

ZERO BRINE Final Forum

De Oude Bibliotheek, Delft,
The Netherlands

4 November 2021 (10:00-16:30 CET)



The ZERO BRINE project (www.zerobrine.eu) has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730390.



IMPACT OF ZERO BRINE

CLOSING SESSION



Dr. Dimitris Xevgenos Innovation Manager ZERO BRINE

ZERO BRINE FINAL FORUM

Dr. Dimitris XEVGENOS is Senior Researcher at Applied Sciences faculty at TU Delft. During the past 10 years of his research career, he has designed and developed cutting-edge technology on circular economy (CE) and resource recovery solutions and delivering them to the market. Dimitris has a strong interdisciplinary engineering background, covering the fields of mechanical engineering (BSc), electrical engineering (MSc), chemical engineering (PhD) and civil engineering (Post Doc). He is the Executive Coordinator of the WATER-MINING project. Dimitris has initiated and prepared several research proposals, raising approx. 40 million EUR through highly competitive LIFE and H2020 calls.



ZERO BRINE Final Forum
Delft, Thursday, 4 November 2021



ZERO BRINE & Market implementation

Dr. Dimitris Xevgenos,
Innovation Manager, ZERO BRINE
Exec. Project Coordinator, WATER-MINING

Outline

1. Introduction
2. ZERO BRINE Task Force
3. WATER-MINING & a new initiative
4. Chlorine recycling demo



Industries are looking for ways to
close the loop and move to
a **circular economy**



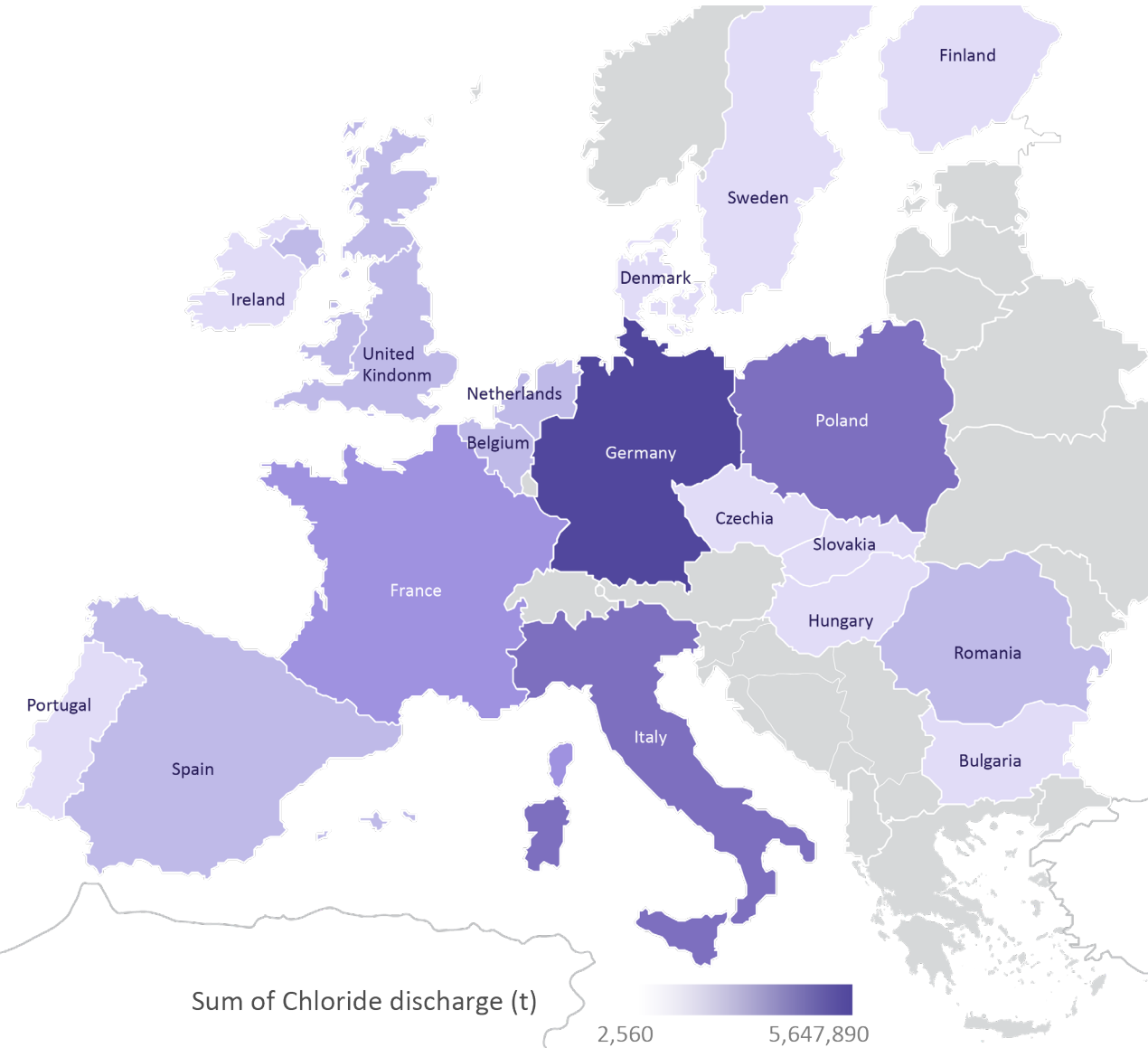
Brines: a shared problem

18Mt

Chloride
releases (2017)

713

facilities





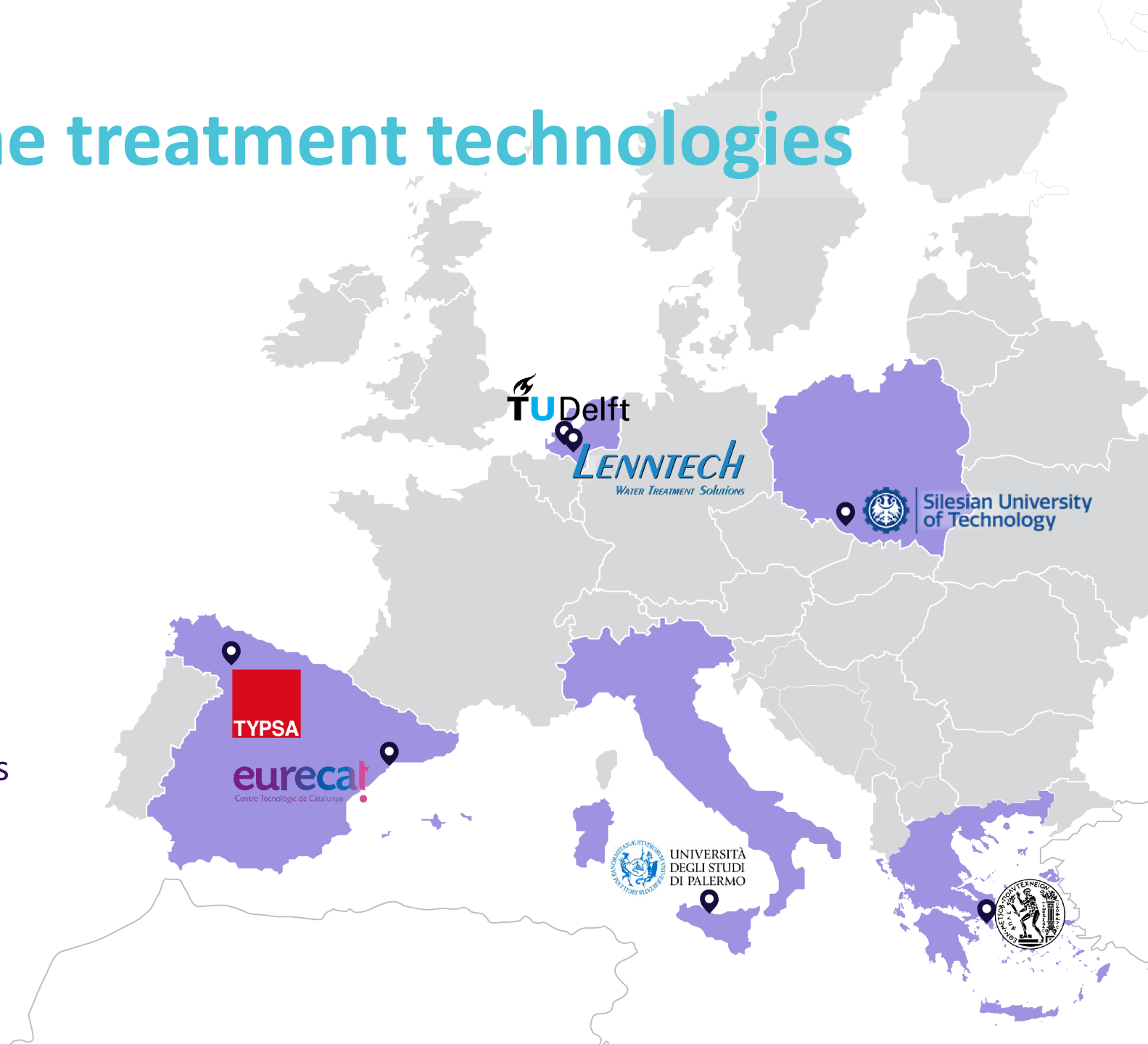
ZERO BRINE

Disruptive brine treatment technologies

In five EU Countries, 10 organizations have been developing leading & **disruptive** technology on brine treatment

