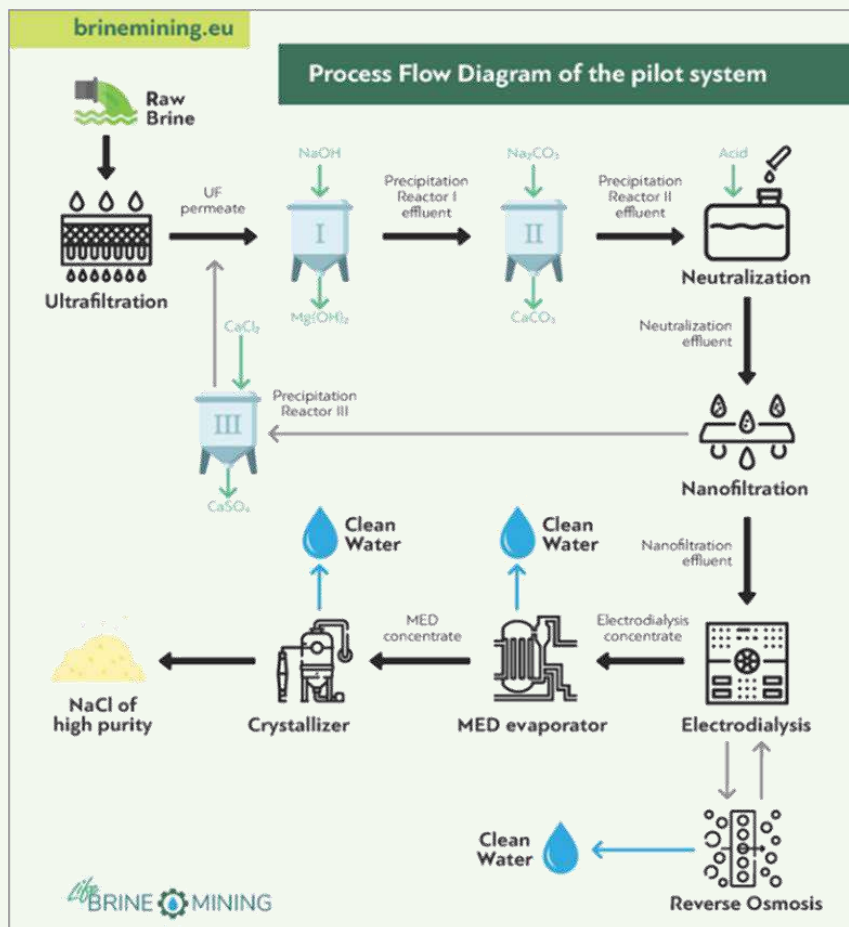
Revenues increase: Besides the reuse, a coal mine can also exploit the secondary raw materials at a good market value, increasing its revenues. On the other hand, the market price of the recovered materials is quite competitive in commerce compared to the industrially produced, making them less costly for other industries.

New business and jobs: The circular economy model in the coal mine sector will create new job opportunities, since the innovative process will require skilled workers in wastewater treatment technologies, material recovery, and waste management.

Project pilot system outcomes

The Brine-Mining project promotes the shift from a linear to a circular business model solution. The main objective of the project is to provide an integrated solution for the management of coal mine effluents, including recovery of water and salts of high purity and quality. A demonstration plant was installed in Poland to treat a saline effluent derived from coal mining activities.





Salts and water recovery

- 90% water recovery for reuse and exploitation in the industrial and the municipal sector
- 83.8% Magnesium recovery (as $Mg(OH)_2$)
- 90% Calcium recovery (as $CaCO_3$)
- 41.5% Sulfate recovery (as $CaSO_4$)
- 99.9% NaCl recovery

Reduction of CO₂ emissions

- 700 tn/year CO₂ emissions reduction by substituting conventional minerals and salts with the recovered ones

The path of Green Technology

Based on the outputs of this project, the following enablers and barriers were identified:

Enablers

- The methods-techniques incorporated in the project pilot system are considered as Best Available Techniques (BATs) in Reference Documents (BREFs) for raw materials and water recovery from wastewater.
- The EU Circular Economy Package enhances water and raw materials reuse and recycling from brines.
- Innovative business models support resource efficiency in several industrial sectors. Therefore, the Brine-Mining project can be applied in various industries boosting significant economic benefits.
- The dossiers of salts recovered from the pilot system are already uploaded to ECHA. So, the procedure that should be followed for the market exploitation of salts (to meet REACH End-of-Waste criteria) is not difficult.

Barriers


- Current regulations prioritize brine disposal over processing and resource recovery quality standards. Updating BREFs with info on water and resource recovery from brines would be a crucial aspect.
- There is limited market adoption of recycled materials due to information gaps and trust issues.
- Lack of financing tools for innovative brine management technologies discourages their adoption in the industry.

