Water, Energy and Carbon Nexus management within circular territories and industries

3 JUNE 2022

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Circular water within the water-smart-urban-industrial symbiosis: ULTIMATE

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(KWR, The Netherlands)

3 JUNE 2022

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Water-Smart-Industrial-Symbiosis

ULTIMATE aims to create economic value and increased sustainability by introducing circular symbiotic arrangements between industry and water service providers

REUSE WATER

EXPLOIT ENERGY

RECOVER MATERIALS

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Successful circular transitions depend on systematically addressing

- Enabling technologies
- Digital support tools
- Exploitation/valorisation schemes
- Stakeholder engagement
- Socio-political and governance context

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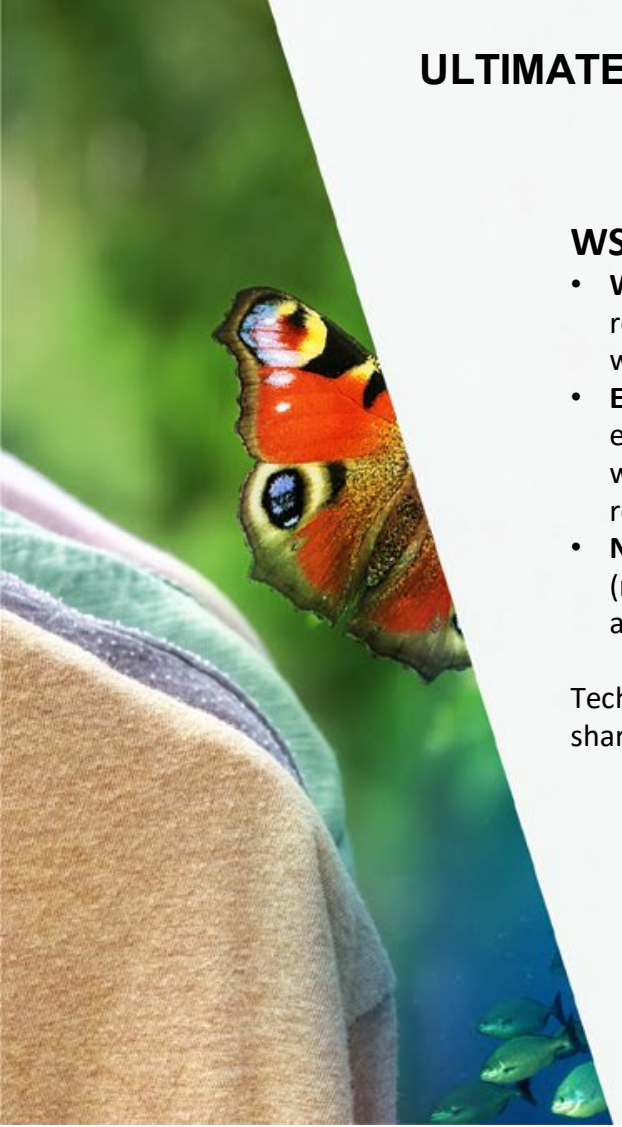

WSIS enabling technologies for

- **Water reclamation and reuse** (recovery, refining, and reuse of municipal and industrial wastewater)
- **Exploitation of energy and heat** (extraction of energy, combined water-energy management, water enabled heat transfer, storage and recovery of heat)
- **Nutrient and material recovery/reuse** (nutrient mining, extraction/reuse of high-added value exploitable compounds)

Technological innovations are made available and shared through the **Water Europe Market Place**

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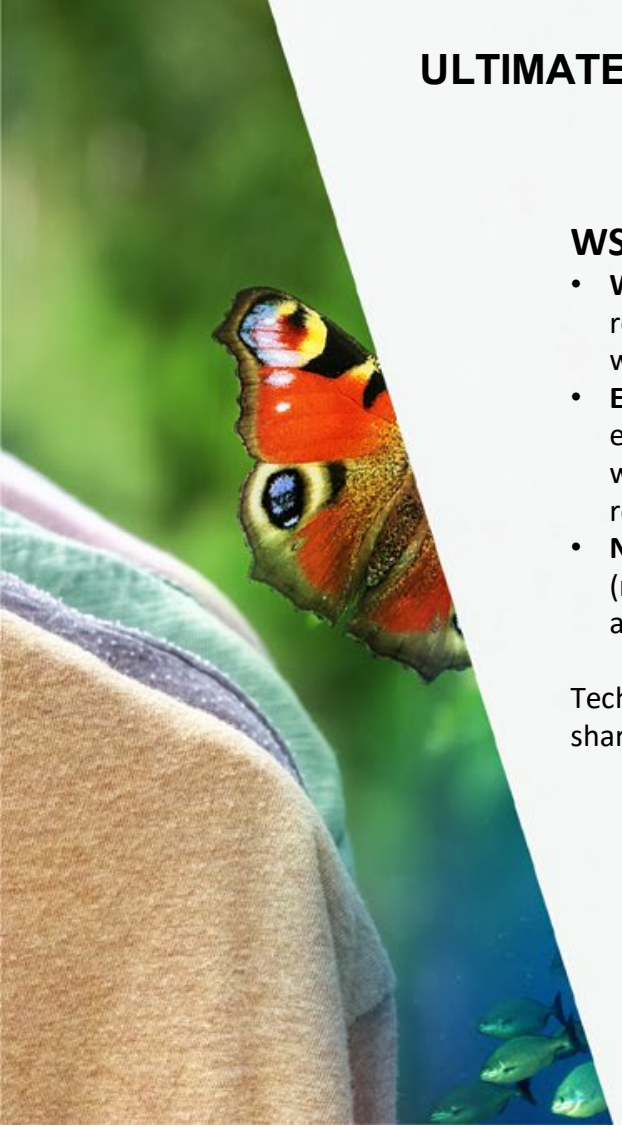