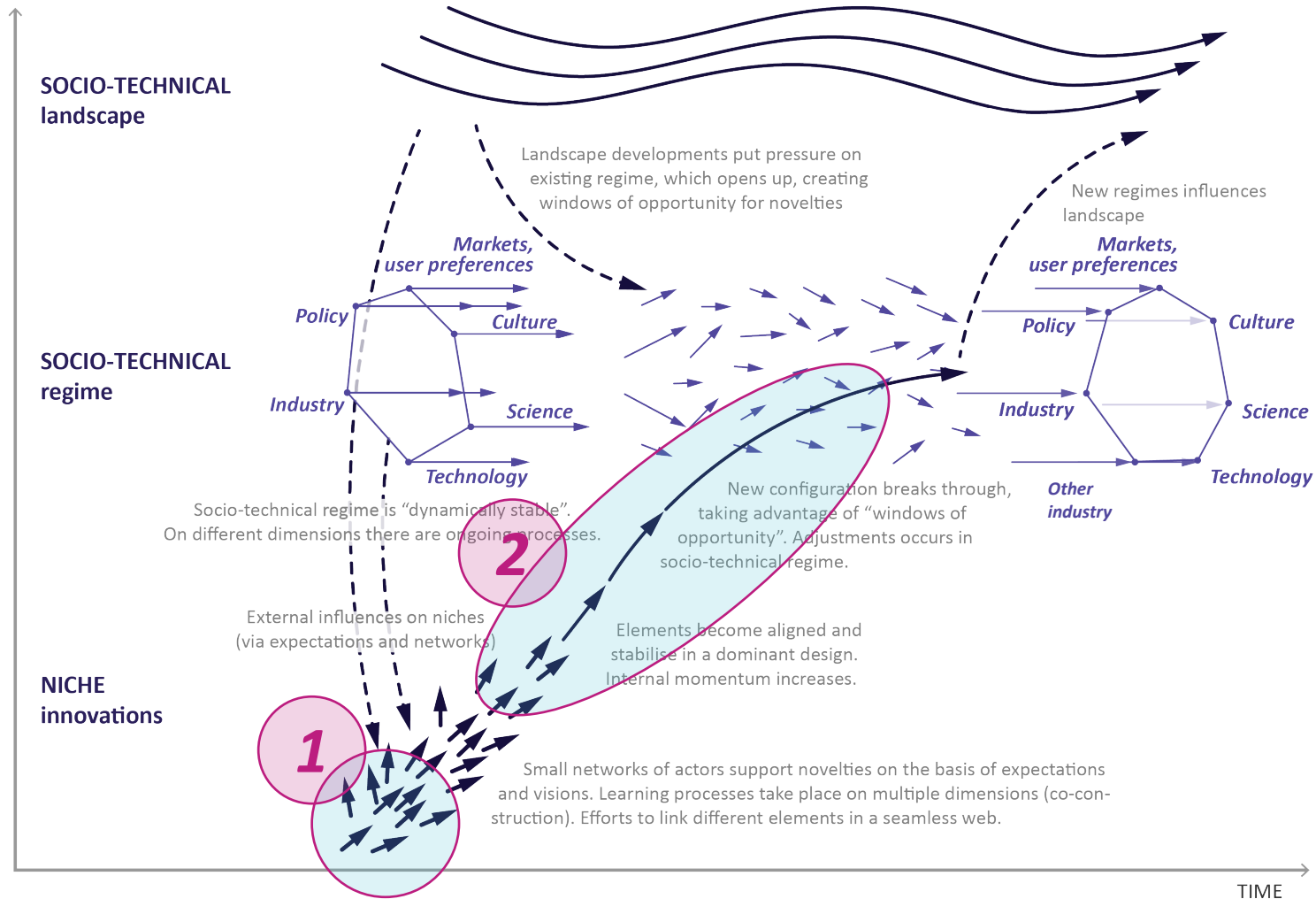
Challenge/Research question:

How can the interests of water innovators be aligned into joint exploitation pathways towards circular economy implementation (sustainable development)?



Dynamic multi-level perspective on system innovations

INCREASING STRUCTURATION OF ACTIVITIES IN LOCAL PRACTICES



1

How to align interests of individual technology innovators into joint exploitation pathways towards CE implementation?

2

How to design a circular economy solution based on systemic innovation that will be taken up by the market (mainstreamed in the regime)?



Establishing the ZERO BRINE Task Force



FRAMEWORK AGREEMENT

This **framework agreement** (hereinafter referred to as the “**Agreement**”) is signed on the 30th of April 2020 (the “**Effective Date**”). The agreement is made by and between:

IMPORTANT ANNOUNCEMENT



Submission

General information

Step 1 - Short Application Information

Proposal Number: 190187571

Acronym: Circular Desalination

“Demonstrating the **first of its kind** **circular and decarbonised** desalination technology to enable wide deployment and transformation of the desalination sector by 2030”

€17M

CIRCULAR
DESALINATION

Backing visionary entrepreneurs

The European Innovation Council
EIC Accelerator

European
Innovation
Council





What support can you receive?

Grant and investment

If you need support for development (TRL 5/6 → 8), deployment and scale-up (TRL 9).

Grant first

If your innovation still requires significant work to validate and demonstrate in relevant environments to assess its commercial potential.

Grant only

If you can prove that you have sufficient financial means for deployment and scale-up (TRL 9).

Investment only

If you are looking to fill the funding gap for rapid scale-up of your high-risk innovation and you don't need a grant.



Investment component

- minimum EUR 0.5 million and maximum EUR 15 million,
- usually in the form of direct equity or quasi-equity,
- maximum 25% of the voting shares of the company,
- “patient capital” principle (7-10 years perspective on average).

Grant component

- maximum EUR 2.5 million,
- eligible costs are reimbursed up to a maximum of 70%,
- innovation activities supported should be completed within 24 months,
- small mid-caps are not eligible for grant (but can apply for investment only).



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“Re-designing the value and supply chain
of *water* and *minerals*:
a circular economy approach for the
recovery of resources from saline impaired
effluent (*brine*) generated by
process industries”

€10M

BUDGET



water
mining
value for society

“Next generation *water*-smart
management systems: large scale
demonstrations for
a circular *economy* and *society*”

€19M

BUDGET

Emissieregistratie: Chloride releases



277
FACILITIES

870
KT CHLORIDES/YEAR

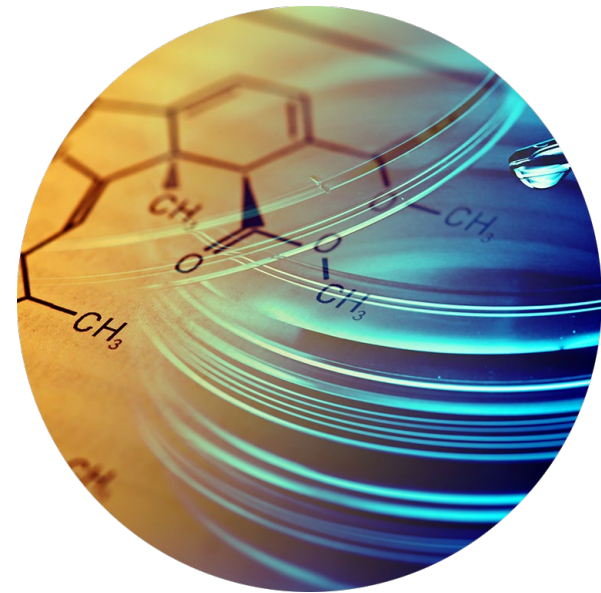
Chloride releases by main sectors

CHEMICAL INDUSTRY

SALT MINING INDUSTRY

FOOD SECTOR

OTHER INDUSTRIES



61%

29%

5%

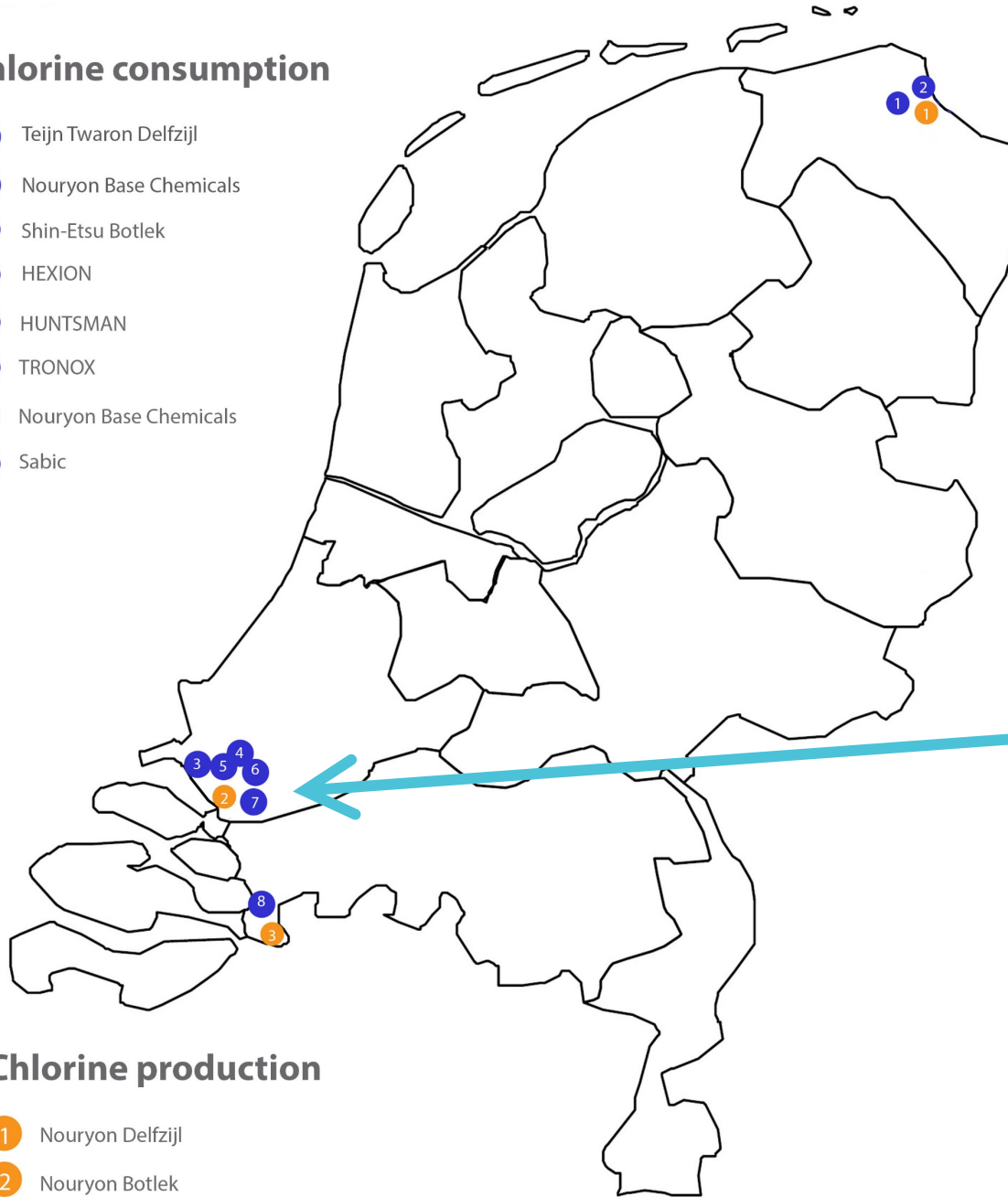
5%



- The Netherlands is the **3rd largest** producer of salt in Europe
- Market share: **NOBIAN: 84.2%**, Frisa Zout: 11.4% and Nedmag: 4.4%
- Salt production: **6.6 Mt** (2013)
- 43% (2.9Mt) is exported (mainly to Germany, Belgium and Scandinavia),
- 47% (3.7Mt) domestic consumption
 - the largest part is used in the **chlor-alkali** industry e.g. Chlor-alkali plant in the Botlek area (NOBIAN) uses 27% (or **1,000kt**) of the total domestic salt consumption

