ZERO BRINE

Online Training for Companies:
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.

SECOND SESSION

WITH:

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

Institute for
Sustainable
Process Technology

ZERO BRINE

Agenda

- 13:00 - 13:10 - Welcome and introductions
- 13:10 - 13:50 - Capacity building (presented by Gijbsert Korevaar)
  - Circular economy, Industrial Ecology and Industrial symbiosis
  - Guest speaker: Jan Willem Mulder (Evides Industriewater)
- 13:50 - 14:20 - Zero Brine Project
  - Project description
  - Project results
- 14:20 - 14:30 - Online coffee break
- 14:30 - 15.20 - Online Brine Platform
  - Video by Revolve and NTUA
  - OBP tutorial
- 15:20 - 15:30 - Online coffee break
- 15:30 - 15:45 – Questionnaire about the Online Brine Platform
- 15:45 - 16:00 - Wrap-up

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

3 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

Sustainable Growth across value chain

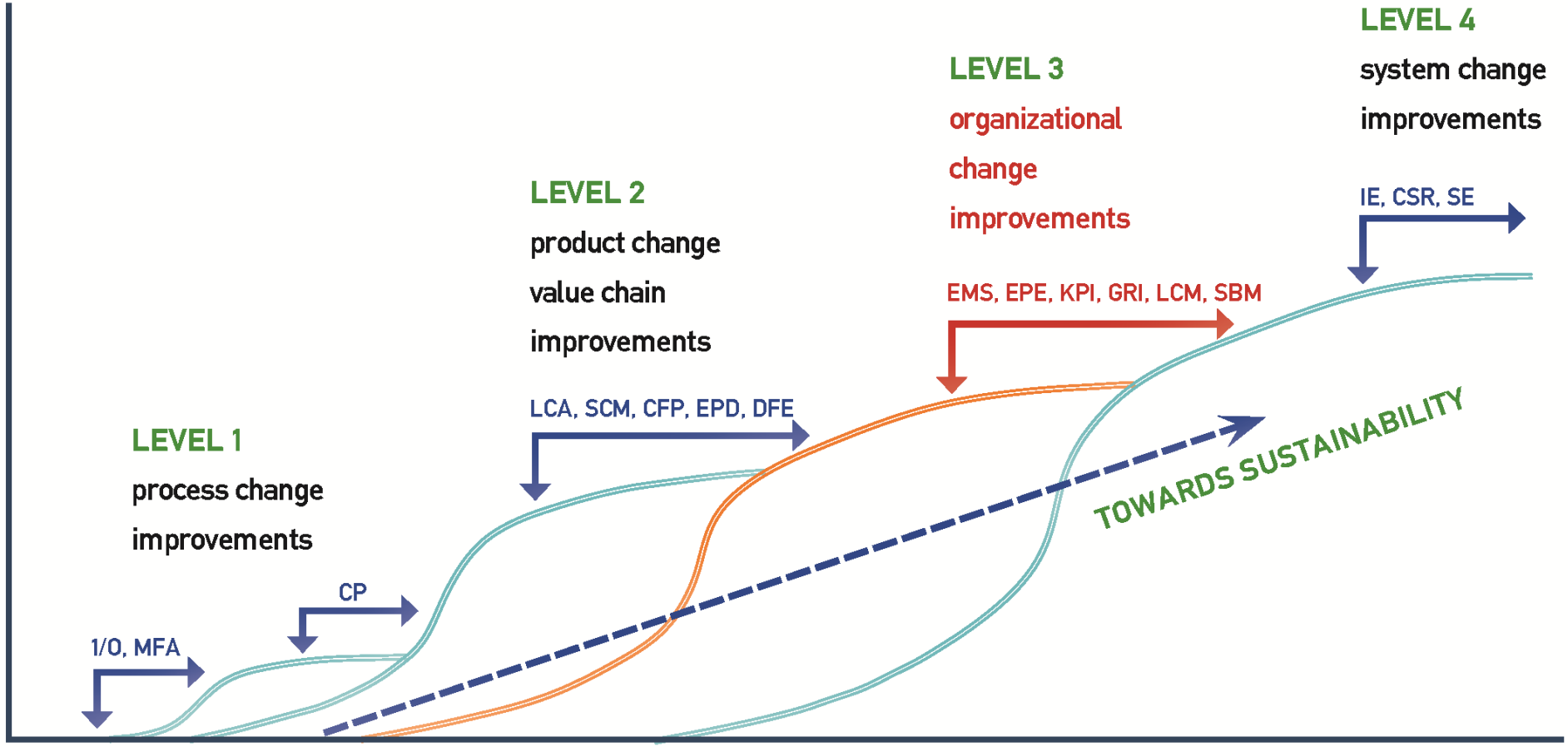
Future feedstocks

Circular Economy

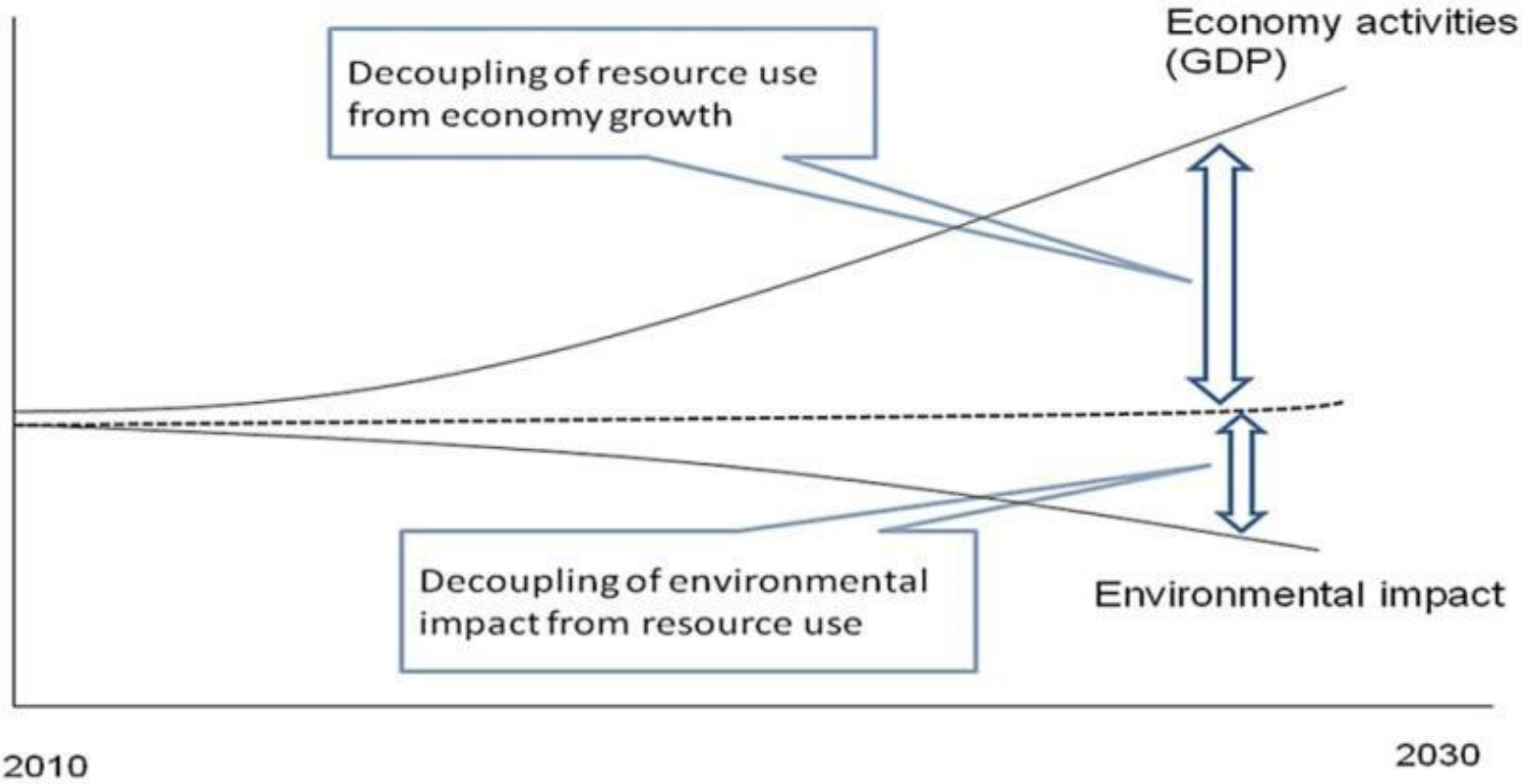
Cross-industry Efficiency

Future products & application

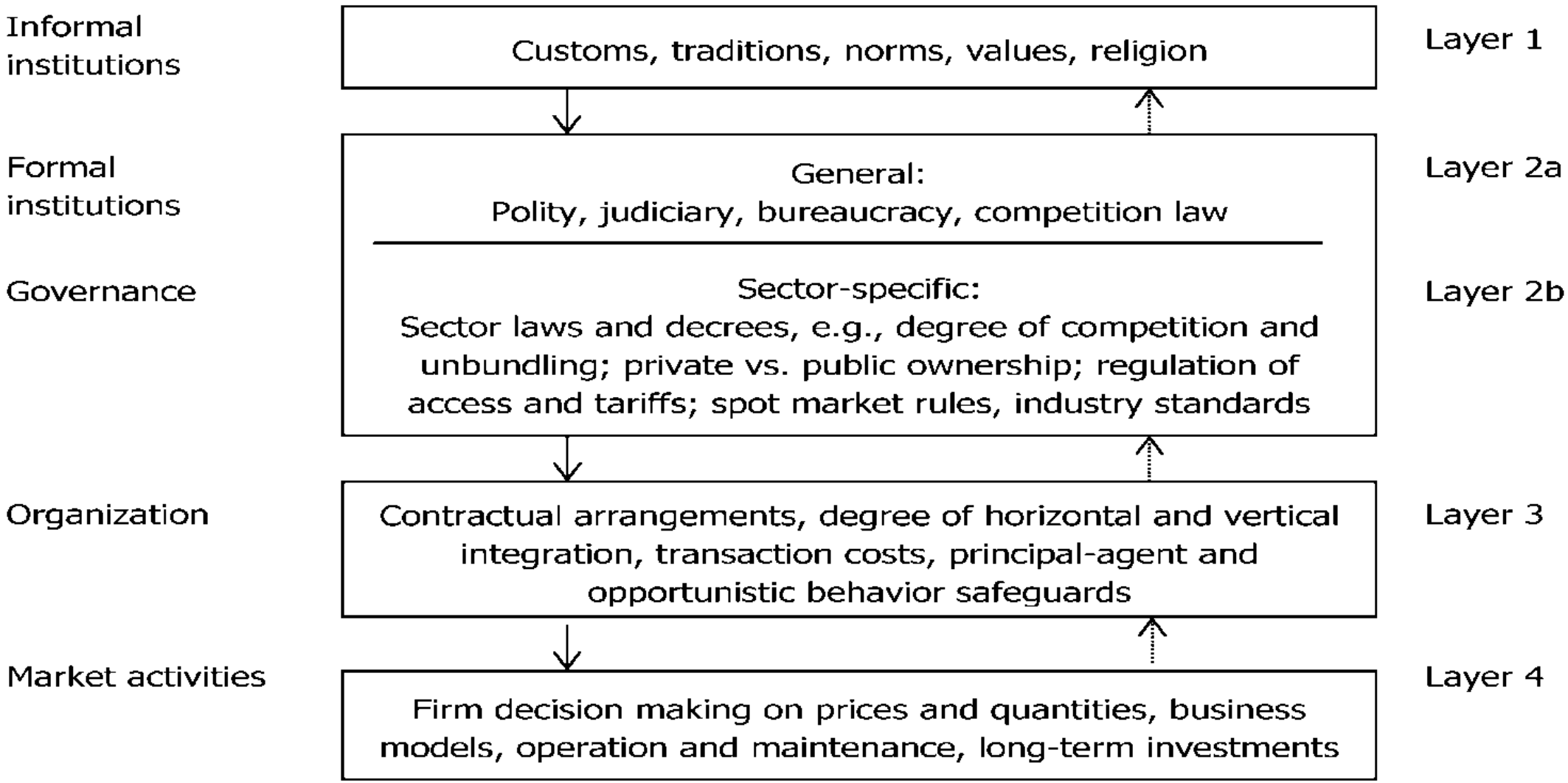
level 4: system change improvements



Decoupling


Economy activities
(GDP)
Decoupling of resource use
from economy growth
Decoupling of environmental
impact from resource use
Environmental impact
2010
2030

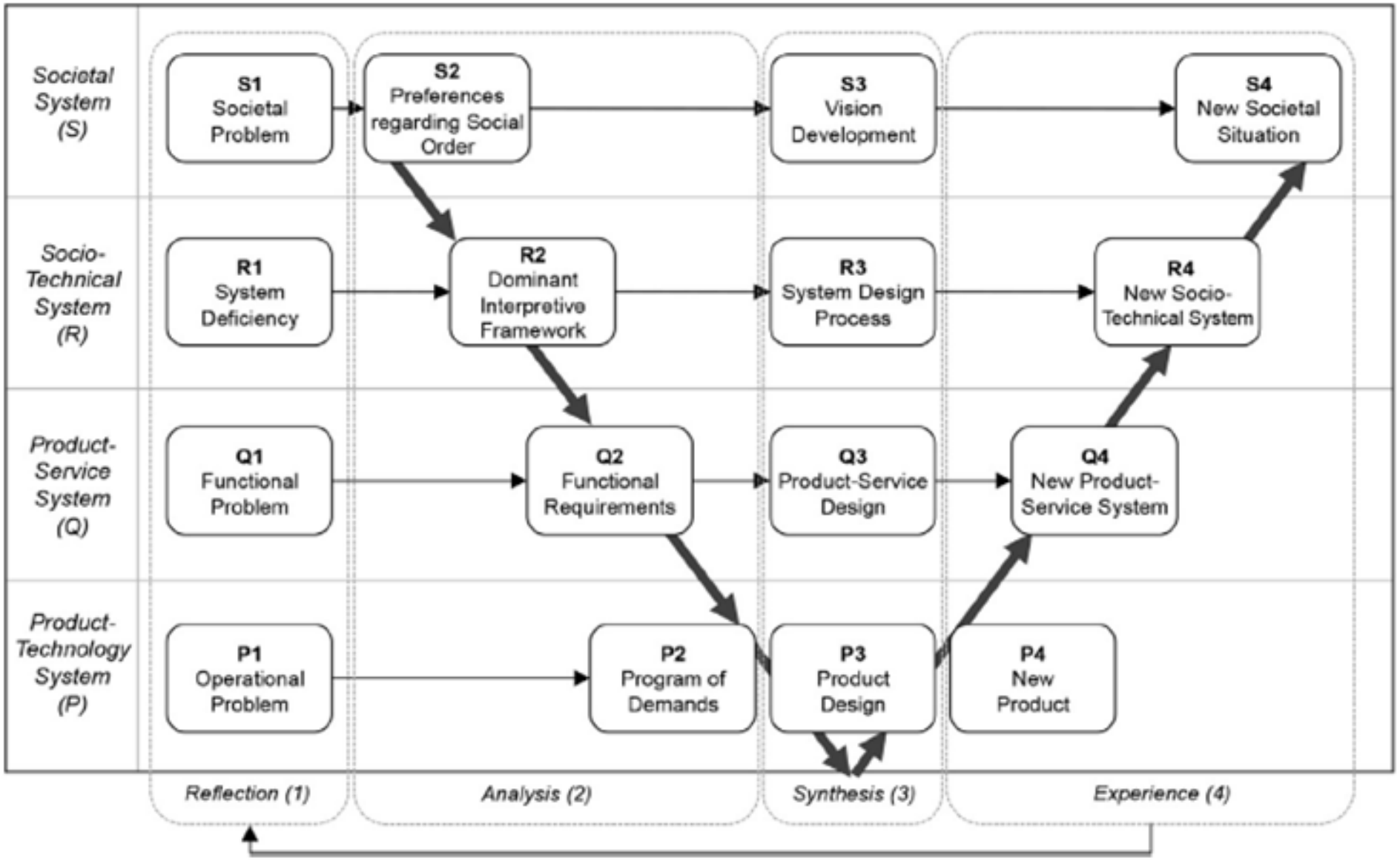
Towards the Comprehensive Design of Energy Infrastructures

