

BENEFITS OF THE BRINE MINING TECHNOLOGY FOR A SUCCESSFUL ZERO POLLUTION STRATEGY

Key information

- The **ZERO POLLUTION ACTION PLAN** is one of the main pillars for the protection of air, water and soil.
- The **Industrial Emissions Directive (IED)** creates an enabling legislative framework for the promotion of the Brine Mining concept.
- The **Water Framework Directive (WFD)** set goals are addressed from the proposed concept of the Brine Mining.
- The **Circular Economy Action Plan (CEAP)** aims to promote sustainable production and consumption practices, which are integral to the Brine Mining approach

General Context

The **ZERO POLLUTION ACTION PLAN** aims to protect the air, water and soil by reducing their pollution to levels that are no longer considered harmful to human health and natural ecosystems, thus creating a toxic-free environment. To achieve that, has set the ambitions of (a) zero pollution (b) improving the health and well-being, (c) living within our planetary boundaries and (d) aiming towards zero pollution from production and consumption.

To achieve the **zero pollution from production and consumption** the action plan is led by the

- (a) **circular economy** action plan
- (b) **sustainable industrial systems**,
- (c) **cleaner technologies**
- (d) less polluting **business models** and consumption habits

BRINE MINING proposes a **circular economy** approach to reduce the negative impacts of the wastewater discharges that results from the coal mining activities. This has been achieved with an economically viable, innovative system that combines various units such as Ultrafiltration, Precipitation, Nanofiltration, Electrodialysis, Reverse Osmosis, Evaporator, and Crystallizer. The system treats coal mine wastewater (brine) and recover high quality water and minerals (NaCl , $\text{Mg}(\text{OH})_2$, CaSO_4 , and CaCO_3) of high quality and purities.

BRINE MINING is a **sustainable system** that addresses a critical environmental issue (salinisation of water bodies from coal mining activities), focusing on cutting-edge technological solutions aiming to social and environmental feasibility promoting **cleaner technologies**.

The new circular economy **business model** derived from the project implementation and results demonstrates the circular design, resource optimisation and new supply chain (more sustainable salt production) of the project, creating a sustainable and strong new framework for businesses to innovate in a resource efficient economy.

BRINE MINING – Supporting the Industrial Emissions Directive (IED) goals

The **ZERO POLLUTION ACTION PLAN** identifies the IED as the main instrument regulating air, water and soil pollutant emissions from over 52,000 of the largest EU industrial installations that account for about 20% of the EU’s overall pollutant emissions into the air, around 20% of pollutant emissions into water, and approximately 40% of greenhouse gas (GHG) emissions¹.

<i>Industrial Emissions Directive goals</i>	BRINE MINING Approach
<p>Prevent, reduce and as far as possible eliminate pollution arising from industrial activities</p>	<p>The BM solution addresses this goal of IED by proposing in full-scale the elimination of untreated discharge of the saline wastewater from the coal mining activity.</p> <p>The very promising results of the pilot system act as a foundation for the full-scale implementation.</p>
<p>Prevention and control of emissions into air, water and soil, aiming to energy efficiency</p>	<p>The BM solution addresses this goal by controlling the saline wastewater discharge into water (ground water and surface water) and soil.</p> <p>The proposed system balances CO₂ emissions with the production of high-quality recovered products. Pilot-scale results demonstrated energy savings due to the replacement of conventional salt production methods with alternative salt production from the demonstration plant.</p>
<p>Apply the best available techniques (BATs) to limit imbalances in the Union as regards the level of emissions from industrial activities</p>	<p>The BM pilot system aligns with the BAT criteria outlined in Annex III of the IED (the existing treatment techniques of waste from mineral excavation and treatment of mineral resources, treatment techniques for the desalinization of liquid extractive wastes, Best Techniques for the removal of emissions to water)</p>
<p>Provide for an integrated approach for energy efficiency</p>	<p>The proposed system is more energy efficient from the treatment of the best current practice of the coal mine wastewater.</p>

The IED has been successful in reducing emissions to air and soil and water. The reported emissions of 94 pollutants from IED-related activities are reported in the Annex II of the Industrial Emissions Portal Regulation-**IEPR** (Regulation (EU) 2024/1244 of the European Parliament). In that list, the chloride (as total Cl) are referred as pollutant with a threshold for releases to water and to land of 2Million kg/year.

The IED encompasses the Best available techniques REFerence documents (BREF). The BREFs sets out the specific limit values for each pollutant, based on the Best Available Techniques (BAT) in a given situation. The BM pilot system aligns with the BAT criteria outlined in Annex III of the IED (the existing treatment techniques of waste from mineral excavation and treatment of mineral resources, treatment techniques for the desalinization of liquid extractive wastes).

¹ Revised Industrial Emissions Directive and Regulation Establishing the Industrial Emissions Portal: outcomes and opportunities

BRINE MINING – Supporting the Water Framework Directive (WFD) goals

The WFD is one of the main pillars of the Zero Pollution Action Plan, which aims to bring the EU closer to achieving the goal of zero pollution of all aquatic ecosystems. The Brine Mining system with its implementation and results contributes to the majority of the goals set by this Directive.

