ZERO BRINE

THE CIRCULAR ECONOMY APPROACH FOR INDUSTRIAL WASTEWATER

BENEFITS OF THE ZERO BRINE TECHNOLOGY FOR THE EFFECTIVE IMPLEMENTATION OF THE INDUSTRIAL EMISSIONS DIRECTIVE

KEY RECOMMENDATIONS

ZERO BRINE proposes a shift from the model of raw minerals extraction to recovery of resources through closing the loop on industry brines.

ZERO BRINE also highlights the necessity to have a holistic approach by:

- Including sectors outside of the existing IED scope that generate brine
- Increasing the emphasis on reducing emissions to water resources
- Strengthening contributions to the circular economy
- Considering the additional benefits of the technology in terms of competitiveness, and reducing pollution in air, water and soil.

ZERO BRINE supports the creation of a horizontal BREF on water efficiency or brine management, or the mandatory inclusion of brine management in each relevant industry process.

• Context

The Industrial Emissions Directive (IED) is key legislation preventing and reducing polluting emissions to air, water, and land, and for minimising waste generation in the context of health and environmental impacts by identifying Best Available Techniques (BATs) within the BREF review process. While important progress has been achieved, the IED needs to be reviewed, not only to fully align with the new climate objectives of the European Union in terms of energy efficiency and circular economy, but also to update the BAT reference documents.

ZERO BRINE proposes a circular economy approach to reduce the negative impacts of brine from process industries and to create economic value from the reuse of its mineral salts, containing sodium, magnesium, calcium, sulphates, bicarbonates, and fresh water. ZERO BRINE demonstrates the use of a combination of existing and innovative technologies for recovery and reuse of both the material constituents as well as energy such as waste heat.

The ZERO BRINE approach can support a better implementation of the IED, to offer new standards within an updated IED while going beyond the siloed approach, in particular for chemicals.

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• ZERO BRINE: A technology supporting the effective implementation of the IED

32% of Best available Techniques (BATs) on circular economy focus on energy[1]. But the circular economy also includes resource recovery and water reuse; however, only 20 BATs out of 850 promote water use reductions[2].

Therefore, there is also a necessity to focus on resource recovery and water efficiency to close the loop entirely. The ZERO BRINE technology offers a new technology to fulfil these objectives which is already aligned with the requirements of the existing IED.

Table 1 How Zero Brine contributes to key objectives of the existing IED

	IED REQUIREMENT (EXISTING)	ZERO BRINE'S CONTRIBUTION
1	An integrated approach to prevent and control pollution	Recovery and reuse of salts takes them out of the waste cycle.
2	Prevent or reduce emissions to water, land, and air	Significant reduction (>90%) in the volumes of brine disposal and constituent pollutants to the environment, impacting land and water. The newly proposed technologies of ZERO BRINE also reduce the emissions to air by using fewer polluting solvents and other consumables in the treatment process.
3	Prevent or reduce the generation of waste	Recovery of Sodium chloride, Sodium bicarbonate, calcium hydroxide, Magnesium hydroxide, Calcium, gypsum
4	Reduce impacts on the environment	Reduce discharge of saline water, constituent minerals and of greenhouse gas emissions (GHGs) through efficient energy use and reduced transport impacts.
5	Apply the best available techniques (BATs)	The ZERO BRINE pilots demonstrate a range of best techniques, in some cases developing new ones.
6	To prioritise generated waste in line with the order of priority of the Waste Framework Directive: re-use, recycle and recover, with responsible disposal as a last resort	While the potential for direct reuse of brine is limited, there is significant recycling following the recovery of salts/minerals and fresh water. Waste generation is minimised.
7	With energy efficiency	See ZERO BRINE Core Policy Brief specific data for each pilot.

The proposed technologies for the treatment of brine effluents will reduce adverse impacts to the environment, through the elimination of the need for brine disposal that today causes significant environmental degradation to land and aquatic environments. The United Nations Environment Program (UNEP-MAP) has stated that "one of the two major, urgent threats to the Mediterranean Sea environment is the pollution caused by the increased number of desalination plants and the releases and the effects of brine to the Mediterranean Sea."

The technology will also have a positive impact on soil health by reducing salination resulting from the discharging of industrial brine. This project constitutes an example for the foreseen Soil Health Law in 2023, particularly in the context of a shift from the model of raw minerals extraction to recovery of resources by closing the loop on industry brines.

ZERO BRINE also contributes to the reduction of energy consumption. To **produce one tonne of salt,** by applying the most energy-saving technologies established today (Mechanical Vapour Recompression – MVR) approximately 150 kWh (electricity) is required, which **results in approximately 75-150 kg of CO_2-eq emissions.** For the case of the demineralised water plant in The Netherlands, **34,000 tonnes of industry water** are produced per day, which requires approx. 2,000 tonnes of NaCl per year, which is an equivalent of 300,000 kWh or **300 tonnes of CO_2 emissions per year.** Even though in terms of mass, the quantity of salt used compared to the quantity of industry water produced is less

1 Report on IED Contribution to the Circular Economy, 2019

2 Report on IED contribution to Water Policy, 2018

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than 0.01%, in terms of energy consumed, it represents approximately 6% of the energy required to produce this quality of industry water. On top of this, energy consumed for transportation and relevant costs and CO_2 emissions should also be considered.

ZERO BRINE proposes a shift from the model of raw minerals extraction to recovery of resources by closing the loop on industry brines.

In the table below, key numbers for reduction are presented, related to the ZERO BRINE project, representing the chemical, demineralized water, coal mining and textile industries.