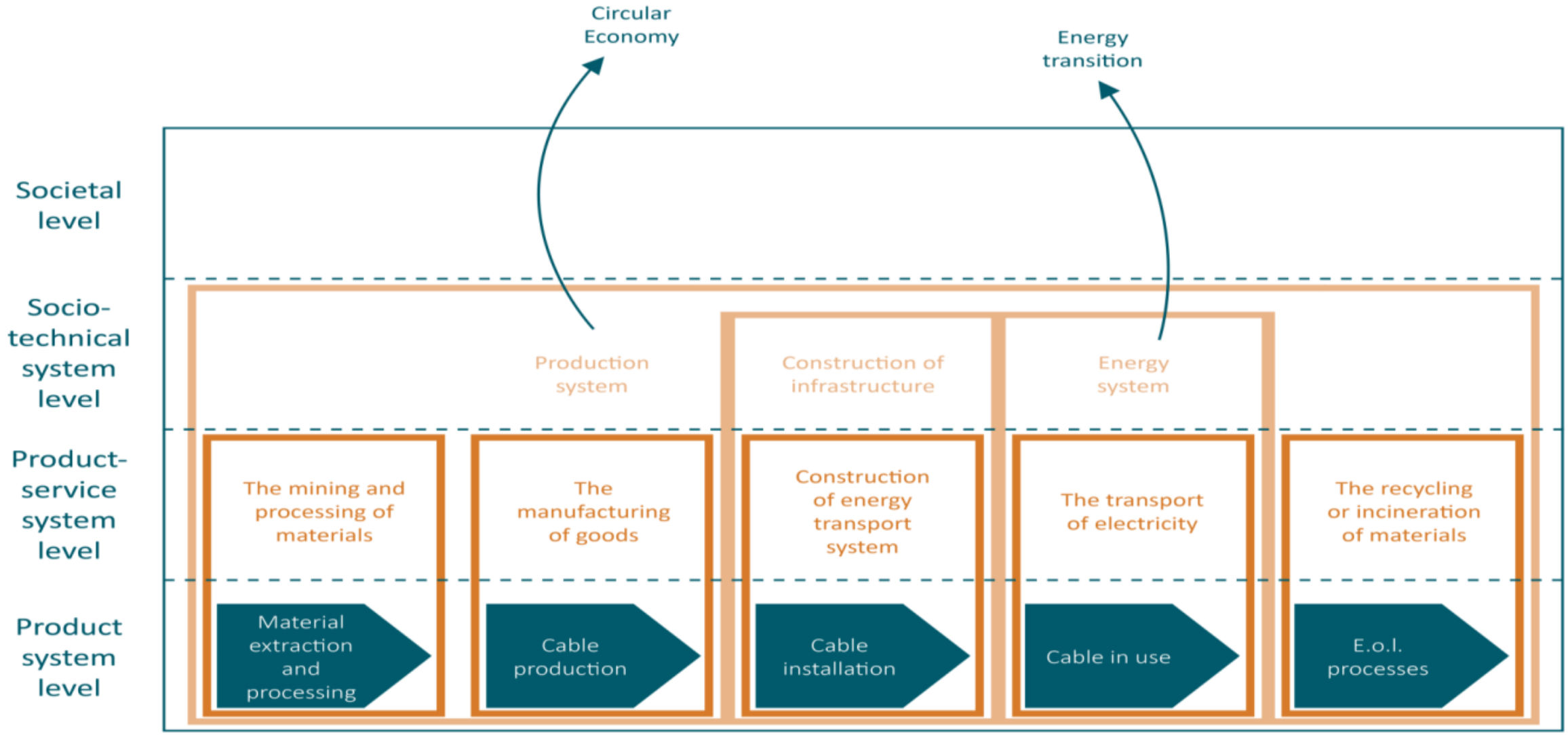


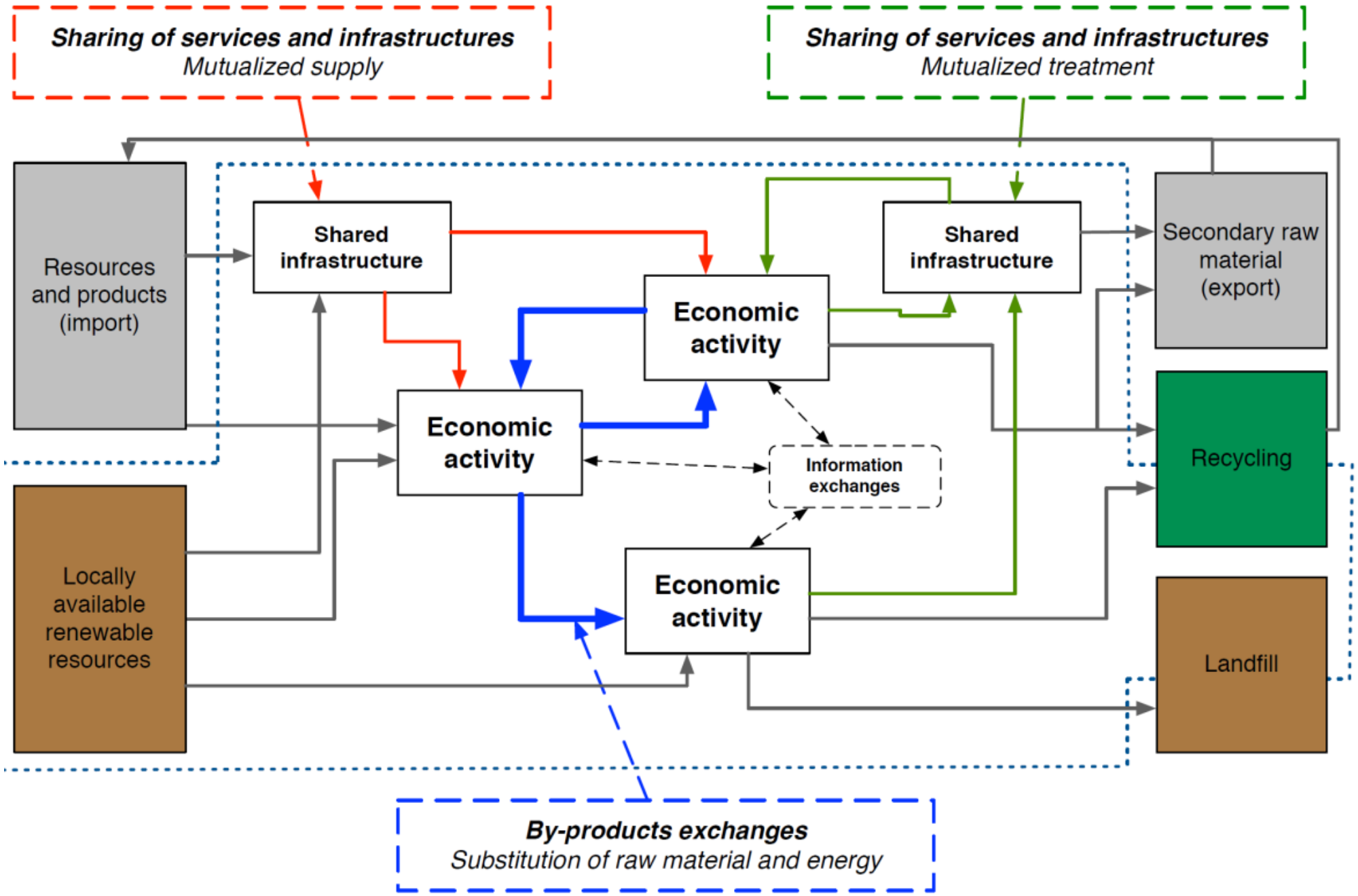
Cluster types

Characteristics	Pure agglomeration	Industrial complex	Social network
Firm size	Atomistic	Some firms are large	Variable
Characteristics of relations	Non-identifiable Fragmented Unstable frequent trading	Identifiable Stable and frequent trading	Trust Loyalty Joint lobbying Joint ventures Non-opportunistic
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	Rent appreciation	No effect on rents	Partial rental capitalisation
Example of cluster	Competitive urban economy	Steel or chemicals production complex	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




Circular Economy
Energy transition
Societal level
Socio-technical system level
Product-service system level
Product system level
Production system
Construction of infrastructure
Energy system
The mining and processing of materials
The manufacturing of goods
Construction of energy transport system
The transport of electricity
The recycling or incineration of materials
Material extraction and processing
Cable production
Cable installation
Cable in use
E.o.l. processes

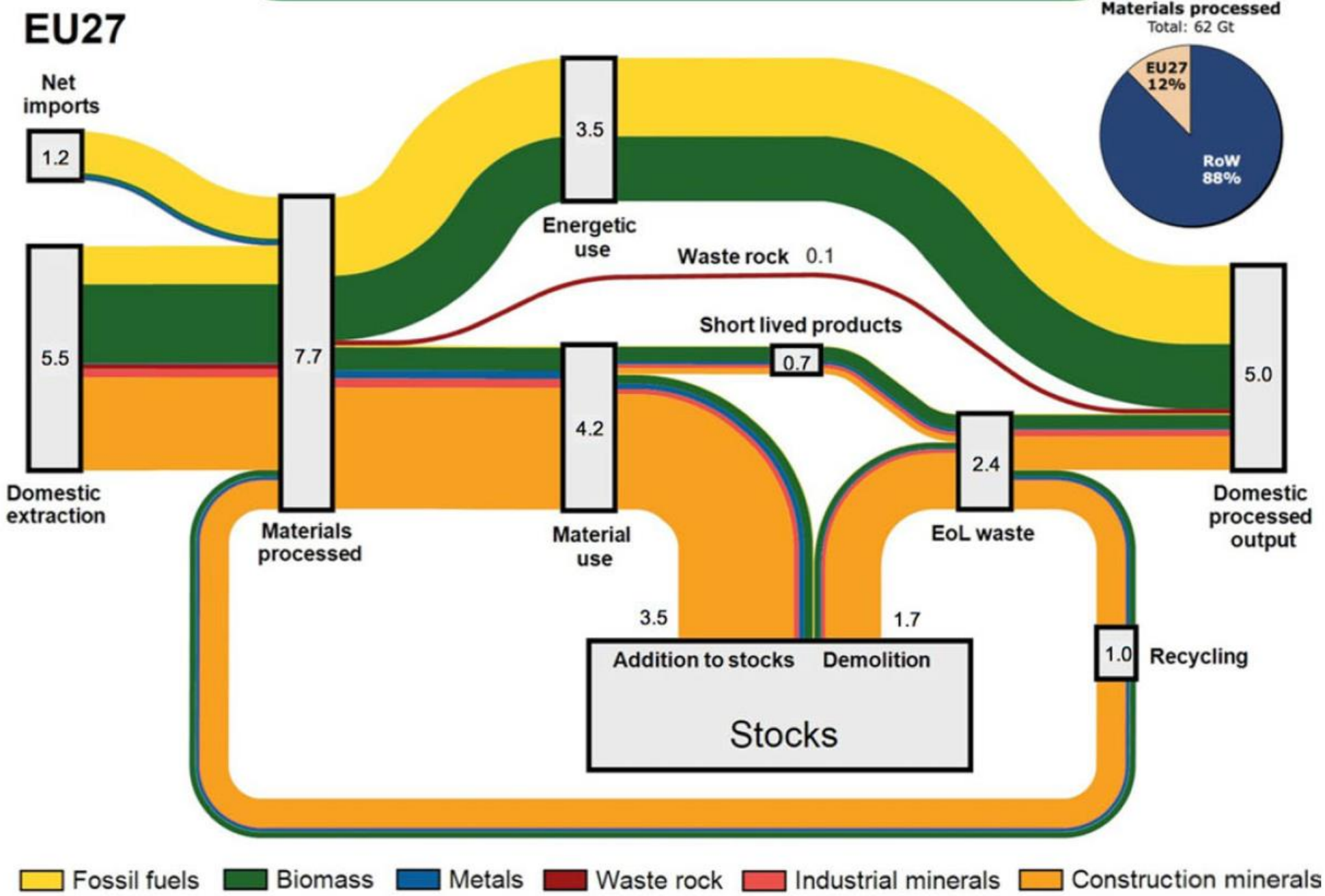

Sharing of services and infrastructures
Mutualized supply
Sharing of services and infrastructures
Mutualized treatment
Resources and products (import)
Shared infrastructure
Shared infrastructure
Economic activity
Economic activity
Economic activity
Information exchanges
Secondary raw material (export)
Recycling
Landfill
Locally available renewable resources
By-products exchanges
Substitution of raw material and energy

