

Online Training for Industrial Cluster Authorities Towards Circularity and Industrial Symbiosis



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.

FIRST SESSION

WITH:

Dr. ir. George Tsalidis Ilse Oude Nijeweme Dr. Kees Roest







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Agenda

9:00 - 9:15 - Welcome and introductions

9:15 - 9:50 - Capacity building (presented by Dr. ir. G. Korevaar)

- Circular economy
- Industrial ecology
- Industrial symbiosis
- 9:50 10:00 Online coffee break
- 10:00 10:40 **ZERO BRINE Project**
 - Project description
 - Project results
- 10:40 10.50 Online coffee break
- 10:50 11:45 Online Brine Platform
 - Video
 - Tutorial
 - Questionnaire (10 minutes)

11:45 - 12:00 - Wrap-up



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My background

- Mechanical engineering
- Industrial ecology

- Process engineering
- Sustainability assessment
 - Life Cycle Assessment
 - Social Life Cycle Assessment
 - Life Cycle Costing







Symbiosis of Circular Economy and Industrial Ecology

1 December 2020

Dr. ir. Gijsbert Korevaar Assistant Professor on Industrial Symbiosis





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







level 4: system change improvements





Decoupling



Towards the Comprehensive Design of Energy Infrastructures



Cluster types

Characteristics	Pure agglomeration	Industrial complex	Social network Variable Trust Loyalty Joint lobbying Joint ventures Non-opportunistic	
Firm size	Atomistic	Some firms are large		
Characteristics of relations	Non-identifiable Fragmented Unstable frequent trading	Identifiable Stable and frequent trading		
Membership	Open	Closed	Partially open	
Access to cluster	Rental payments Location necessary	Internal investment Location necessary	History Experience Location necessary but not sufficient	
Space outcomes Example of cluster	Rent appreciation Competitive urban economy	No effect on rents Steel or chemicals production complex	Partial rental capitalisation New industrial areas	
Analytical approaches	Models of pure agglomeration	Location-production theory Input–output analysis	Social network theory (Granovetter)	
Notion of space	Urban	Local or regional but not urban	Local or regional but not urban	

Transition Design Theory







Industrial Symbiosis – main topics

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





Willy Haas et al. (2015), How Circular is the Global Economy?: An Assessment of Material Flows, Waste Production, and Recycling in the European Union and the World in 2005, Journal of Industrial Ecology 19(5), p765



Fenna Blomsma, Making Sense of Circular Economy, 2016 PhD Thesis Imperial College London

INDUSTRIAL ECOLOGY

Discipline that uses ecological principles in order to analyze and design industrial systems and to reduce their impact on the environment.

Eco-industrial park

Community of manufacturing and service businesses seeking enhanced environmental and economic performance through collaboration in managing environmental and resource issues including energy, water, and materials.

Industrial symbiosis

Dynamic process based on the interaction of separate businesses entities that create a cooperative network to achieve competitive advantage by physical exchange of materials, energy, water, and/or by-products as well as services and infrastructures.

Industrial symbiosis dynamics

Ways in which an industrial symbiosis is generated and structured from a technical and organizational point of view.

Technical dynamics

- Process oriented
- Residue oriented
- Place oriented

Organizational dynamics

- Anchor manufacturer
- Eco-cluster development
- Government planning
- Business incubator

CIRCULAR ECONOMY

Industrial system that is restorative or regenerative by intention and design.

Circular economy principles

- 1. Design out waste/Design for reuse
- 2. Build resilience through diversity
- 3. Rely on energy from renewable sources
- 4. Waste is food/Think in cascades/Share values
- 5. Think in systems

Circular economy strategic framework

Narrowing resource loops
 Slowing resource loops
 Closing resource loops

- A. Technical innovation
- B. Business model innovation C. Collaboration

Circular business models

Disruptive business models aiming to drive the sustainability of a business network through the circular strategies, linking up material flows, using resources most efficiently and ideally eliminating waste.

+

Dematerialization Produce of (1. Avoid)		n demand Remanufa (2. Replace)		nufac	turing	Refurbishing (2. Replace)	
Upgrading (2. Replace)	Hybr (3. Re	r id model educe)	Industrial symbiosis (3. Reduce)			Collection service (4. Reuse)	
Collaborative consumption (4. Reuse)		Performance model (4. Reuse)		el	Closed loop recycling (5. Recycle)		
Downcycling (5. Recycle)	U (5	pcycling 5. Recycle)	Energy rec (6. Recover)	overy			

Keep in touch

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Zero Brine project section





Water: Clean water and sanitation







Poll: Zero Brine

- Had you heard about Zero Brine project before this session?
- A. Yes
- B. No





What is Brine?