Chlorine consumption

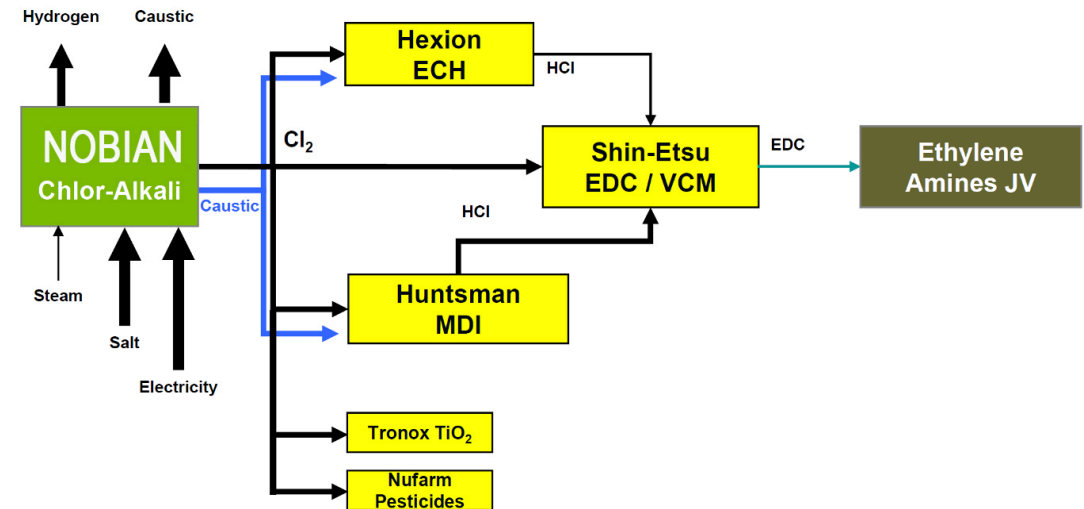
- 1 Teijn Twaron Delfzijl
- 2 Nouryon Base Chemicals
- 3 Shin-Etsu Botlek
- 4 HEXION
- 5 HUNTSMAN
- 6 TRONOX
- 7 Nouryon Base Chemicals
- 8 Sabic



Chlorine production

- 1 Nouryon Delfzijl
- 2 Nouryon Botlek
- 3 Sabic (former GE Plastics)

Chlorine cluster in Rotterdam



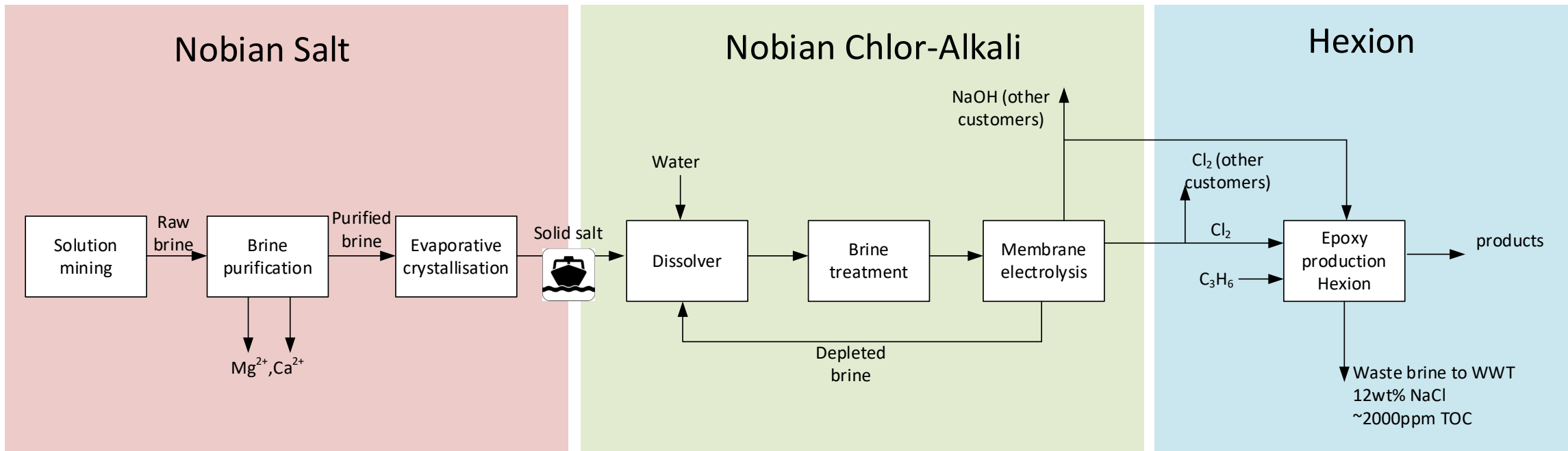
A photograph of two circular pipes set into a concrete wall, with water pouring out of them into a large pool of water below. The concrete wall is weathered and has several small holes. The water is clear and creates a white splash where it hits the pool.

50 kt NaCl salt
100 kt CaCl₂ salt

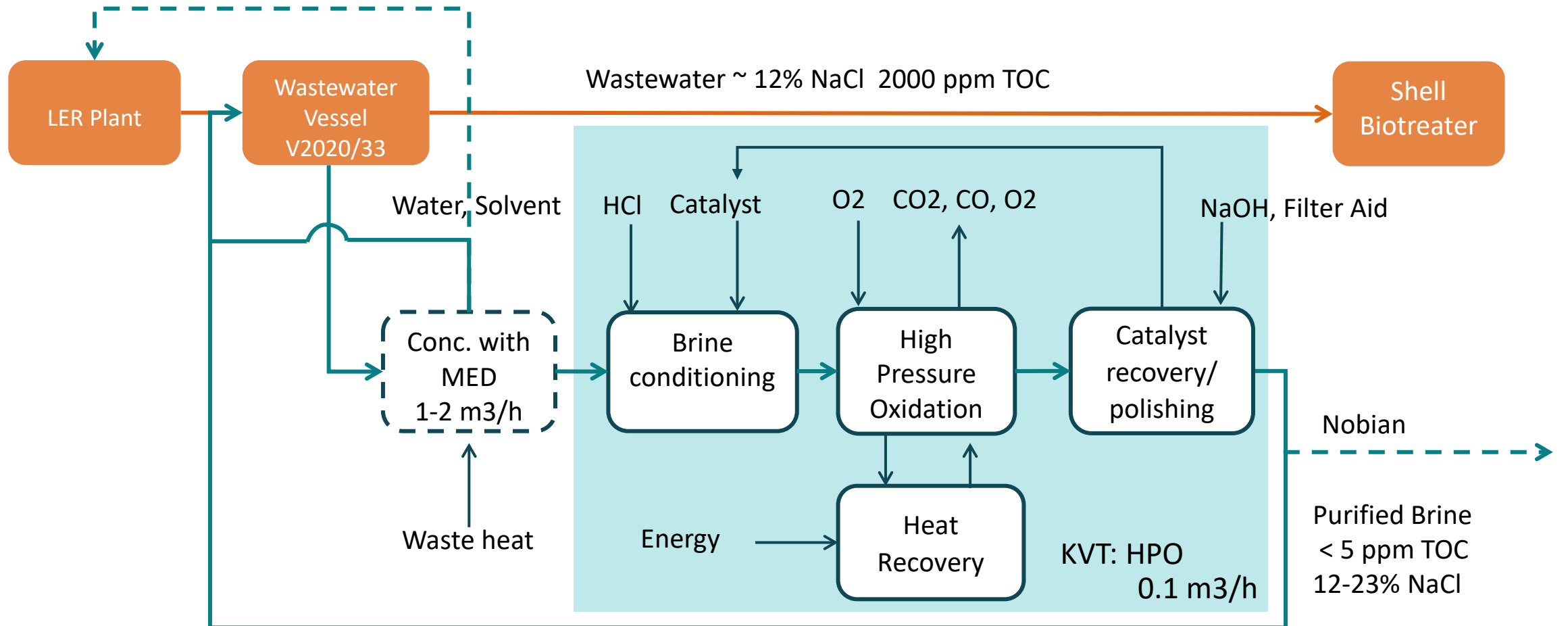
But how to reuse 3,000,000 m³ of wastewater, containing **salts** and **organics**?