Industrial Symbiosis – main topics

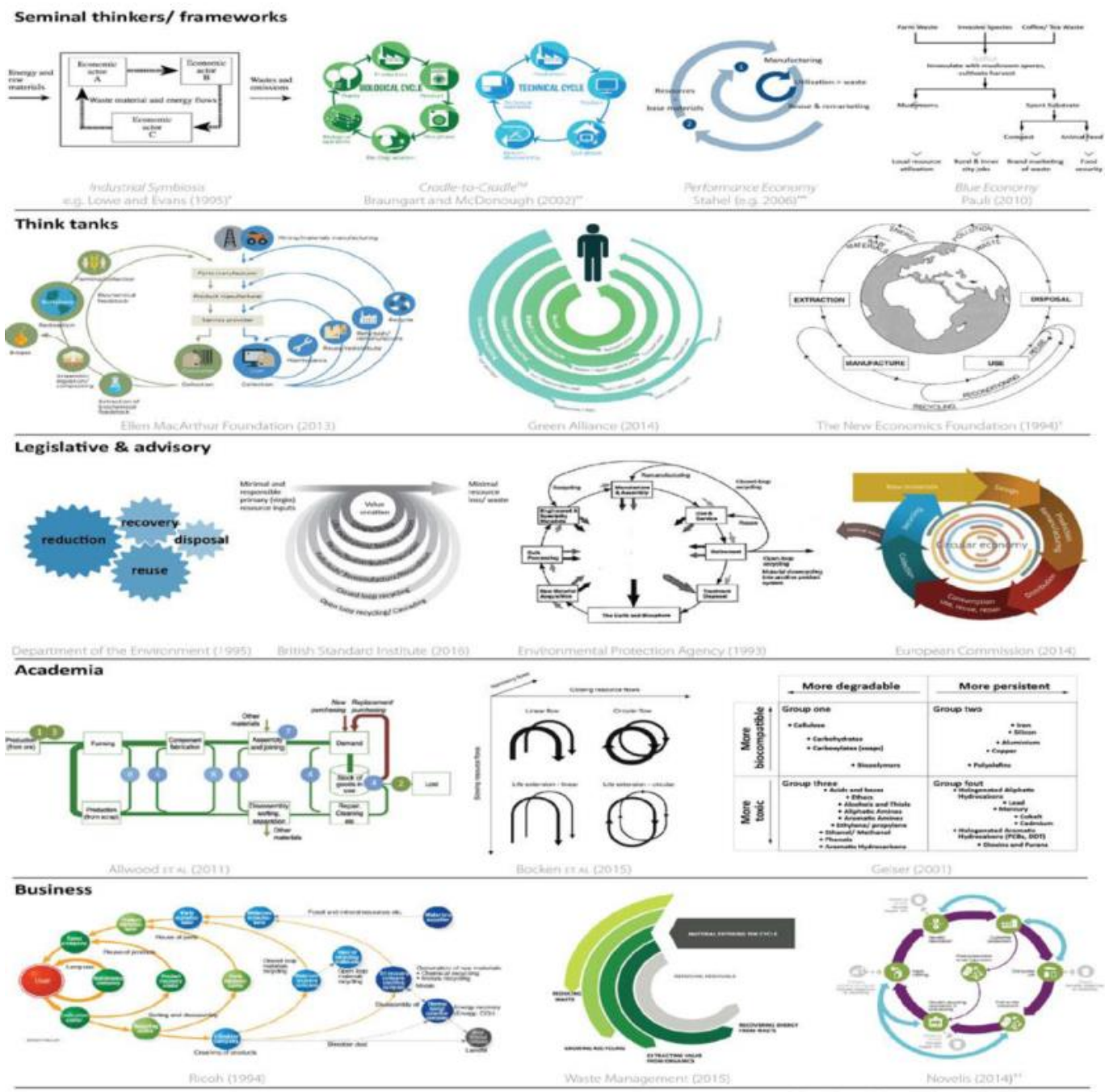
Industrial - resources, production, transport, waste treatment
- Symbiosis … linked together with a mutual benefit

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

1. Narrowing resource loops		A. Technical innovation
2. Slowing resource loops	+	B. Business model innovation
3. Closing resource loops		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 (1. Avoid)	**Produce on demand** (1. Avoid)	**Remanufacturing** (2. Replace)	**Refurbishing** (2. Replace)
Upgrading (2. Replace)	**Hybrid model** (3. Reduce)	**Industrial symbiosis** (3. Reduce)	**Collection service** (4. Reuse)
Collaborative consumption (4. Reuse)		**Performance model** (4. Reuse)	**Closed loop recycling** (5. Recycle)
Downcycling (5. Recycle)	**Upcycling** (5. Recycle)	**Energy recovery** (6. Recover)	

Keep in touch

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Circularity at Evides Industriewater

Jan Willem Mulder

ISPT webinar – 3 December 2020

Evides makes water valuable

Mission:

Offering water solutions, reliable and innovative

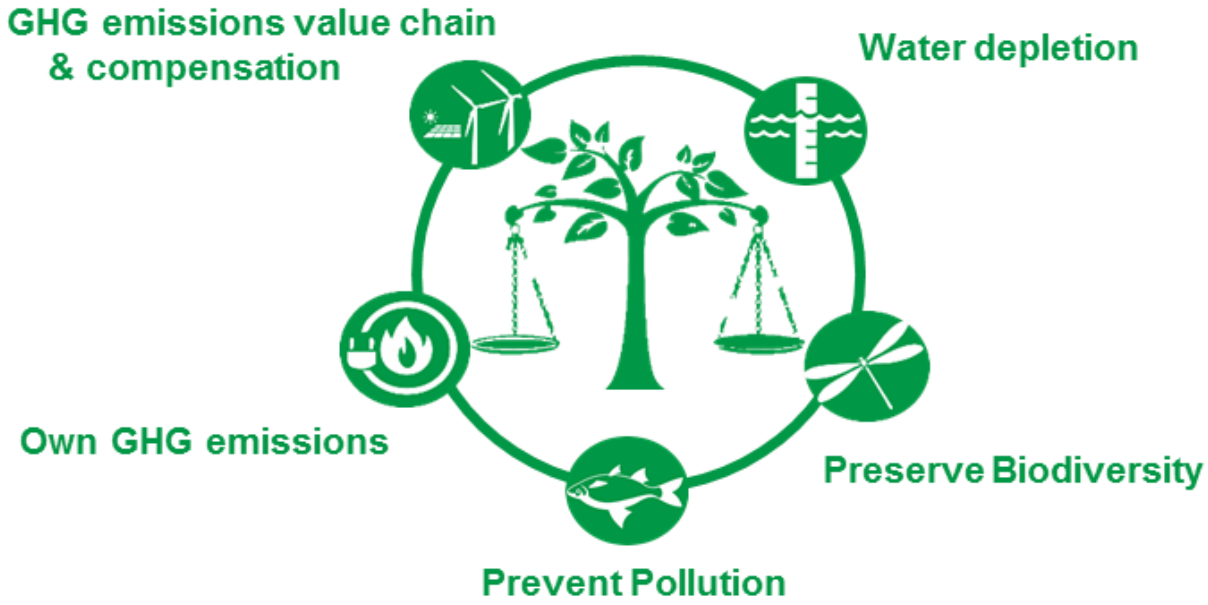
Activities Evides Industriewater

- Supply of industrial process water (one third polished deminwater)
- Tailor-made water by DBFO or commodity
- Multi-client demin water plants in the Rotterdam area (2,400 m^3/h)
- Treatment of industrial wastewater
- Treatment of domestic wastewater in the Hague region
- Re-use of water and resources
- Cooling tower water Research and innovation

Sustainability – Water Without Waste

- Without Waste programme to reduce our environmental impact
- Not only focus on CO2, also other sustainable goals
- LCA tool for calculating our impact

water without waste



GOLD 2019 ecovadis CSR Rating

Certified Sustainabilty

evides industriewater

Circularity

- Until now mainly focused in water reuse
- Examples:
  - Reuse of domestic wastewater for demiwater production for Dow Terneuzen
  - Reuse of treated industrial wastewater Dow Terneuzen
  - Reuse of wastewater for Lamb Weston Meijer Kruiningen

Circularity – heat recovery

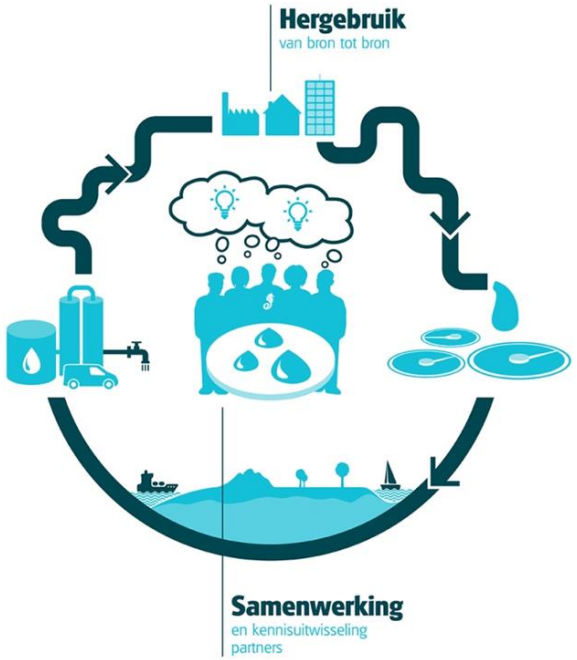
- Heat exchange for preheating demiwater production in the Botlek
- *'Sloewarmte Vlissingen'*; heat exchange between Zeeland Refinery and other clients

Circularity –recovery of resources

- Part of R&D
  - NEREUS project: recovery of components from wastewater (cellulose, P, N, humic acids, energy, water)
  - NEWBIES project: electrochemical recovery of ammonia
  - WWTP effluent reuse pilots
  - Zero Brine project: recovery of minerals from brines