Table 2 - Impacts of the ZERO BRINE technology on water, emissions, energy, and resource recovery in industry

	Expected reduction in:			
	Water	**Emissions**	**Energy**	**Recovered resources**
Demineralised Water Plant	• 15-20% reduction in water withdrawal at Evides DWP	• >98% reduction of brine discharged to the environment (>2.5 million m^3/year) • 1,012 tons/year CO_2 emissions or 14% CO_2 reduction by recovering minerals, salts, and clean water	• Thermal energy required for the evaporation process can be supplied by waste heat/residual heat of neighbouring industries • 44% less energy used by MED evaporator when compared to conventional methods	• 92% water recovery for internal use (demi water) • 6.2% IEX regeneration solution recovery for internal use (>3.1% purity) • 94.7% Calcium recovery ($Ca(OH)_2$) for external valorisation (>95.6% purity) • 87.8% Magnesium recovery ($Mg(OH)_2$) for external valorisation (>88.9% purity) • 93% Sulphate recovery (Na_2SO_4) for external valorisation (unwashed: 94.6% purity)
Coal mine	NA	• 92.8% reduction of sodium chloride (NaCl) discharged to freshwater resources • 347 kg CO_2 /ton NaCl or 32.5% CO_2 reduction	• 33% energy reduction	• 90.6% water recovery (demi water) • 92.8% salt recovery (99% purity) • 94.9% magnesium hydroxide recovery $Mg(OH)_2$) for external valorisation (97% purity) • 0.84 kg/m^3 gypsum for external valorisation
Textile factory	• 7% reduction in total freshwater consumption of Zorlu Textile or freshwater abstraction by 123,000 tons/year	• 90-95% reduction of brine discharged to the environment • 150-200 tons/year CO_2 reduction	NA	• 70-80% water recovery from brine treatment system for onsite use • 600-700 tons salt/year for onsite dyeing of textiles

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	Expected reduction in:			
	Water	Emissions	Energy	Recovered resources
Silica factory	• 30% reduction in overall annual water consumption at IQE	• 100% reduction of brine discharged to the environment • 60% reduction of sodium sulphate (Na_2SO_4) releases into the Ebro River 6,000 tons/year CO_2 reduction or 5 kg CO_2/ m^3 of wastewater	• 72% reduction by waste heat (EFC technology compared to direct evaporation)	• 75-90% water recovery suitable for internal use • 90% recovery of sodium sulphate (Na_2SO_4) or 20,000 tons/year for external valorisation (>99% purity) • Sodium hydroxide (NaOH) (94% purity) and sulphuric acid ($H2SO_4$) (72% purity) for external valorisation

Further benefits will also be demonstrated through the Water-mining project (https://watermining.eu/) which aims to work on the next generation water smart management systems with large scale-demonstrations for a circular economy and society.

• ZERO BRINE: An available technology for a more resilient European industry

Several points of attention in the IED have been stressed by the European Commission that make the revision a priority. ZERO BRINE partners welcome the revision of the IED to update the directive in line with the EU Green Deal and the Zero Pollution Strategy.

Particularly, the ZERO BRINE technology demonstrates the opportunity for industries to contribute to GHG reduction and energy efficiency meeting requirements in terms of brine management:

- **GHG reductions and energy efficiency through the promotion of heat reuse in recovery processes. (see Table 2)**
- **GHG indirect reductions and energy efficiency by reduced transportation impacts** from the import of raw minerals, often from outside the EU. The reuse of water will also reduce the energy needs for pumping ground water.

However, the revision of the Industrial Emission Directive should also consider in the development and update of BREFs the dilemma between energy consumption and resource recovery. In line with the Zero Pollution Strategy, the IED can contribute to prevent diffuse pollution in our environment (see ZERO BRINE Policy Brief on the Zero Pollution Strategy).

Furthermore, the benefits of the ZERO BRINE technology support competitiveness through the implementation of river basin management plans with the permits provided by the national authorities. The production might increase without requesting additional rights to pollute.

The IED BREFs focus principally on individual industry sectors; however, the ZERO BRINE approach applies to a wide range of sectors that produce brine. At least it can contribute to improving the BREFS of the 4 industrial sectors selected for this project. Therefore, the consortium also welcomes the revision of Best Available techniques Reference documents (BREFs) such as the ones for Textiles Industry (BREF TXT) and the large volume inorganic chemicals – solids and other industry (BREF LVIC-S).

But its impact can be maximised by its opportunity to break the siloed approach and develop industrial symbiosis by the interconnection of sectors by, for example, recovering minerals or water volumes that are of value to others.

ZERO BRINE focuses on the manufacturing sector. According to Eurostat, this sector includes a vast array of economic activities performed by 2.1 million enterprises in Europe. It therefore contributes to:

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- **Highlighting the environmental benefits of reduced demand for raw materials and resource efficiency and recovery.** The impacts that will be reduced include less mining (both inside and outside Europe) and all its associated impacts, and reduced transportation with its associated energy and GHG emissions.
- **Identifying and highlighting the positive opportunities and benefits of compliance.** For the operator, they can include: a reduced need to purchase raw materials, and reduced spending on energy and water supplies. Some operators will also gain an economic benefit from the selling of recovered minerals to others.

Consequently, the ZERO BRINE technology can support the revision of the BREF process and the update of the BATs by either creating a horizontal and mandatory BREF on water-efficiency or including the need for circular brine management in several key industrial processes.

ZERO BRINE also encourages the necessity to have a holistic approach by:

- Including sectors outside of the existing IED scope that generate brine
- Increasing the emphasis on reducing emissions to water
- Strengthening contributions to the circular economy
- Considering the side benefits of the technology in terms of strategic autonomy, competitiveness, and diffuse pollution in air, water, and soil. (see ZERO BRINE Core Policy Brief)

For more information, see our Core Policy Brief

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