Current situation: linear production process

- Linear business: salt → chlorine → product + brine (salt) waste treatment
- Bringing salt from sedimentary deposits underground to the sea



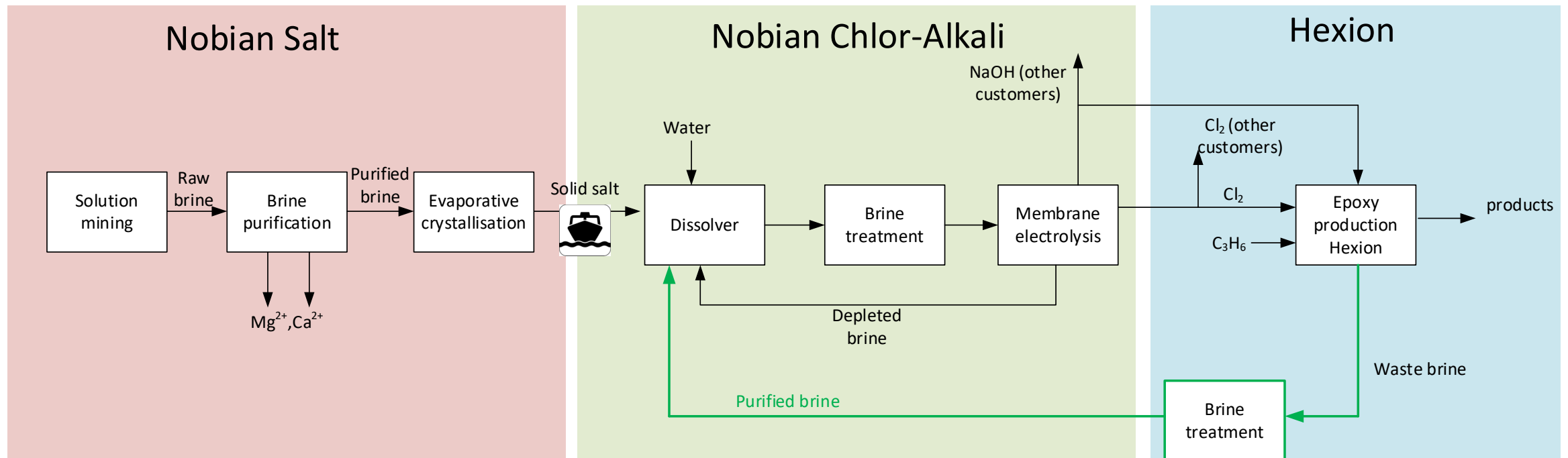
Optimized treatment train



Envisioned situation: circular salt



- Sustainable solution: recycling of salt
- Waste brine produced in epoxy production process has relatively high salt content and no inorganic impurities
- Innovative business model : Chemical leasing





1st CoP meeting: 4 October 2021





Thank you!

Dr. Dimitris Xevgenos,
Executive Project Coordinator, WATER-MINING
Senior Scientific Coordinator,
DELFT University of Technology
Email: d.xevgenos@tudelft.nl

www.watermining.eu



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Zero Brine Policy Review

Dr Maria Kyriazi

National Technical University of Athens

makyriazi@gmail.com

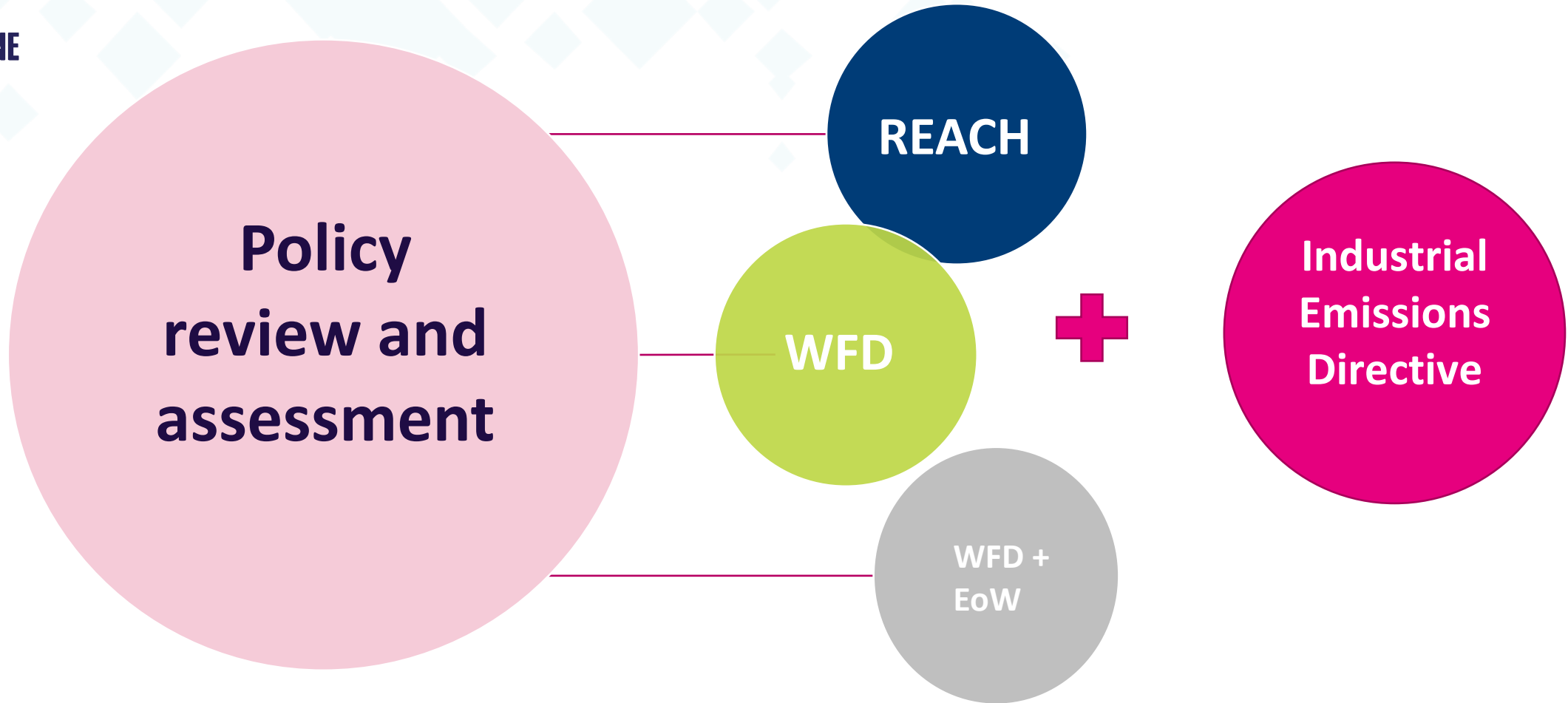


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Policy review and assessment



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REACH (1907/2006)-Steps need to be followed

NaCl,
CaSO₄,
Mg(OH)₂,
Ca(OH)₂,
NaHCO₃,
Na₂SO₄,
are
recovered
from brines

Valorization of
recovered salts is
strongly taken into
consideration.

Market of chemicals is
subjected to legislation
to ensure safety.

REACH is the regulation
for improving protection
of human health and
environment from risks
caused by chemicals.

REACH:
Registration,
Evaluation,
Authorization and
Restriction of
Chemicals





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REACH and recovered materials in ZeroBrine

- Registration: According to REACH for the commercialization of a chemical, upload of safety and toxicological data folder to the platform of ECHA (European Chemical Agency) is necessary.
- **All recovered salts in ZB have been already registered.**
- According to REACH if an industry wants to commercialize a chemical, already registered, need to send an access letter to ECHA and pay the relevant fee for taking access to the folder with the safety and toxicological data.
- Industries using recovered salts for their own processes do not need to follow this procedure.





REACH and recovered materials in ZeroBrine

The procedure needed to be followed is clearly described in ECHA-REACH sites.

All ZB operators have been informed adequately about the procedure.

No obstacles exist for salt commercialization and the application of REACH.





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Water Framework Directive (WFD 2000/60/EC)

- Aim: Good qualitative and quantitative status of water bodies and their dependent wildlife/habitats.
- **Water recovery and reuse are encouraged** and shown as alternative water source.
- This philosophy is mainly referred to urban and not industrial wastewaters.
- The WFD is mainly oriented to the use of recovered water in agriculture and not in industrial sector
- Gaps in National legislations on the use of recovered water in industrial sector.





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Water Framework Directive (2000/60/EC) and recovery of water in ZeroBrine

Zero Brine is in full agreement with WFD as:

- The systems design takes into consideration the relevant EU and local policy legislation.
- Achieve appropriate quality level of treated water.
- Take into consideration human health, environmental risks and carbon footprint
- Provide treated water to industry or agriculture. This way the use of treated industrial wastewater substitutes the use of drinking, surface or underground water.





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Waste Framework Directive (2008/98/EC) and ZeroBrine

- WFD mainly focuses on the fundamental terms of recycling, recovering and by-products.
- Aiming to the prevention of municipal waste, increasing recycling, phasing out land filling practices.





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WFD and EoW criteria-the four conditions

The Waste Framework Directive (WFD) incorporates the concept of end-of-waste (EoW) by setting out conditions whereby substances or objects which meet the waste definition can achieve, after undergoing a recovery operation (including recycling), a non-waste status and thus fall outside the scope of waste legislation.

1. The substance or object is commonly used for specific purposes;
2. A market or demand exists for such a substance or object;
3. Substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products;
4. Use of substance or object will not lead to overall adverse environmental or human health impacts.





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Industrial Emissions Directive (IED 2010/75/EU)-BREFs

- IED is one of the main legislative tools for controlling and mitigating industrial impacts on human health and environment.
- IED does not refer to specific standards for water emissions.
- However, it is clearly mentioned that an industry should be based on BATs (Best Available Techniques) as these referred to BREFs (Best Available Techniques Reference Documents) and national legislation about emission levels, in order to obtain operation permission from the EU Members authorities.
- IED covers all the categories of industries participating in ZeroBrine (**extractive industry, textile industry, silica industry and water industry**).





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BREFs (Best Available Technique (BAT) Reference Documents)

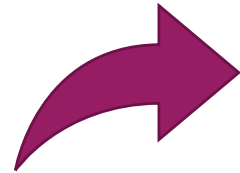
2/2

What is BREF?



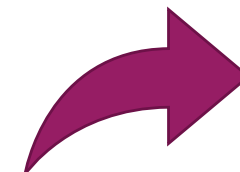
a publication resulting from information exchange between stakeholders

What does a BREF describe?



applied techniques, emissions and consumption levels, techniques considered for the determination of best available techniques and conclusions and any new/innovative technique

Which is the most important part of a BREF?



Conclusions are the final evaluations of BAT and one of the most important part of BREFs





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Why must we review BREFs?

- New installations must achieve the BAT standard required before startup.
- Existing installations responsible to reconsider everything in production procedure for meeting the BREF's required standards.
- In case of BAT conclusions absence, operators should continue to ensure that their installations meet the highest standards of environmental control.