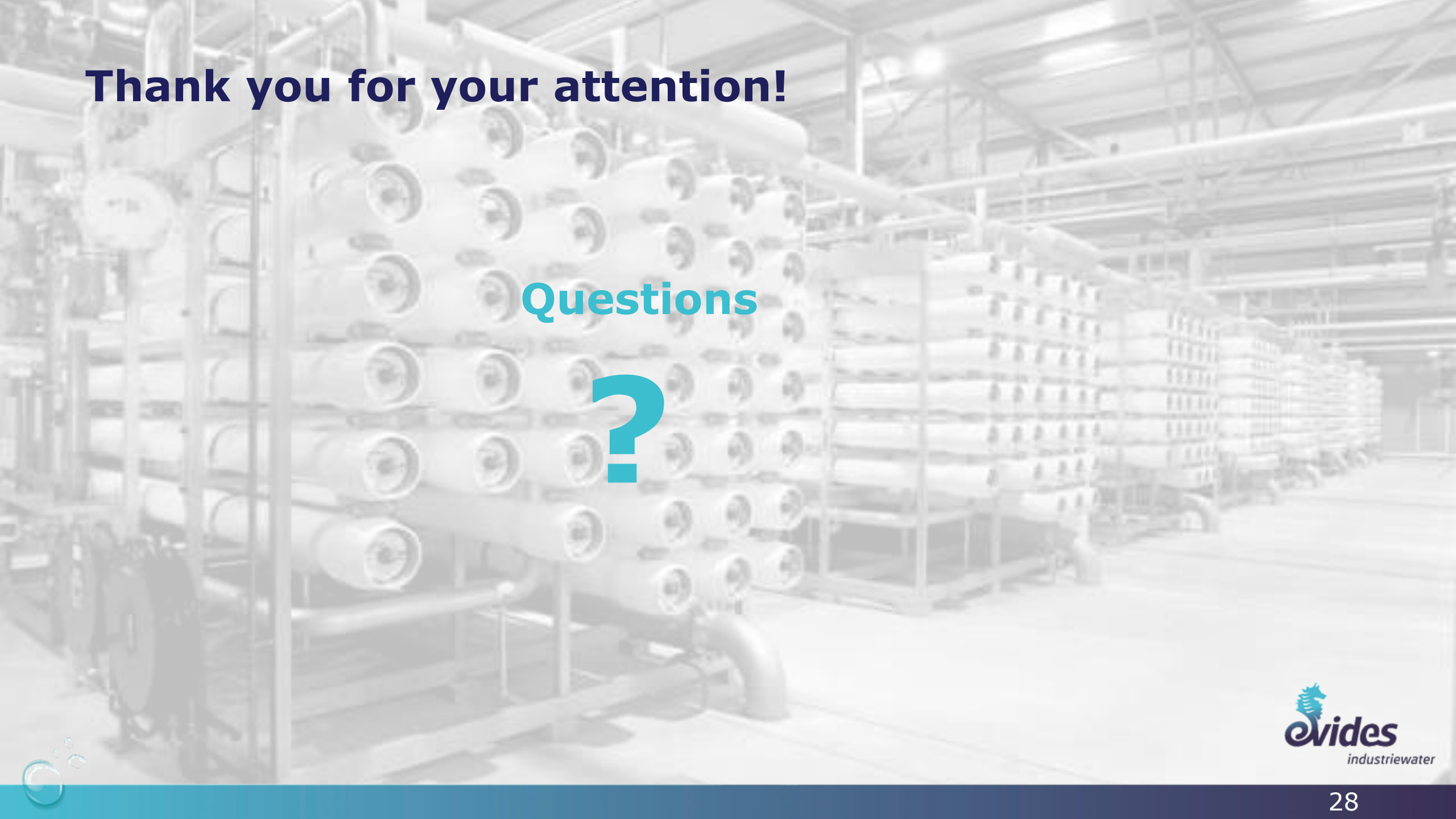
Conclusions and future developments

- Environmental impact is a mix of different aspects (LCA)
- Circularity is growing and will grow further in the future
- Looking for opportunities in the value chain, cooperation is necessary
- Still a lot to be developed



Thank you for your attention!

Questions



Zero Brine project section

Water: Clean water and sanitation

Poll: Zero Brine

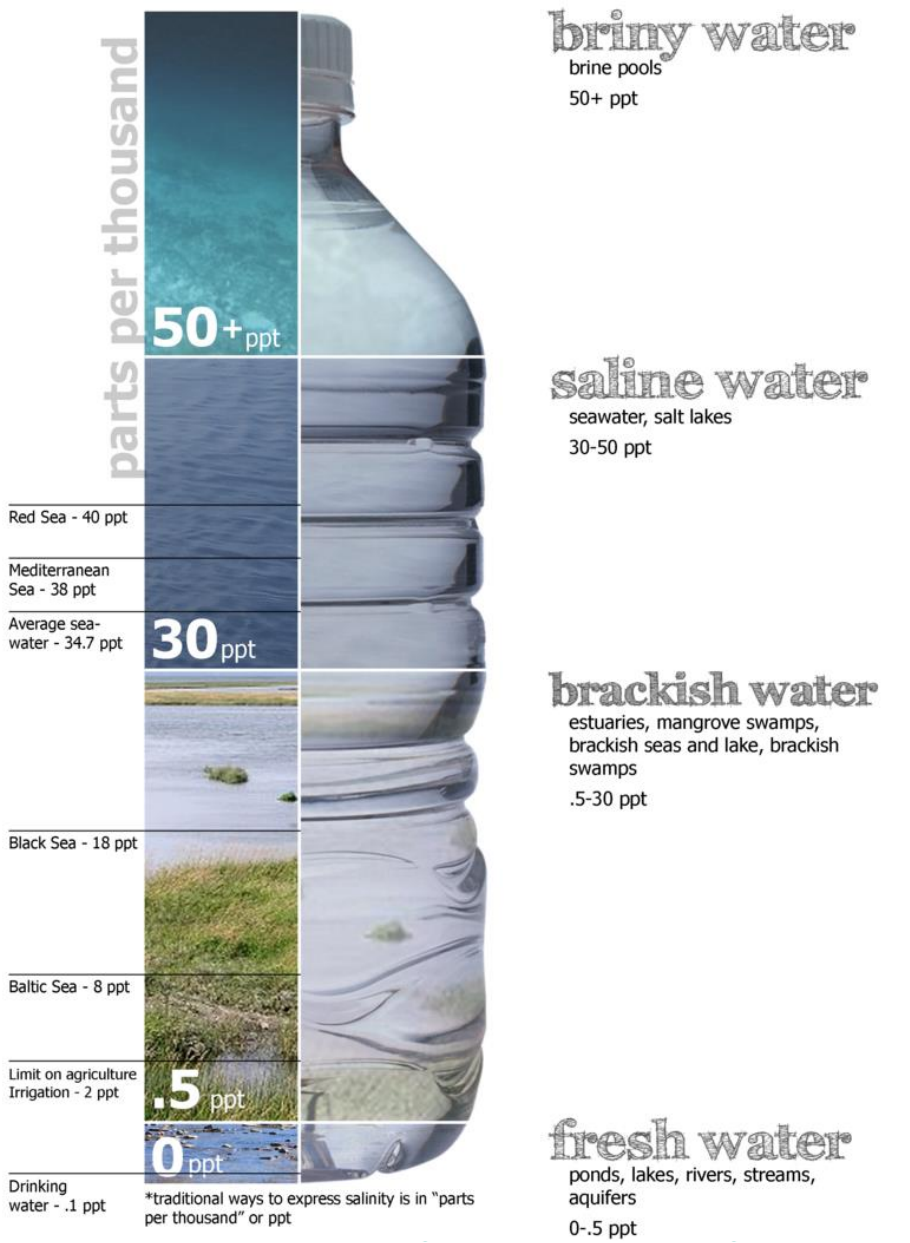
- Had you heard about Zero Brine project before this session?

A. Yes

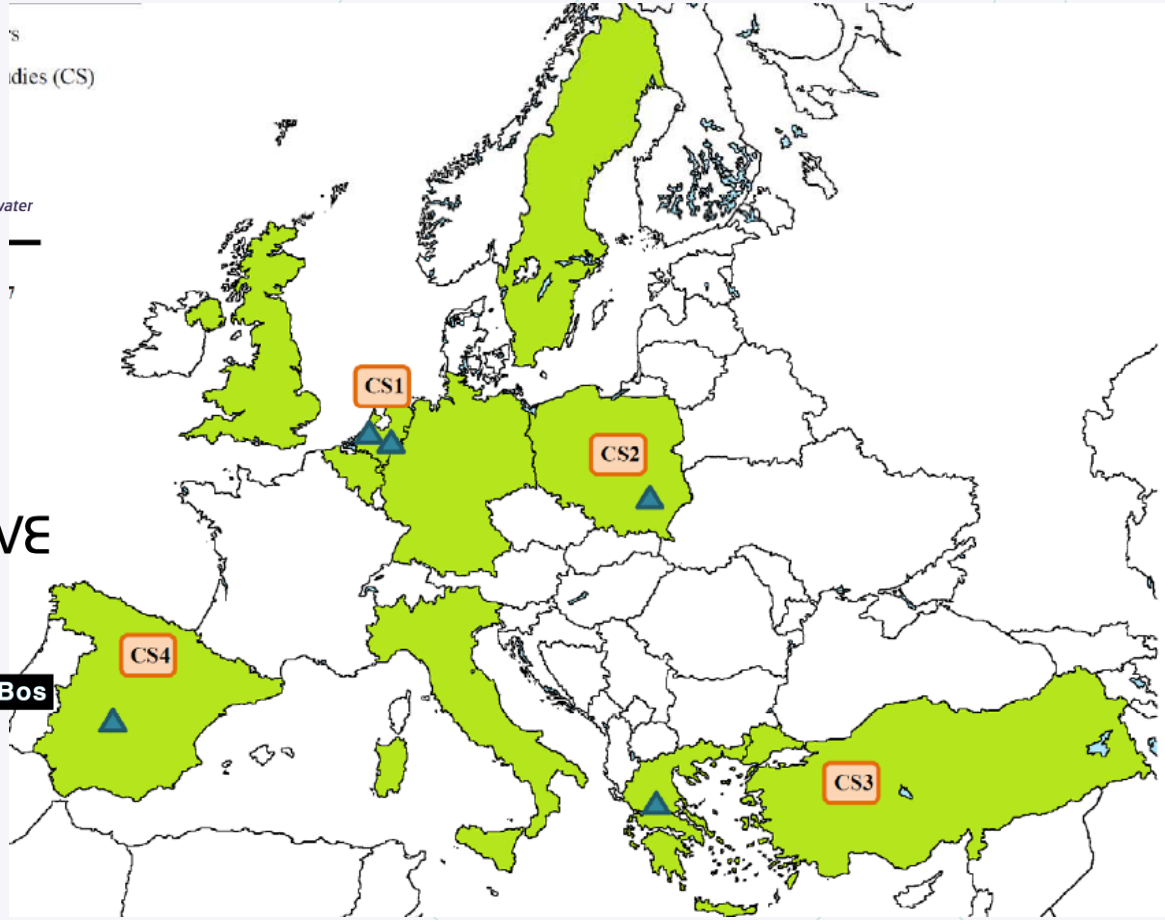
B. No

What is Brine?