Policy recommendations for Green European Industry

Water Framework Directive

The Water Framework Directive aims to achieve a good ecological and chemical status of all waters in the EU, including rivers, lakes, coastal, transitional, and ground waters. **The Brine-Mining project facilitates the WFD by eliminating coal mine wastewater discharge in the environment and reducing the freshwater abstraction.**

As for policy recommendations to the WFD, the project's ability to produce clean water from wastewater contributes to the WFD for overall water quality improvement. **Sharing data on the quality of the recovered water from the coal mine wastewater can help in the establishment of benchmarks for the coal mining sector.** Since the project focuses on the minimization of pollutants in the water discharged in water bodies, **data on pollutant reduction achieved by the project can benefit the development of stricter discharge limits for the coal mine industry.** Nevertheless, the project's success contributes to the **development and implementation of innovative wastewater treatment technologies across different industries**, aligning with the WFD vision of continuous improvement in water management practices.

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Elimination of coal mine wastewater discharge in the environment –
Reduction of freshwater abstraction

Zero Pollution Strategy

The Zero Pollution Ambition is a long-term goal of the EU to achieve a toxic-free environment by 2050. It focuses on the drastic reduction of pollution levels in air, water, and soil so that there will be no harm for public health and natural ecosystems.

According to the EU Action Plan: "Towards Zero Pollution for Air, Water, and Soil", the enforcement of freshwater legislation remains inadequate due to various factors, including insufficient investment, inadequate integration of freshwater protection goals into other policy domains, slow implementation of measures, and the need to address chemical contamination more effectively. Therefore, the primary focus will be on bolstering enforcement measures.

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Innovation in Wastewater Management

Brine Mining facilitates the implementation of the Zero Pollution Strategy in many ways. **The project pilot system protects water resources from pollution**, by treating the coal mine wastewater, before it is discharged in aquatic environment. **It drives the innovation in wastewater management**, as it provides effective coal mine wastewater treatment solutions contributing significant knowledge and technology in the wastewater treatment field.

As for the recommendation to the Zero Pollution Strategy, the project can contribute to the development of policies for similar resource recovery practices with the Brine Mining, in the industrial sectors throughout Europe, by demonstrating the technical and economic feasibility of

recovering $Mg(OH)_2$, $CaCO_3$, $CaSO_4$, and $NaCl$ from coal mine wastewater. **The project success can set the pace for further adoption of proposed recovery technologies applicable to various industrial waste streams**, aligning with the Zero Pollution Strategy goal on continuous improvement and innovation.

End-of-Waste Criteria

The End-of-Waste Criteria set clear standards and conditions under which a waste material ceases to be considered as waste and is regarded as product or secondary raw material. This regulatory framework provides legal clarity for businesses, encouraging investment in recycling infrastructure and technologies. A well-designed project can achieve End-of-Waste criteria for recovered materials from wastewater treatment, promoting a more sustainable approach. **Brine-Mining aims in ensuring that the recovered water and minerals/salts meet End-of-Waste Criteria.** By meeting these Criteria, they are no longer classified as waste, but rather as valuable products or secondary raw materials.

The project's experience can **lead other industrial waste streams with resource recovery potential.** Till now EoWC have been published only for 3 streams. Iron, steel and aluminium scrap, glass cullet and copper scrap. Data on the treatment process, recovered materials quality, and potential challenges can be of significant assistance to the policy makers.

Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals (REACH regulation No. 1907/2006)

To ensure that recovered salts can be safely sold, the project took into consideration the REACH regulation. REACH plays a crucial role ensuring the safety of chemicals used in the EU. Under REACH, the companies that manufacture or import chemicals exceeding 1 tn/year need to register them to the European Chemicals Agency (ECHA). To accomplish registration, hazards and proposing safe use methods must be identified. **All recovered salts from the Brine-Mining project are already registered under REACH,** enabling their commercialization without any additional obstacles.

As for the recommendations in REACH regulation, the Brine-Mining project does not have a direct impact for two reasons. First, REACH focuses on registration, evaluation, authorization, and restriction of chemicals and LBM system recovers well-defined existing minerals, which are already registered. Second, REACH mainly regulates the safety of introduced chemicals, not necessarily the outputs from the waste streams processing, that Brine-Mining focuses on.