As science and technologies are continuously developed, new methods and techniques are introduced into the industries. These changes must be included to BREFs. As a result, **BREFs must be periodically reviewed and updated.**





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What could ZeroBrine offer to IED and BREFs?

1/2

- ZeroBrine suggests that IED should be **more oriented to circular economy and reuse of water within industrial facilities.**
- ZeroBrine proposed solutions/systems, for the treatment of wastewater, **do not have the perspective of pollutants removal** from brines in order to discharge treated water to the receiving water bodies.
- ZeroBrine suggests systems which have as target the **recovering of valuable salts for the European and International market and clean water production** that could be used by the same or another industrial sector.
- Concluding: ZeroBrine proposed systems are based on **Circular Economy Strategy, Industrial Symbiosis and Zero Pollution Ambition** and they embed the main principles of **Water Framework Directive and Industrial Emissions Directive.**





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Thank you for your attention



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Corinne van Voorden
Advisory Board Member
ZERO BRINE

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Gijsbert Korevaar

Assistant Prof Policy Management Studies
TU Delft



Loïc Charpentier
Water Innovation Policy Officer
Water Europe

**EU POLICY PANEL – HOW CAN ZERO BRINE SUPPORT
CIRCULAR ECONOMY IN EU POLICIES?**



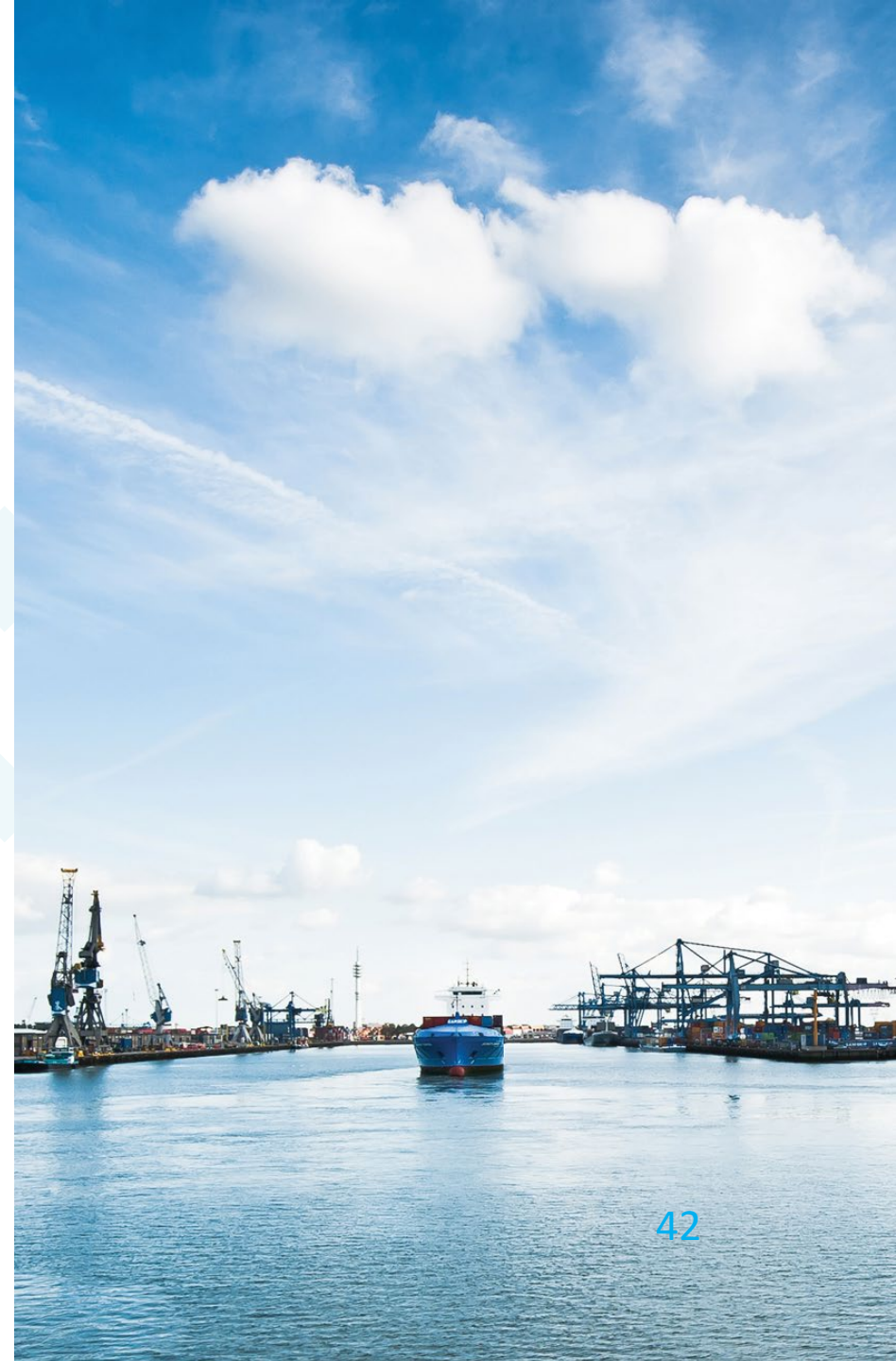
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Key aspects for the development of sustainability indicators

Dr. Gijsbert Korevaar



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No 893924.





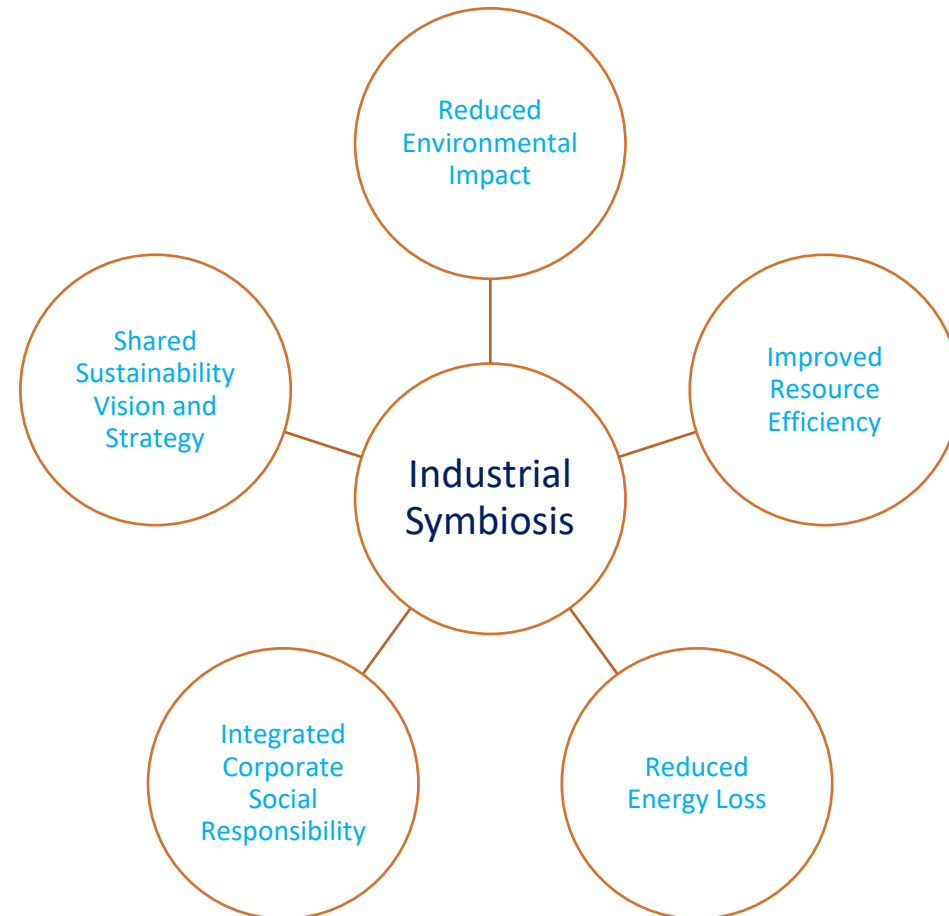
My background

- Chemical Engineering design research
- Industrial Ecology education development
- Industrial Symbiosis projects and research
- Circular Economy education and research

- Faculty of Technology, Policy and Management
- Department of Engineering Services and Systems
- Energy and Industry section



Key Aspects of Industrial Symbiosis





Industrial Symbiosis – needs

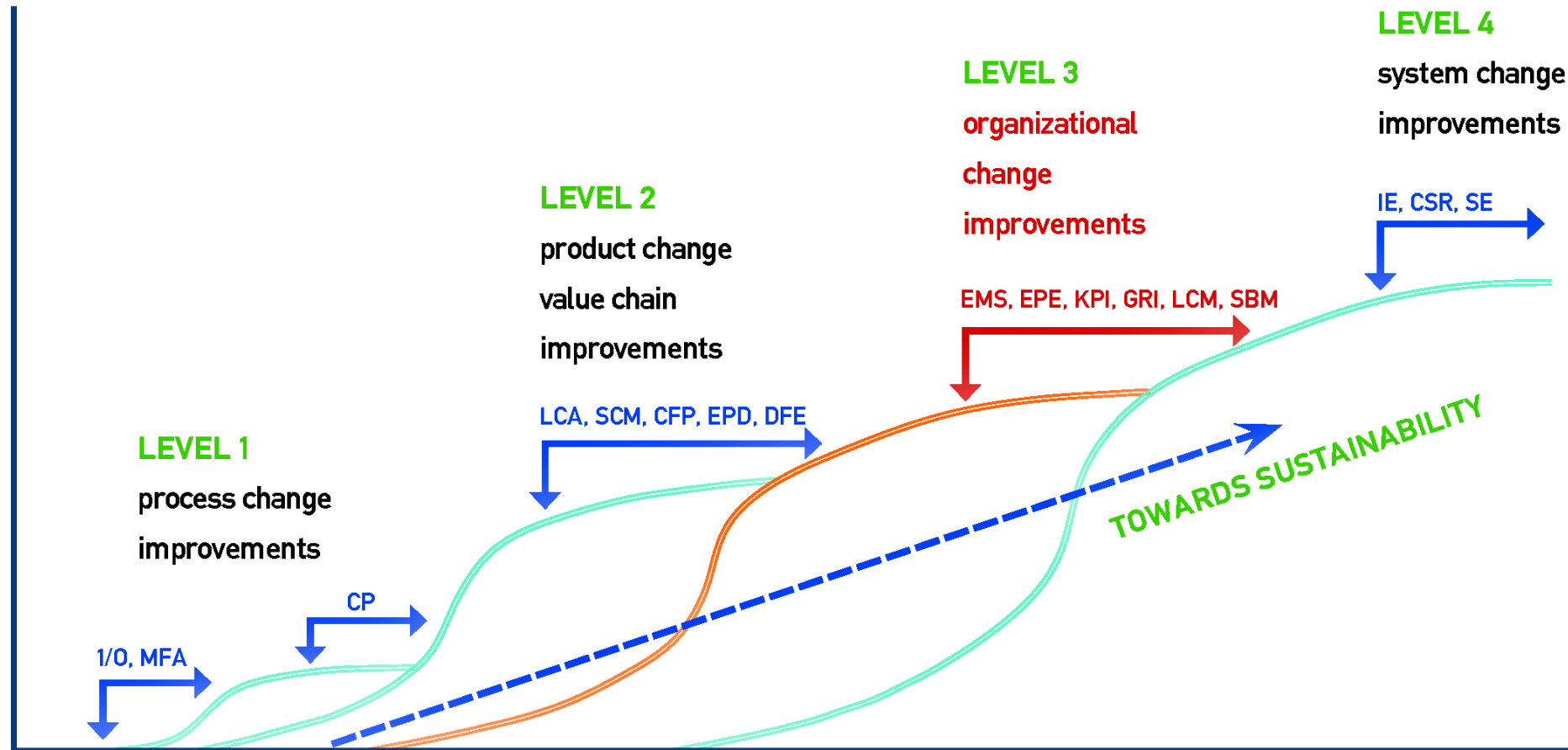
Industrial - resources, production, transport, waste treatment
- Symbiosis ... linked together with a mutual benefit