- Brine is a high-concentration solution of salt (usually sodium chloride) in water
- Brine is generated and discharged in the Netherlands, as a matter of fact 650 ktons chloride releases per year

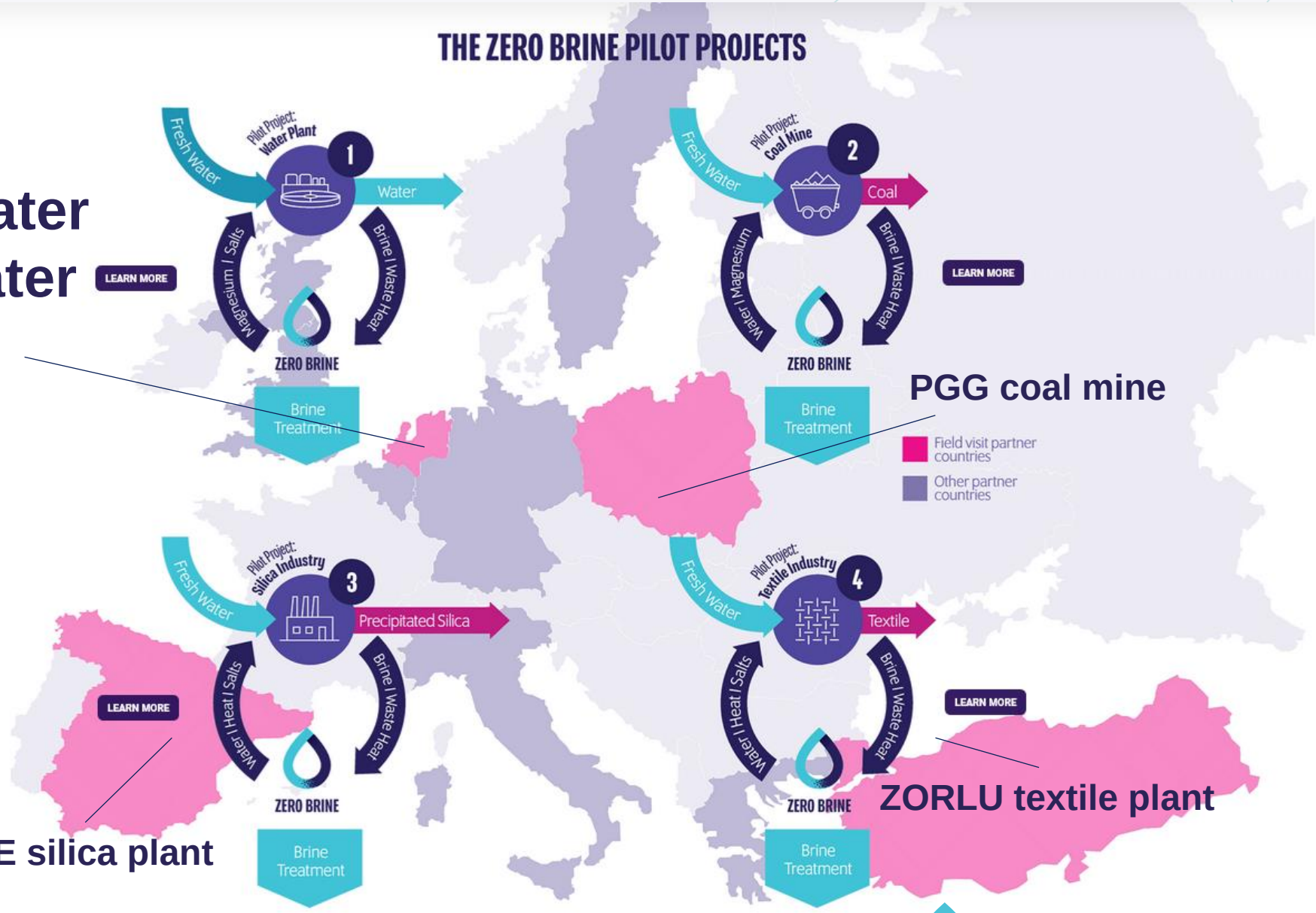


Consortium and activities



Case studies

Evides Industriewater Ultra-pure Demiwater plant

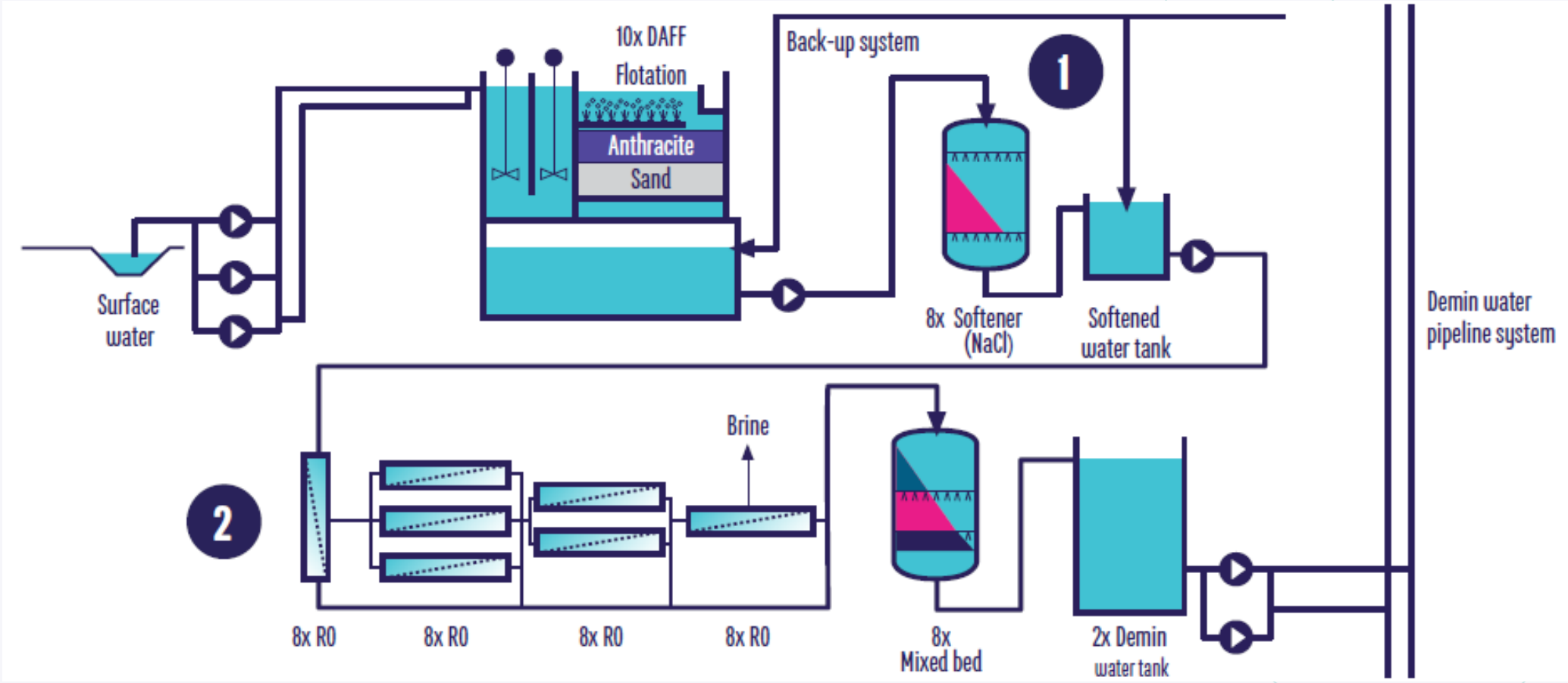


PGG coal mine

IQE silica plant

ZORLU textile plant

Dutch case study: Demineralized water plant (Evides Industriewater)



Poll: Zero Brine

- What kind of benefits do you expect the most due to the Dutch ZB case study?