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Explanation of colour code		WATER RECLAMATION AND REUSE	NUTRIENT & MATERIAL RECOVERY & REUSE	ENERGY & HEAT RECOVERY & REUSE
CS	Name	Technologies applied & Circular Economy contributions		
1	Tarragona (ES) Sector: Chemical/petrochemical	Zeolite adsorption for ammonia removal from urban reclaimed water, reducing energy consumption of urban WWRP *TRL 5 → 6*	nZLD systems (membranes) for industrial water reuse *TRL 5 → 7*	Concept study for integration of urban and reclaimed water production for industrial water use *TRL 4 → 6*
2	Nieuw Prinsenland (NL) Sector: AgroFood	Water treatment solution for recycling of drainwater from greenhouses allowing safe reuse in horticulture *TRL 4 → 6*	Closed loop greenhouses with water and nutrient recycling *TRL 4 → 6*	HT-ATES for use in greenhouse horticulture to balance out energy supply and demand using industrial residual heat *TRL 5 → 7*
3	Rosignano (IT) Sector: Chemical/petrochemical	Real-time data driven process control for salinity management to improve reclamation yield from municipal WWTP *TRL 5 → 7*	Data-driven matchmaking platform for water reuse of water from various sources *TRL 5 → 7*	Use of industrial byproducts as wastewater treatment process chemicals in ARETUSA reclamation plant *TRL 4 → 7*
4	Nafplio (EL) Sector: AgroFood	Water reuse in industry after filtration, adsorption, super critical water extraction & AOP *TRL 5 → 7*	Mobile wastewater treatment unit for use in seasonal food processing industry *TRL 5 → 7*	Extraction of value added compounds from fruit processing wastewater by filtration, adsorption and supercritical fluid extraction *TRL 5 → 7*
5	LLeida (ES) Sector: Beverage	Water reuse after treatement with AnMBR and ELSAR with fit-for-purpose post-treatmet in combination with an online control system to reduce membrane fouling *AnMBR & ELSAR: TRL 7 → 9; TRL 5 → 7* *Online Monitoring: TRL 5 → 7*	Concept study for nutrient recovery via digestate application in agriculture *TRL 5 → 7*	Increased yield in biogas production in anaerobic membrane bioreactors AnMBR: TRL 7 → 9 ELSAR: TRL 5 → 7
6	Karmiel, Shafdan (IL) Sector: AgroFood	Combined immobilised high rate anaerobic filter (AAT) with membrane filtration and activated carbon (AC) *TRL 5 → 7*	Extraction of value added products from olive mill wastewater by adsorption & supercritical fluid extraction *TRL 5 → 7*	Karmiel: AAT for biogas production from poorly degradable organic matter *TRL 5 → 8* Shafdan: Increased biogas production by removing inhibitory compounds by AC in a novel AAT + AnMBR combination *TRL 5 → 7*
7	Tain, Scotland (UK) Sector: Beverage	RO treatment of AnMBR effluent for water reuse in cleaning processes at the distillery *TRL 5 → 7*	Ammonia recovery from distillery wastewater *TRL 5 → 7*	Heat recovery from AnMBR effluent *TRL 5 → 7*
8	Saint Maurice, l'Exil (FR) Sector: Chemical/petrochemical	Flue gas scrubbing & dust removal for sulphur recovery as sodium bisulphite *TRL 4 → 6*	Concept study for a method to recover metals (e.g. Fe, Cu, Zn, Ni, Cr) from flue gas cleaning water *TRL 4 → 6*	Concept study to recover heat from the flue gas washing water for steam or electricity production *TRL 2 → 4*
9	Kalundborg (DK) Sector: BioTech	Combination of novel ultrafiltration membranes as pre-treatment for wastewater with high-nondegradable organic matter *TRL 5 → 7*	Concept study for nutrient and/or high-value product recovery (*integration of solutions of other sites with TRL > 6*)	Data driven control system to increase energy efficiency through a synergetic operation of an industrial and municipal WWTP *TRL 5 → 8*