What is needed:

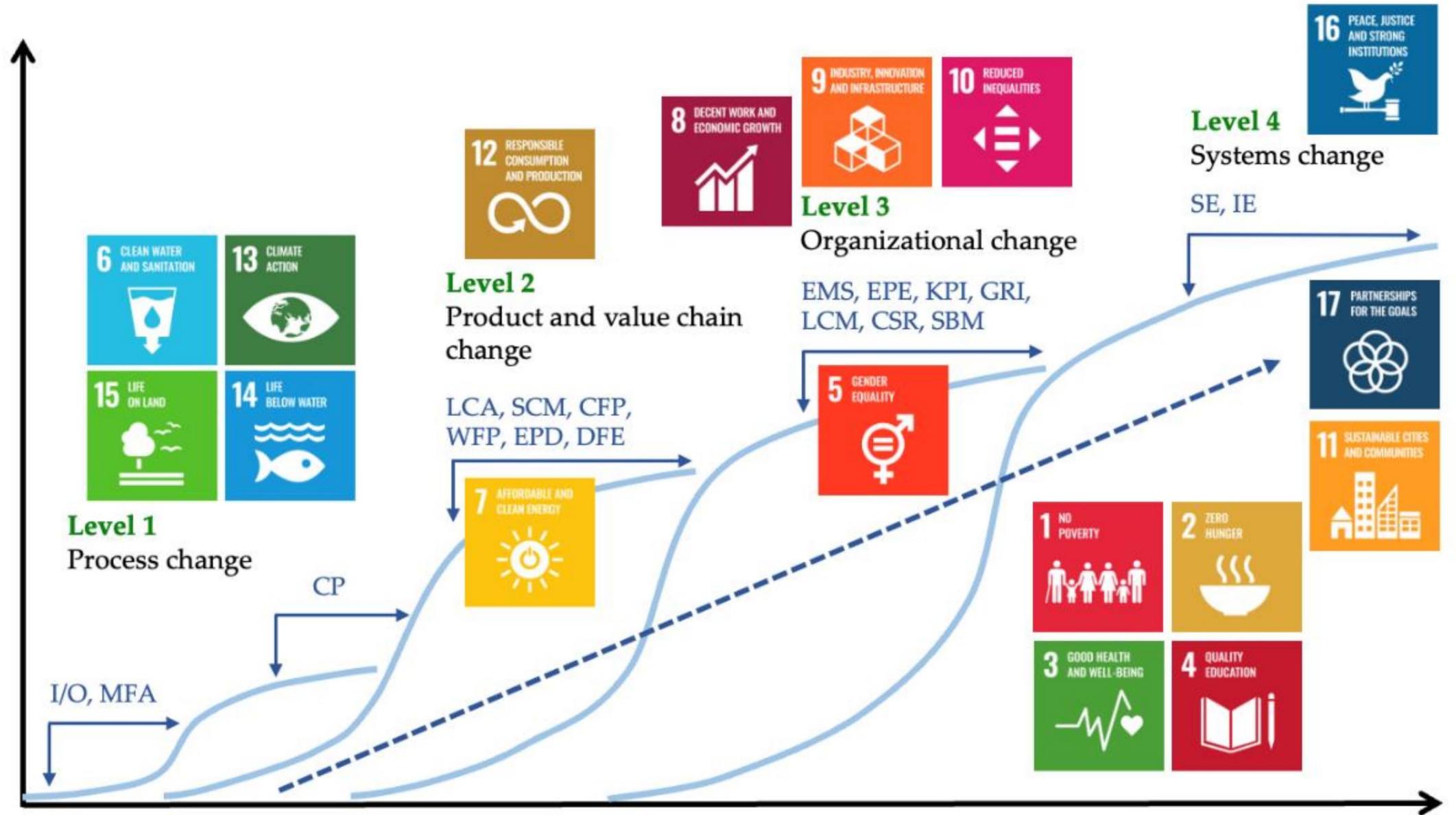
- Process Intensification
- Innovative (Bio)-Chemical Routes
- **Design Value Chains and Supply Chains as Closed Loops**
- Smart Infrastructures
- Sufficient Diversity
- Organisational Embedding
- **Evaluation and Management of Sustainability Performance**



System change improvements



From Fet, A.M.; Knudson, H. An Approach to Sustainability Management across Systemic Levels: The Capacity-Building in Sustainability and Environmental Management Model (CapSEM-Model). Sustainability **2021**, *13*, 4910. <https://doi.org/10.3390/su13094910>



From Fet, A.M.; Knudson, H. An Approach to Sustainability Management across Systemic Levels: The Capacity-Building in Sustainability and Environmental Management Model (CapSEM-Model). Sustainability **2021**, *13*, 4910. <https://doi.org/10.3390/su13094910>



Key aspects for the development of sustainability indicators

1. Environmental and economic assessments
2. Life Cycle Sustainability Assessment
3. Ecological impacts from brine discharge
4. Policy review and assessment



Keep in touch

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Grzegorz Gzyl
Assistant Professor
Główny Instytut Górnictwa (GIG)

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Grzegorz Gzyl (PhD Eng.) is an Assistant Professor at GIG, specialist in the field of hydrogeology, geology and water protection. He is a successful coordinator and project manager in several finished and on-going international projects (MAGIC, FOKS, AMIIGA, LoCAL, FLOMINET, LINDANET, LIFEPOPWAT, LIFE Brine-Mining) with a focus on groundwater contamination assessment and treatment, mine water assessment, management and treatment, recovery of energy and chemicals from mine water. He has co-authored several scientific publications in international journals.



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Environmental impact of brines discharged from coal mining industry in Poland

Grzegorz Gzyl

Central Mining Institute, Katowice, Poland

Zero Brine Final Forum, Delft, 4th Nov 2021



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15 November 2021

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FACTS ABOUT BRINES FROM COAL MINING INDUSTRY IN POLAND

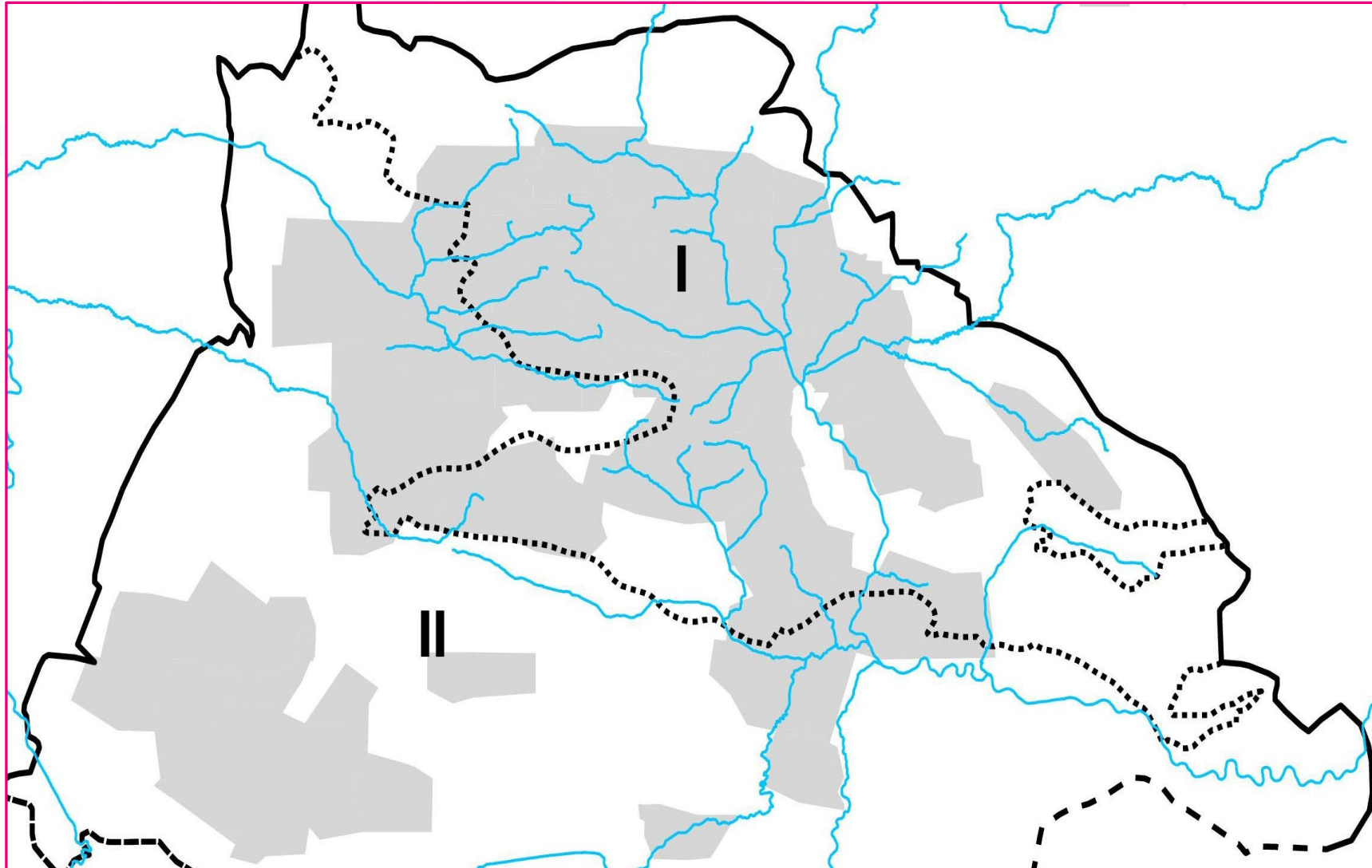
- Deep coal mines need to pump huge amounts of water, so that the coal extraction is possible.
- The deeper the mines operate - the more saline is mine water.
- In Upper Silesian Coal Basin in Poland there are many mines that pump and discharge brines that are extremely saline.
- In many cases the discharge of saline mine water is done into small rivers and therefore mine water dominates the flow of these rivers.
- For such rivers it is impossible to reach the goals set by National and EU regulations - such as Water Framework Directive.