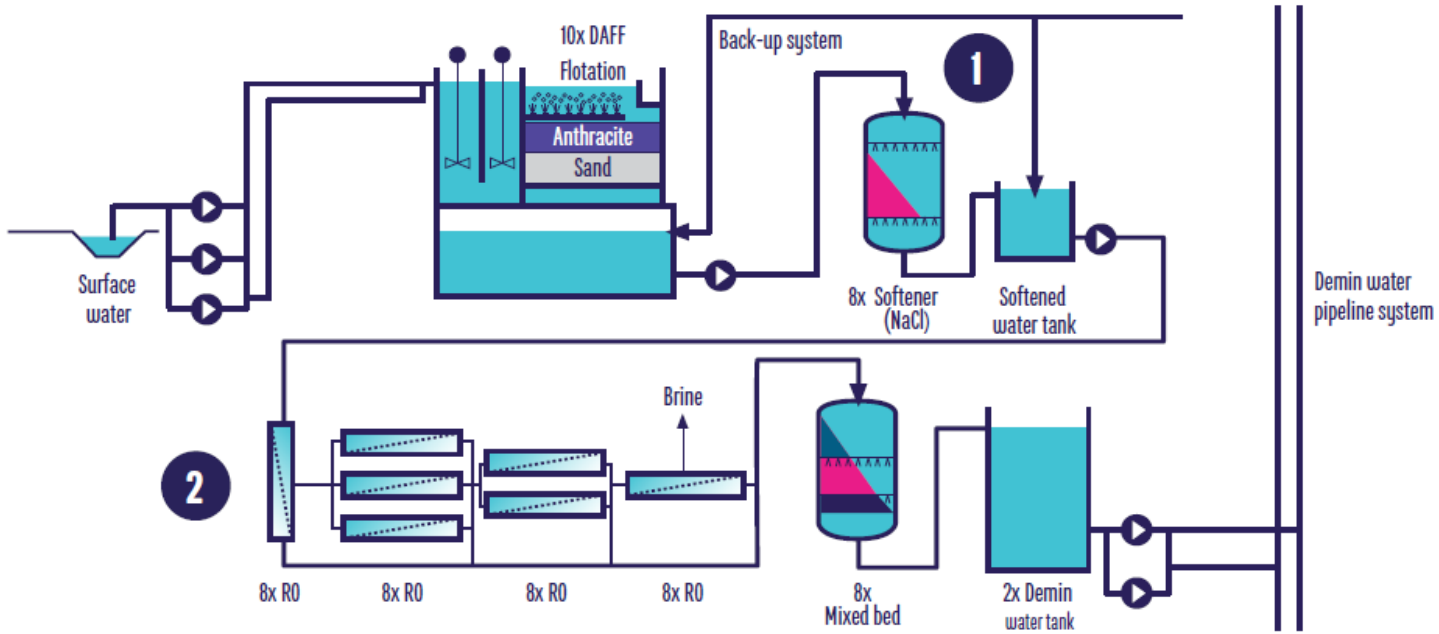
A. Environmental benefits

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
- NaHC03
- Clean Water
- NaCl regeneration solution

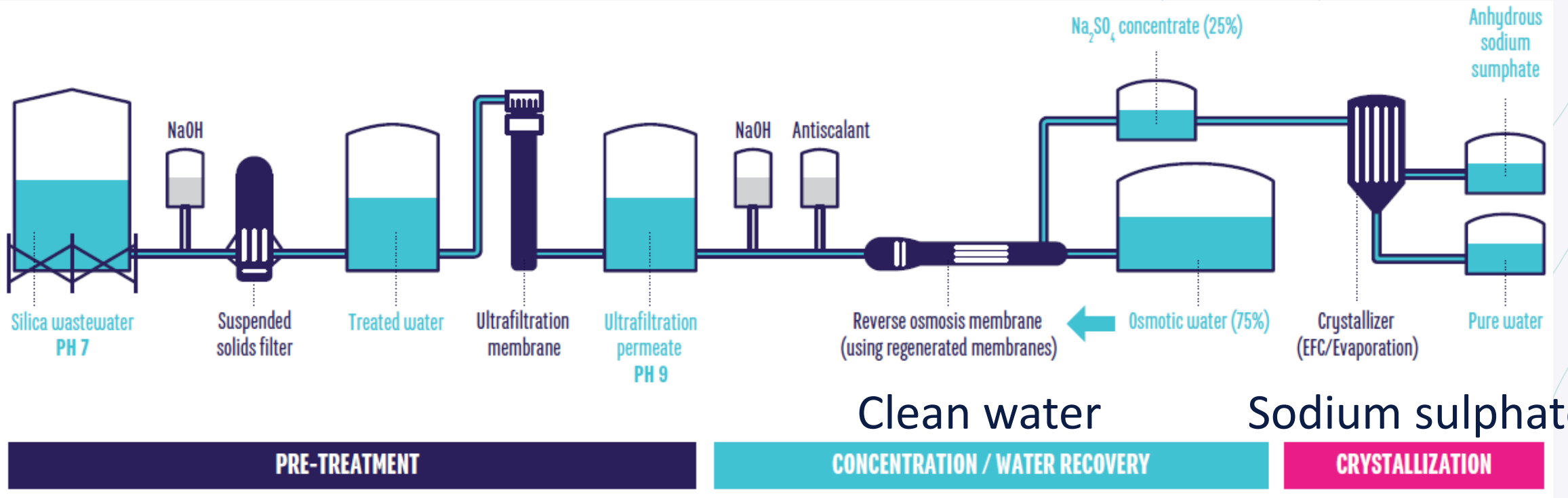
1 Site 1: Technologies

Demonstration of Nanofiltration (NF) – Crystallizer (MF-PFR)
Evaporation for treatment of Ion Exchange (IEX) Regenerates

2 Site 2: Technologies

Nyex (TOC Removel) – Nanofiltration – Reverse Osmosis (RO) – Evaporation
Eutectic Freeze Crystallization (EFC) for treatment of RO Concentrates

ZERO BRINE project results: Spanish Silica plant



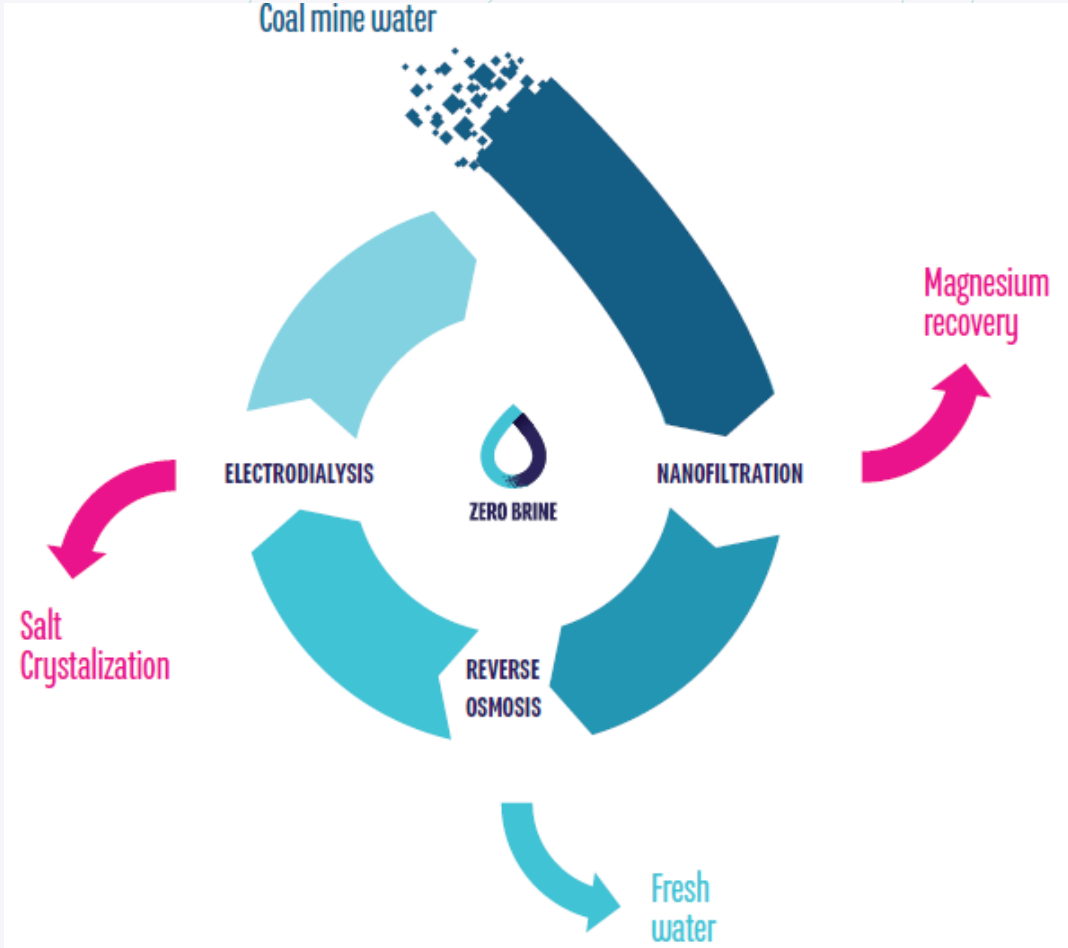
€460,000 per year and turnover of €1,800,000 per year from the sodium sulphate recovered.

