ZERO BRINE

THE CIRCULAR ECONOMY APPROACH FOR INDUSTRIAL WASTEWATER
POLICY BRIEF: INDUSTRIAL EMISSIONS DIRECTIVE

The Horizon 2020 project ZERO BRINE demonstrates the technical feasibility, economic and environmental benefits of recovering minerals and water from waste industrial brine for reuse, and its compatibility with the principles of a Circular Economy, the EU Green Deal and the Industrial Emissions Directive.

1. BACKGROUND

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 Technologies within the BREF process. While important progress has been achieved, **the IED needs to be reviewed not only to be fully fit with the new climate objectives of the European Union in terms of energy efficiency and circular economy, but also to update the BREF process.**

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 new or innovative technologies for recovery and reuse of both the material constituents as well as energy such as waste heat. **This approach can support a better implementation of the IED, to offer new standards within an updated IED while going beyond the siloed approach, particular for chemicals.**

2. ZERO BRINE: A TECHNOLOGY SUPPORTING THE EFFECTIVE IMPLEMENTATION OF THE IED

As stressed in the Evaluation of the IED, there is a necessity to reduce resource use and support the circular economy. 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 less polluting solvents and other consumables in the treatment process.
3	Prevent or reduce the generation of waste	Brine as a 'waste product' is almost entirely removed from the waste cycle.
4	Reduce impacts on the environment	Reduce discharge of saline water, constituent minerals and of greenhouse gas emissions (GHGs) through efficiency energy use and reduced transport impacts.

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	IED Requirement (existing)	ZERO BRINE's contribution
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 recovery of salts/minerals and fresh water. Waste generation is minimised.
7	With energy efficiency	Energy efficiency and heat recovery is demonstrated. Reduced transport needs (for importing new minerals) reduces total energy use and GHG emissions.

The proposed technologies for the treatment of brine effluents will reduce adverse impacts to the environment, firstly 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".

In order 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 large-scale demonstration in EVIDES – The Netherlands, 34,000 tonnes of industry water is 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 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.

Producing 34,000 tonnes of industry water per day causes 300 tonnes of CO_2 emissions per year.

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

In the table below, key numbers for reduction are presented, related to the ZERO BRINE project, representing the chemical-, water-,coal mine- and textile industry.

Table 2 – Expected impact of the ZERO BRINE technology on water, CO_2, energy use and raw materials in industry

Expected impact	Reduction in:			
	Water use	CO_2 emissions (yearly)	Energy use	Raw materials
Water plant	-15%	-300 tonnes CO_2	Waste heat recovery	-75% (salt), Water recovery
Coal mine	>75% water recovery	-414 kg CO_2/t of NaCl	-50%	Salt recovery
Textile factory	-50 kt/year	-200 tonnes CO_2	Waste heat recovery	400 tonnes NaCl/year
Silica factory	-70%	-1300 tonnes CO_2 (emissions avoided due to Na_2SO_4 recovery)	Waste heat recovery	-70% (water) 2,300 tonnes Na_2SO_4/year -25% H_2SO_4 and NaOH

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3. 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** by the promotion of heat-reuse in the recovery processes.
- **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 water.

The **ZERO BRINE** technology proposes the following standards for a more resilient IED:

- **To include sectors outside of the existing IED scope that generate brine**
- **To increase the emphasis on reducing emissions to water**
- **To strengthen contributions to the circular economy**

The IED BREFs focus principally on individual industry sectors. However, the ZERO BRINE approach applies to a wide range of sectors that produce brine. It also provides **strong opportunities 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.

The ZERO BRINE technology position can then 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 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:

- Highlighting the environmental benefits of reduced demand for raw materials and resources that re-use and recycling can achieve. 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.

See the ZERO BRINE core policy brief for the environmental and economic benefits.

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4. ZERO BRINE RECOMMENDATIONS REGARDING THE REVISION OF THE IED

Considering the results of the ZERO BRINE technology, the project suggests the following amendments of the IED for a modern and resilient legislation on industrial emissions.

- Have the IED more oriented to a circular economy approach to look at **both emission reduction and recovery and reuse of water and minerals.** Better consider the opportunities in brine management to improve energy savings and also to effectively implement reduction of resource use through recycle and reused processes.
- Consider the indirect **environmental benefits of reuse**, principally the reduced demand for raw materials and their transportation.
- Emphasise the **BATs that contribute to cross-sectoral benefits such as brine management** to maximise the impact of the IED as a key legislation in the EU's arsenal for climate neutrality.

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