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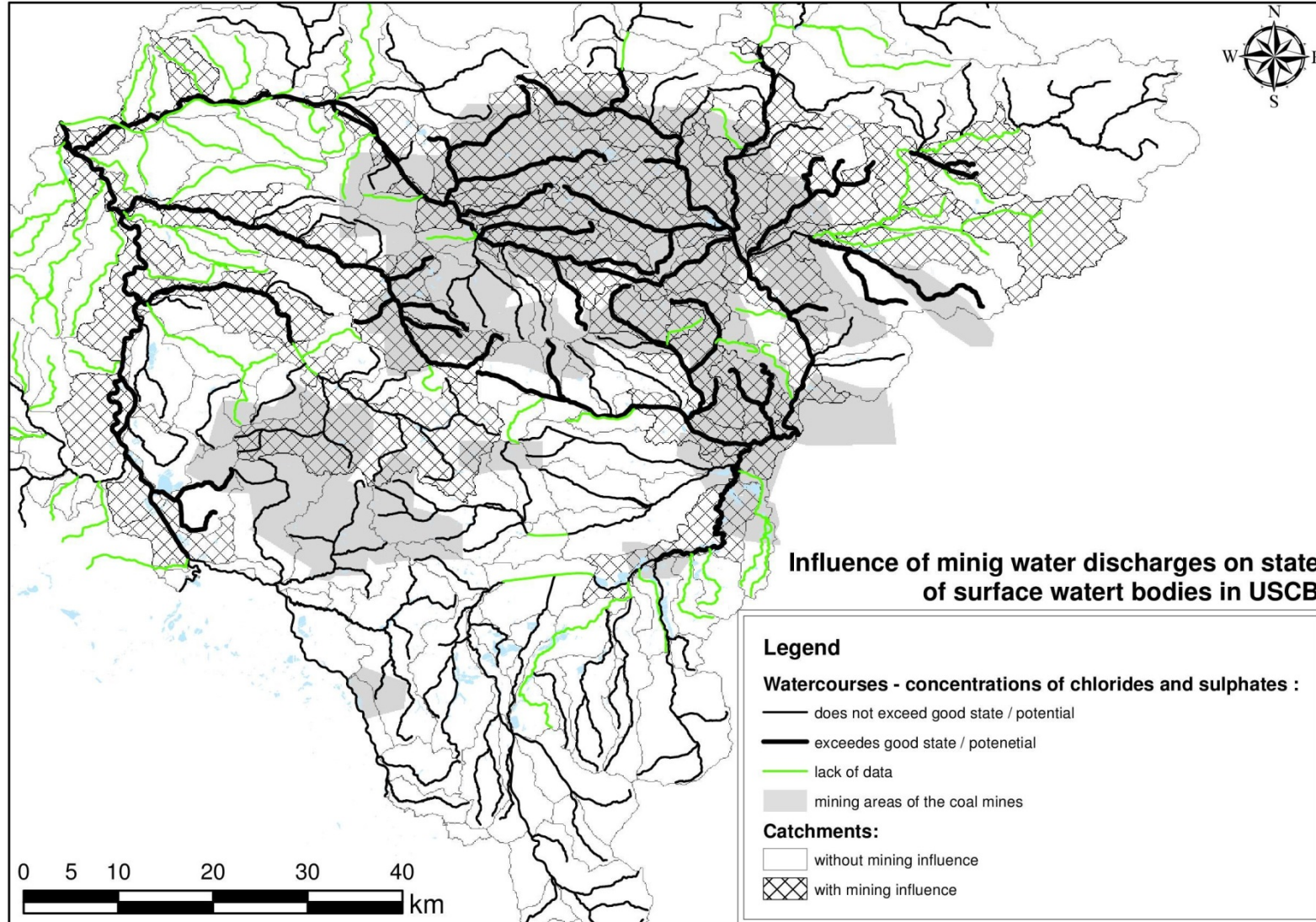
HYDROGEOLOGICAL SETTING OF USCB





ZERO BRINE

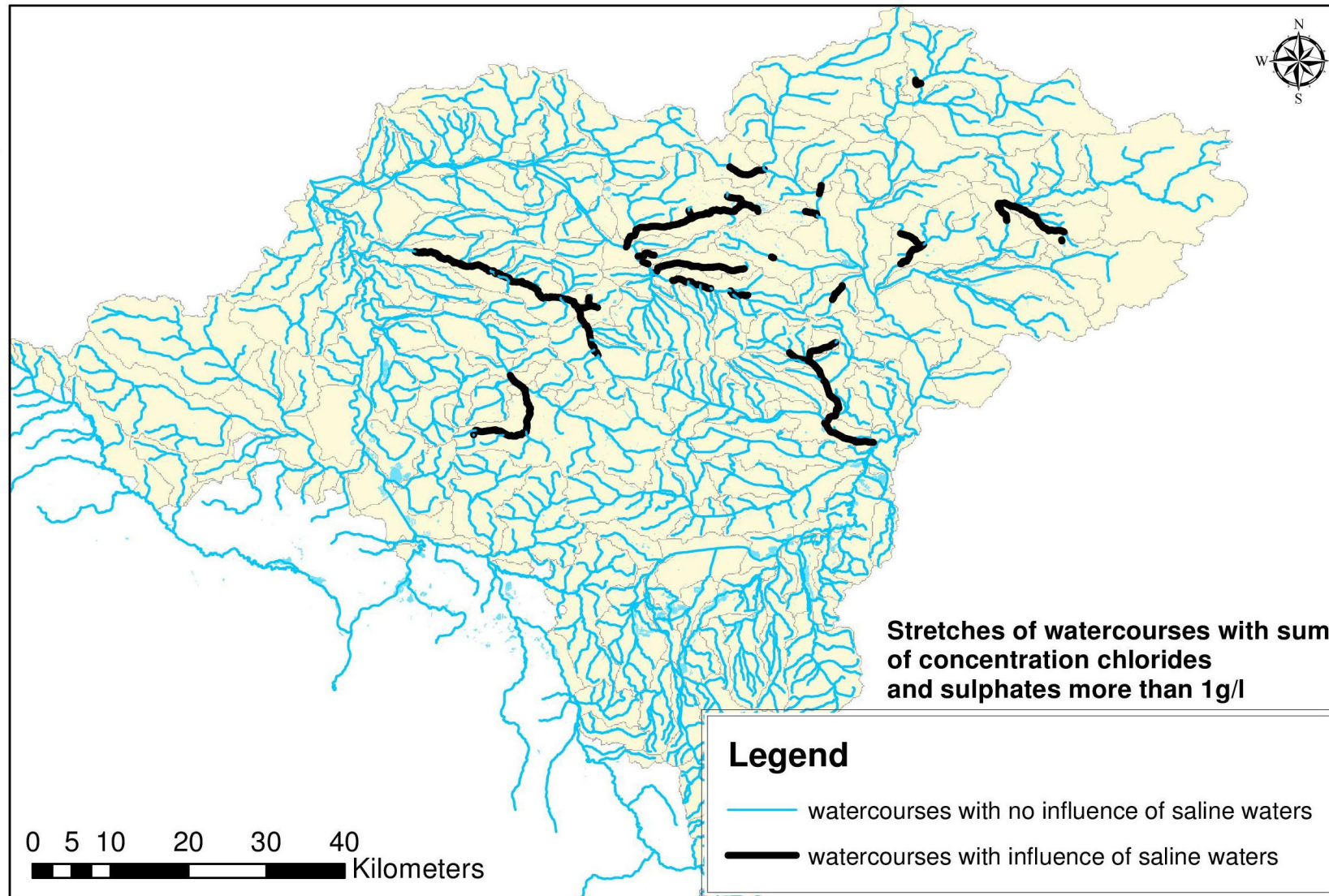
THE IMPACT OF MINE WATER DISCHARGES ON SURFACE WATERS IN USCB



SALINE RIVERS...