ZERO BRINE project results: Polish Coal mine

Decrease energy consumption by **50%**

Faster processing time than existing technologies

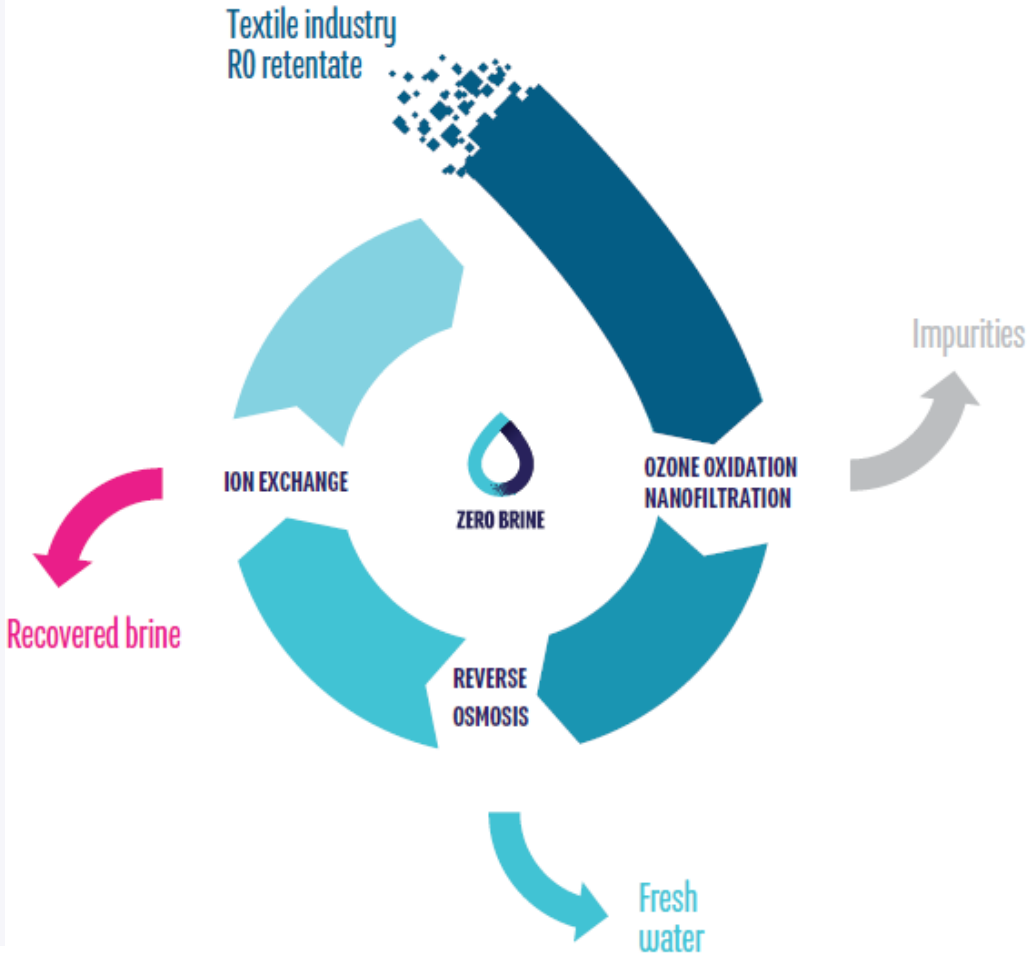
Recover materials such as **salt or concentrated brine, magnesium hydroxide**



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 NaCl (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 conflict-free 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

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

Budget: 6,3 M€

Budget: 19 M€

Budget: 6.9 M€

Online Brine Platform section

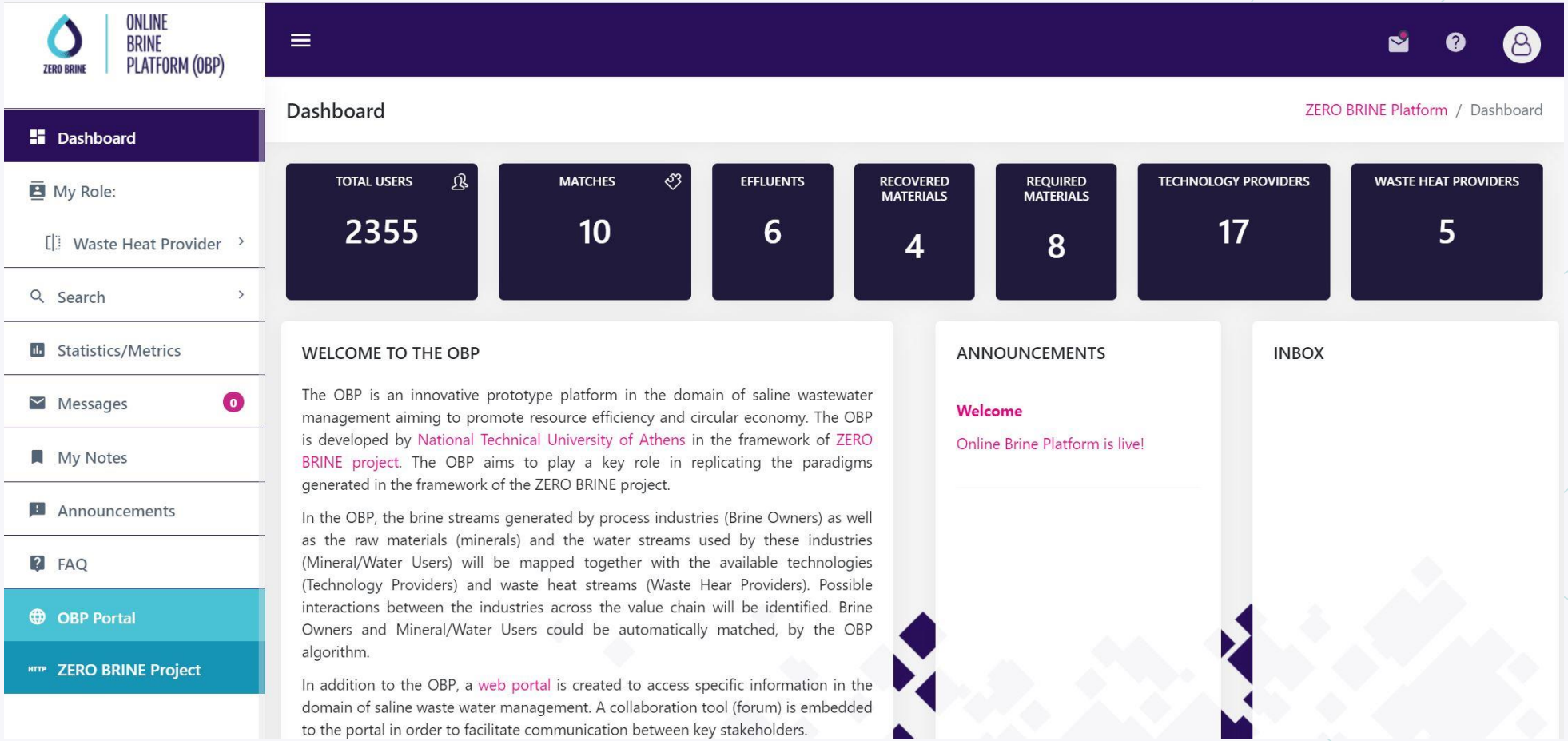
Circular Business models (*Lacy and Rutqvist, 2015*)

- 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.

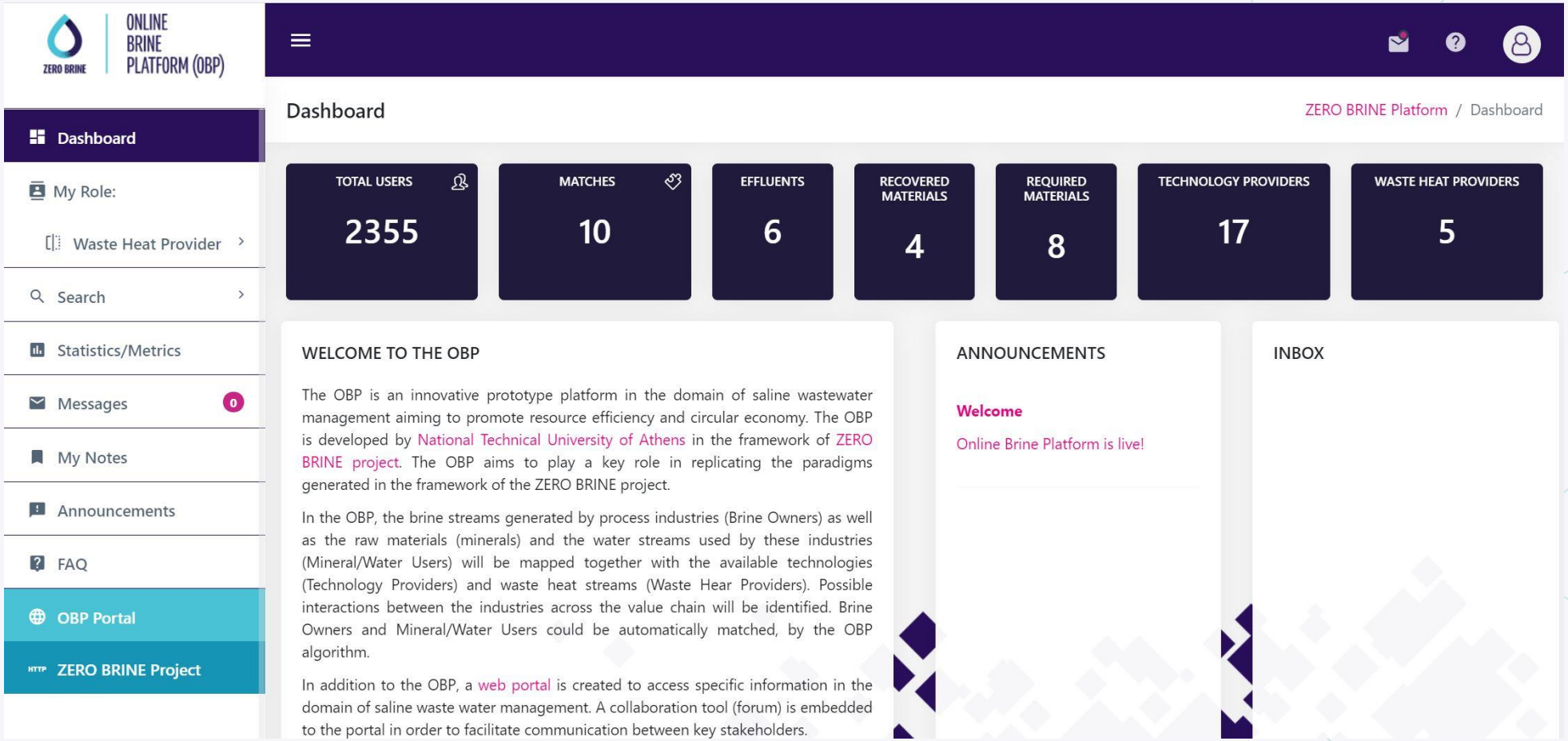
Such a sharing platform allows multiple users to use similar resources or (by-) products thereby reducing demand → **Online Brine Platform**

Online Brine Platform



Online Brine Platform: Tutorial

Online Brine Platform



Poll: Online Brine Platform

Thank you

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