However, the project can contribute indirectly to REACH. By demonstrating a method recovering valuable resources from wastewater, it boosts a more sustainable approach to waste management. This **aligns with the REACH goal to minimize the risk related to chemicals throughout their lifecycle.** The project's data on the recovered materials, such as their purity levels, could be valuable for **future REACH assessments of these specific minerals depending on their intended use.**

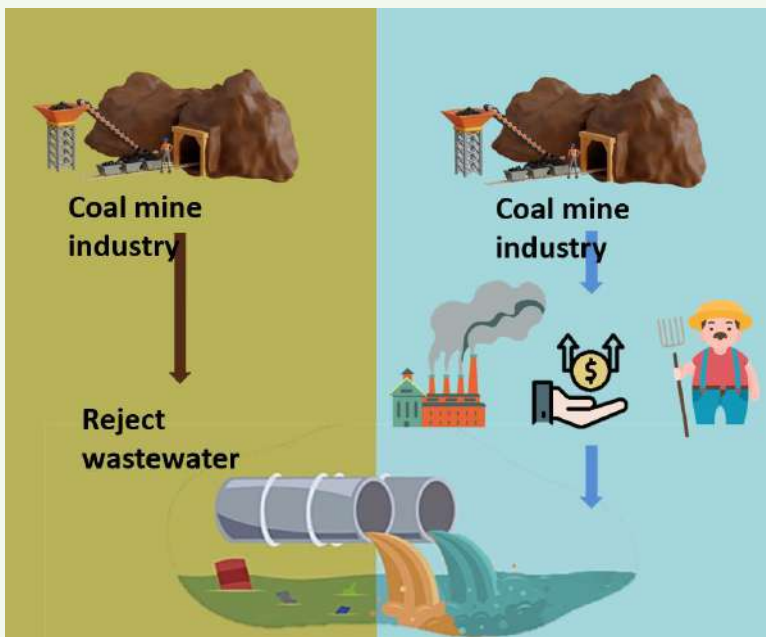
The Industrial Emissions Directive (IED) 2010/75/EU

The Industrial Emissions Directive (IED) is a key legislation of European Union focused on reducing harmful emissions from industrial activities. It is based on two pillars: the Integrated Pollution Prevention and Control (IPPC), which requires authorities to consider a facility's entire environmental impact during the permitting process, not just individual emissions, and the Best Available Techniques



(BAT), which set the emission limit values for various industries based on the most effective and advanced available technologies for minimizing pollution.

While the Industrial Emissions Directive (IED) contributes to reduce air pollution, further efforts are required to address water and soil emissions. Currently, only 17% of Best Available Techniques (BATs) encompass measures for water discharges, and these measures often prioritize treatment over source reduction. Furthermore, 20 out of 850 BATs explicitly promote water use minimization.



The Brine-Mining project can support a better implementation of the IED, as it focuses on circular economy and water reuse in the industrial sector. The project can contribute in **the expansion of Best Available Techniques use for wastewater treatment at source**, before the discharge in the environment, by showcasing the project ability to achieve **source reduction of pollutants in the wastewater**, before this flows into surface water bodies, in the coal mine sector.

The IED could also incorporate resource recovery as a potential strategy for reducing environmental impact in the coal mining industry. This strategy can also involve the adoption of the technologies

developed in the project. The direct recovery of valuable minerals, such as $Mg(OH)_2$, $CaSO_4$, $CaCO_3$, and $NaCl$, emphasizes how the project adds value to a **BAT utilization beyond just treatment**.

The project can also recommend the IED **stricter discharge limits for pollutants** and encourage the use of technologies similar to the ones incorporated in the project, at the source of pollution.

The project also promotes **water use minimization** in the coal mine sector. This could include the **implementation of closed-loop water systems in the industrial sector**, starting from the coal mine sector.

Circular Economy Action Plan

The Circular Economy Action Plan (CEAP), as part of the European Green Deal, targets in the minimization of resource consumption and the maximization of resource reuse. Through a combination of legislative and non-legislative measures, it targets the entire product lifecycle, from design to waste management, shifting on sustainable practices across the value chain.

Brine-Mining directly addresses to CEAP goal for transition to a circular economy model. By recovering valuable minerals ($Mg(OH)_2$, $CaCO_3$, $CaSO_4$, and $NaCl$) from coal mine wastewater, the project keeps these resources in use for longer periods. This assists the **detachment from resource extraction, promoting a closed-loop material cycle**. By minimizing wastewater discharge, therefore minimizing water pollution and conserving natural resources, **the project contributes also to the CEAP goal to reduce the environmental footprint of the industrial production**.

As for the project recommendations to the CEAP, the technical and economic feasibility of recovering valuable resources from coal mine wastewater can be used for the **development of policies that focus on similar resource recovery practices across various industries**. CEAP could also **introduce financial tools**, like tax breaks or subsidies, for industries to adopt technologies like the ones developed in this project, encouraging broader adoption of resource recovery from wastewater streams. The **establishment of platforms to promote knowledge sharing among industries for successful resource recovery technologies**, including the Brine-Mining approach, would also boost the spread of these practices. Brine-Mining, being a concrete example of resource recovery through the development of innovative wastewater treatment technologies, can promote the argument of **funding increase by CEAP for research and development of innovative technologies** for wastewater treatment.