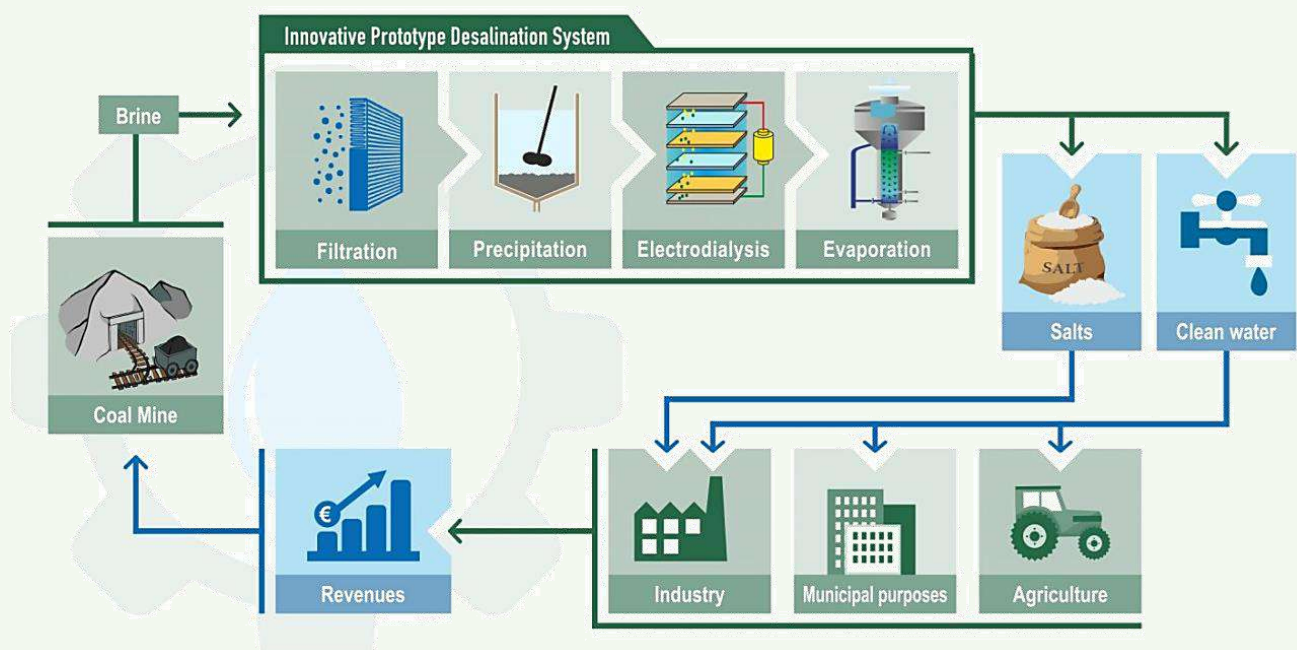
Water Framework Directive goals	BRINE MINING Approach
<p>Prevents further deterioration and protects and enhances the status of aquatic ecosystems and, with regard to their water needs, terrestrial ecosystems and wetlands directly depending on the aquatic ecosystems;</p>	<p>With the installation and implementation of the proposed Brine Mining system, the further degradation of the aquatic ecosystem could be prevented. The results of the pilot testing showcase that the aquatic environment will be protected, and the salinization will be prevented.</p>
<p>Promotes sustainable water use based on a long-term protection of available water resources</p>	<p>The sustainable water use is promoted by the Brine Mining concept optimizing the resource recovery but also supporting the circular economy principles. Furthermore, the recovered water, can serve as a way to protect the existing available water resources.</p> <p>Brine mining contributes to environmental sustainability and resource conservation by reusing water that would otherwise be wasted, reducing pressure on natural water sources and ensuring their long-term availability.</p>
<p>Aims at enhanced protection and improvement of the aquatic environment.</p>	<p>The concept of Brine Mining aims to enhance the protection and improvement of the aquatic environment by minimizing the discharge of harmful brine waste into water bodies and promoting the sustainable use of water resources. By recovering valuable materials and reusing treated water, it reduces stress on freshwater ecosystems, prevents pollution and helps maintain healthy aquatic habitats.</p>
<p>Ensures the progressive reduction of pollution of ground and surface water and prevents its further pollution</p>	<p>With the prevention of the brine discharge the progressive reduction of pollution from the wastewater that results from the coal mine activities will be achieved.</p>

The Annex V of the WFD includes the quality elements for the classification of the ecological status for surface water, the salinity is one of the parameters that are mentioned. Therefore, monitoring and managing the salinity levels is critical for maintaining or improving the ecological status of surface waters in line with the WFD’s objectives to protect the water bodies.

BRINE MINING – Supporting the Circular Economy Action Plan (CEAP) goals

As mentioned in the Zero Pollution Action Plan, the Circular Economy Action Plan (CEAP) is one of the main ways to achieve zero pollution from production and consumption. A number of the CEAP goals are fulfilled with the implementation of the Brine Mining project.

- The CEAP aims to design **sustainable products**. To achieve this, recycling and reducing carbon and environmental footprints throughout the chemical value chain is critical. In the case of Brine Mining, this is achieved by recovering usable minerals/salts that would otherwise be discharged creating a new, more sustainable value chain while protecting the environment.
- The CEAP aims at **Circularity in production processes**. This involves ensuring that materials and resources are reused, recycled, and kept in the production cycle for as long as possible. The circular economy is also the fundamental concept behind Brine Mining, where valuable materials are recovered from brine, reducing waste and turning what was once a waste into reusable resources



Circular Economy Concept of the LIFE Brine-Mining project: Coal mine revenues increase from the exploitation of coal mine wastewaters