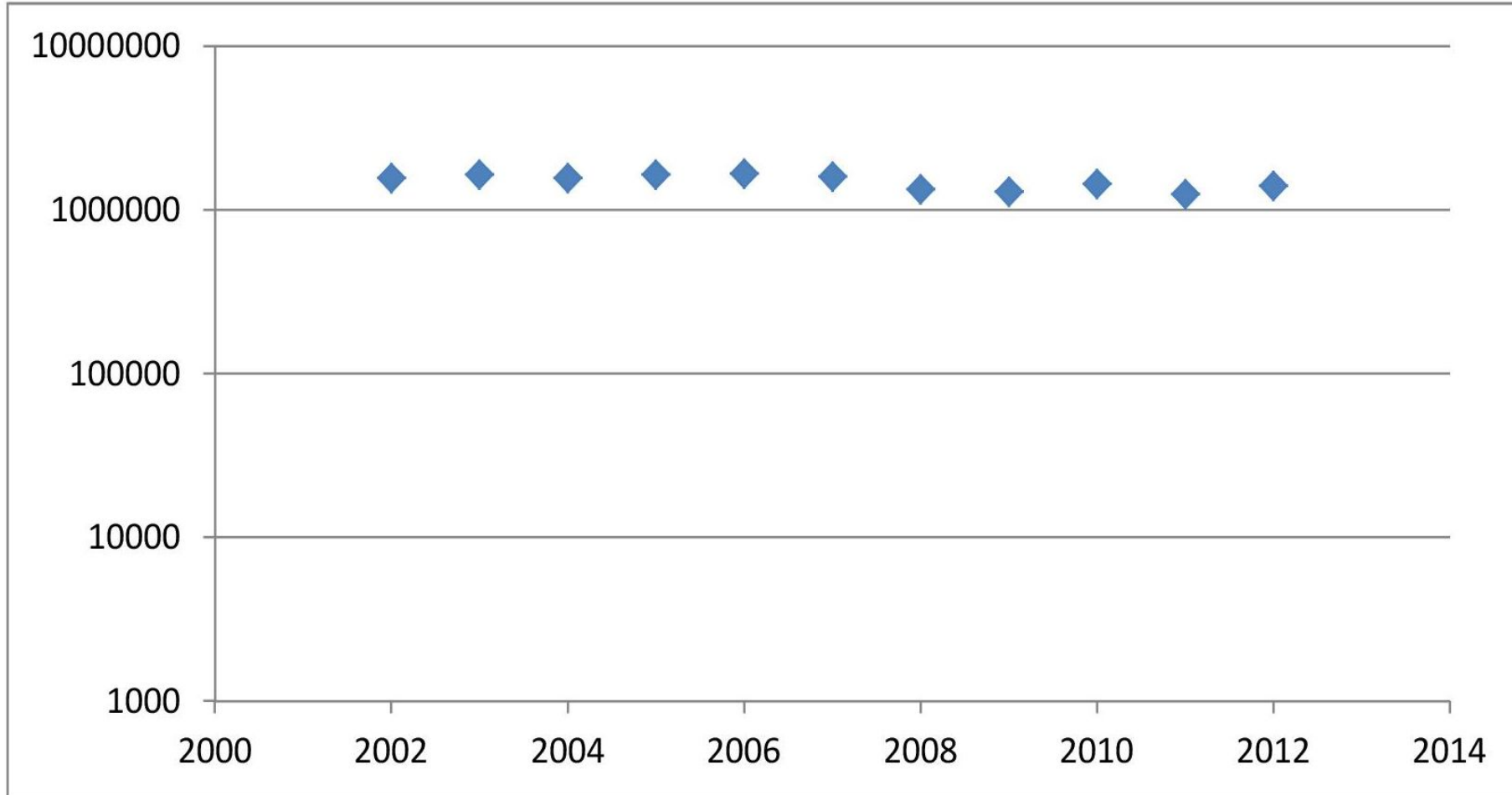
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TEMPORAL VARIATION OF TOTAL CHLORIDE AND SULPHATE LOAD (MG/YEAR)





ZERO BRINE



Coordinating beneficiary



National Technical University of Athens



Beneficiaries



GLOWNY INSTYTUT GORNICHTWA



LENNTECH



NEVIS-NOVEL Environmental Solutions S.A.



POLSKA GRUPA GORNICZA



SEALEAU B.V.



Silesian University of Technology



THERMOSSOL STEAMBOILERS S.A.

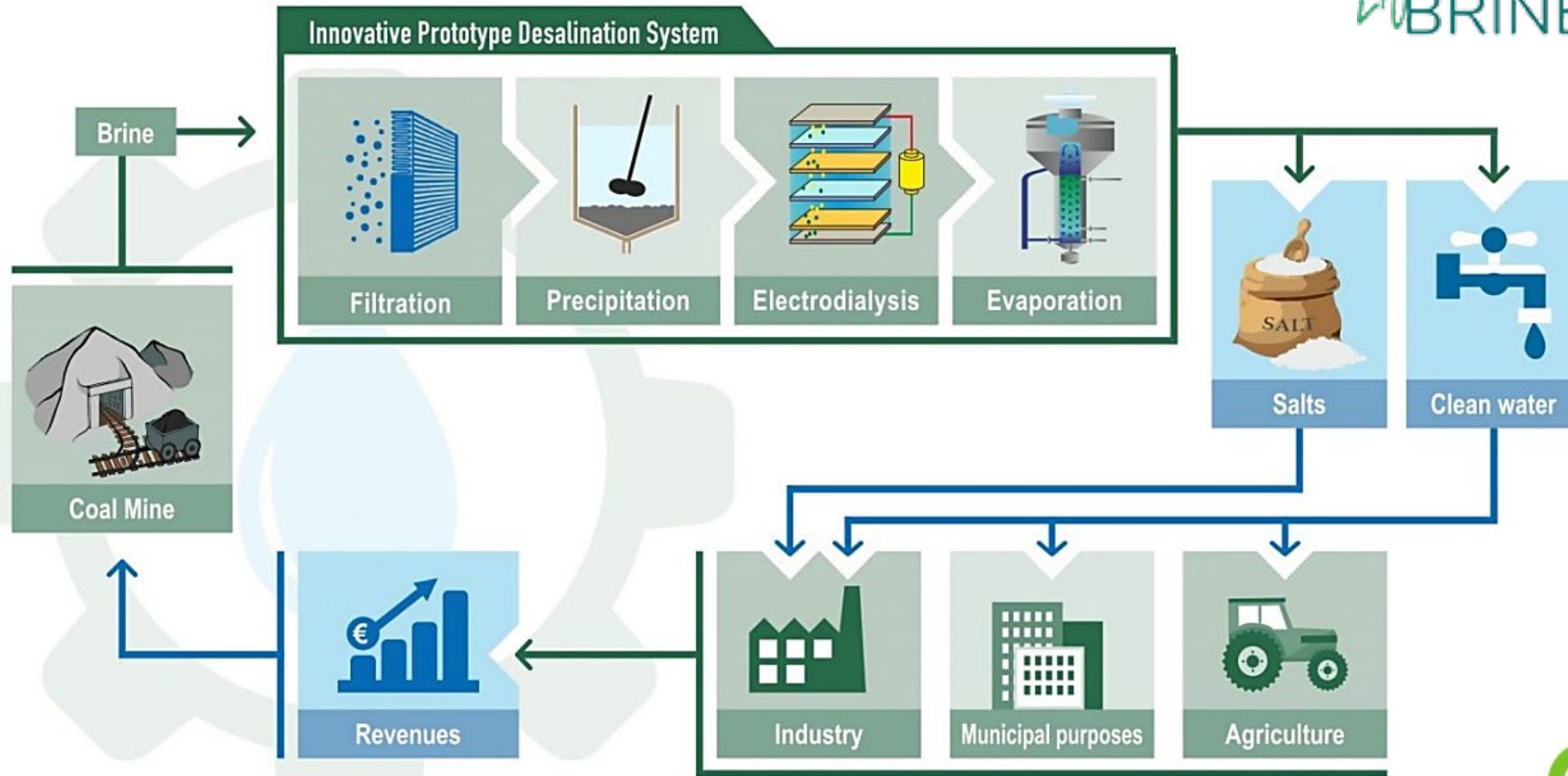


Titan Salt B.V.

LBM - CIRCULAR ECONOMY CONCEPT



LIFE Brine-Mining: From coal mine brine to marketable minerals, salts and water



The project is co-funded by the EU LIFE Programme





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LBM - LATEST PROJECT EVENTS



Site visit to Dębieńsko – September 2021

Dębieńsko is globally the 1st plant applying a Zero Liquid Discharge system to treat coal mine effluents, able also to recover salt of edible quality. The project team members' visit to Dębieńsko took place at the end of September 2021.



Dębieńsko Plant Premises.



1st Stakeholder Consultation Event – September 2021

The event took place in Poland, in the premises of GIG, with representatives from the political, scientific and industrial sector.





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Thank you for your attention

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#ZeroBrine

@zero_brine_



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Michiel van Haersma Buma
Chairman of the Advisory Board
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Michiel van Haersma Buma studied law and received his master's from the University of Utrecht. He has served as mayor of Markelo in the East of the Netherlands, of Voorburg and of Leidschendam-Voorburg, during which he served on several boards throughout civil society. Since then, Michiel has served as chairman of Delfland where he is responsible for the cooperation with the University of Delft and other institutions. He continues to advise the government and contribute to several other advisory boards.



ZERO BRINE White Paper - Challenges Ahead

Industrial waste water - Resources recovery – Waste reduction

Advisory Board 4 November 2021



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Technologies

Technology Development:

- 📖 High purity minerals and water can be recovered and reused;
- 📖 Permanent investments in innovative technologies;
- 📖 Some technologies can be further optimized for operational use.

Matchmaking:

- 📖 Online Brine Platform (OBP): An on-line vehicle for matchmaking is available;
- 📖 Further dissemination and use within Europe to be fostered.



EU Policy development

EU Policies: Industrial Emissions Directive and the Zero Pollution Strategy

- Requirement for EU Directive to strengthen circularity in production!
- ZERO BRINE Technologies, Best Available Techniques (BATs), to be promoted;
- Investments in circular innovations like the zero brine production chains to be developed and stimulated by a mix of taxes and subsidies;
- One of the points to address is the CO₂ emission, for which emission rights need suddenly be payed once a waste stream turns into a product.



Market & strategic development

Business cases:

- 📖 Inspiring examples to enhance circular market development;
- 📖 Ever present role of government policies in valuating products and waste.

Sectoral and strategic development within Europe:

- 📖 Self sustainability in natural resources;
- 📖 Reduction of dependencies for scarce resources from China imports.



White Paper offered to prof. Luuk Rietveld



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THANK YOU ZERO BRINE PARTNERS!