• Brine is a high-concentration solution of salt (usually sodium chloride) in water

 Total brine generated and discharged in the Netherlands is 650 ktons chloride releases per year







Consortium and activities

- Industry companies
- SME technology suppliers
- Universities
- Applied research institutes
- Public authorities
- European Technology Platforms
- SMEs for dissemination
- Construction management and O&M companies









Dutch case study: Demineralized water plant (Evides Industriewater)





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Poll: Zero Brine

- What kind of benefits do you expect the most due to the Dutch ZB case study?
- A. Environmental benefits
- B. Social benefits
- C. Cost benefits
- D. None





ZERO BRINE project results: Dutch DM Water plant



Site 1

- High purity magnesium & calcium
- Clean Water
- NaCl regeneration solution

Site 2

- Sulphate salts
- NaHCO3
- Clean Water
- NaCl regeneration solution



ZERO BRINE project results: Spanish Silica plant



€460,000 per year and turnover of €1,800,000 per year from the sodium sulphate recovered.





ZERO BRINE project results: Polish Coal mine



Faster processing time than existing technologies

Recover materials such as salt or concentrated brine, magnesium hydroxide



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ZERO BRINE project results: Turkish Textile plant

The ZERO BRINE textile pilot is capable of treating 300 L/hr discharged RO concentrate

70-80% of recovery of NaCl for textile dyeing 55-60% reusable pure water stream for process





ZERO BRINE Dutch case study results

- Recovered materials: clean water, brine or NaCI (common salt), magnesium hydroxide
- Environmental benefits: significant (eco) toxicity benefits

Tsalidis et al. Unpublished work

- Economic benefits: profitable if high quality recovered minerals and water
- Social benefits: reduction of Russian magnesium hydroxide (high conflict mineral) → EU target

Tsalidis and Korevaar, 2019 Tsalidis et al. 2020





ZERO BRINE project conclusions

- Opportunities exist to produce circular water and circular minerals!
- The Netherlands: less toxic ports, biodiversity benefits, potential financial benefits and conflictfree sourcing minerals

Tsalidis et al. Unpublished work

- Spain: large potential financial benefits and significant decrease in water use
- Poland: high energy efficiency improvement and potential financial benefits and conflict-free sourcing minerals
- Turkey: potential environmental benefits due to avoided products, especially water



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Brine Excellence Center (BEC)

 The central BEC facility will be established in the Netherlands (TU DELFT), while four satellite BECs will be developed in Poland (SUT), Spain (Eurecat), Greece (NTUA) and Italy (UNIPA).

- Dutch BEC:
 - Ion Exchange Column
 - Reverse Osmosis
 - Eutectic Freeze Crystallization
 - Nanofiltration



Top view of Water Lab, Civil Engineering faculty TU Delft (relevant to Dutch BEC)





Zero Brine "follow up" projects



Online Brine Platform section





Circular Business models (Lacy and Rutqvist, 2015)

- Circular Supply chain
- Recovery and recycling
- Product life extension
- Products as a service (PaaS)
- Sharing platform: to promote or facilitate the renting, swapping, lending, sharing, gifting or bartering of the resources, to connect the (by-) product owners with the individuals or firms

 → collaboration is formed among them.

Such a sharing platform allows multiple users to use similar resources or (by-) products thereby reducing demand \rightarrow Online Brine Platform





Online Brine Platform





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Online Brine Platform: Tutorial

HOW TO REGISTER TO THE ONLINE BRINE PLATFORM





ZERO BRINE

Online Brine Platform

ZERO BRINE ONLINE BRINE PLATFORM (OBP)	≡ 2 2 2
Dashboard	Dashboard ZERO BRINE Platform / Dashboard
My Role: []: Waste Heat Provider > Q Search >	total usersAMATCHESImage: SEFFLUENTSRECOVERED MATERIALSREQUIRED MATERIALSTECHNOLOGY PROVIDERSWASTE HEAT PROVIDERS235510648175
Statistics/Metrics	WELCOME TO THE OBP ANNOUNCEMENTS INBOX
Messages O	The OBP is an innovative prototype platform in the domain of saline wastewater management aiming to promote resource efficiency and circular economy. The OBP is developed by National Technical University of Athens in the framework of ZERO BRINE project. The OBP aims to play a key role in replicating the paradigms generated in the framework of the ZERO BRINE project.
Announcements	In the OBP, the brine streams generated by process industries (Brine Owners) as well as the raw materials (minerals) and the water streams used by these industries
FAQ	(Mineral/Water Users) will be mapped together with the available technologies (Technology Providers) and waste heat streams (Waste Hear Providers). Possible
OBP Portal	interactions between the industries across the value chain will be identified. Brine Owners and Mineral/Water Users could be automatically matched, by the OBP algorithm.
MTP ZERO BRINE Project	In addition to the OBP, a web portal is created to access specific information in the domain of saline waste water management. A collaboration tool (forum) is embedded to the portal in order to facilitate communication between key stakeholders.





Thank you







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