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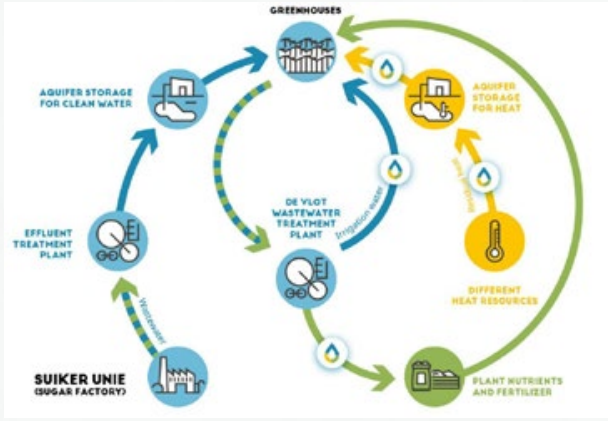
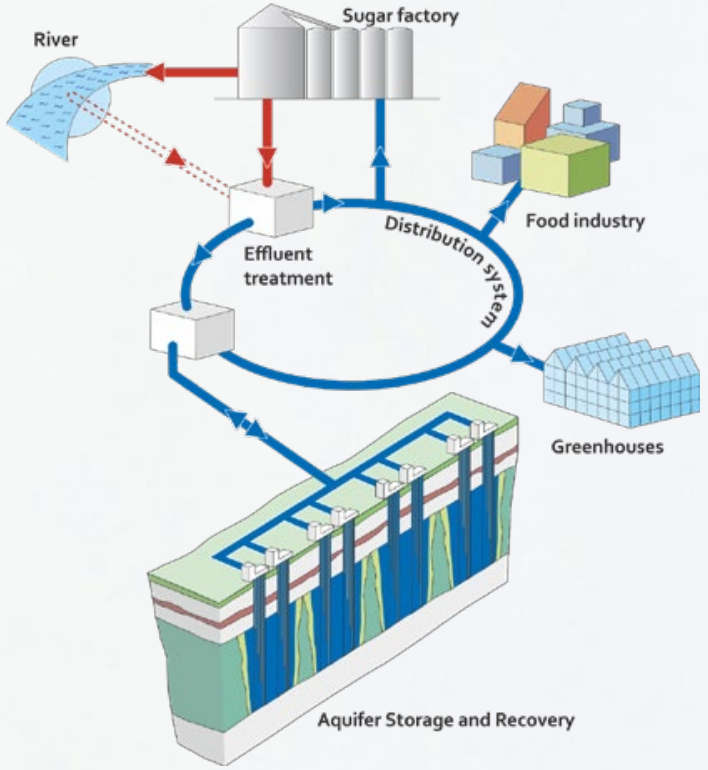
CS2, CURRENT STATUS



SUBSOL video



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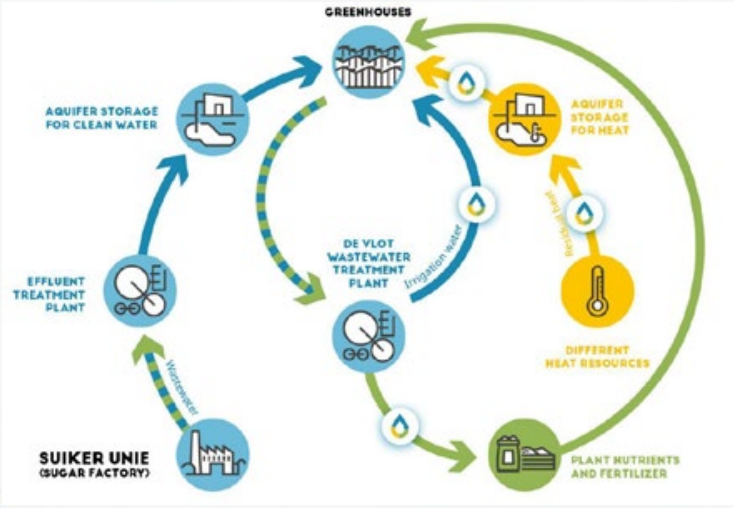

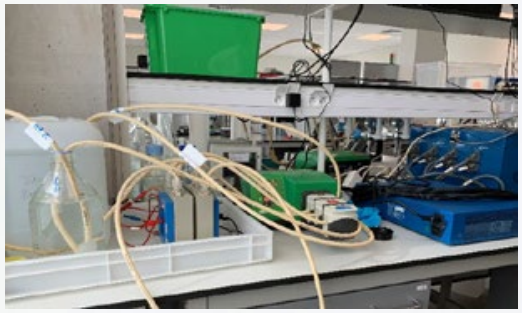

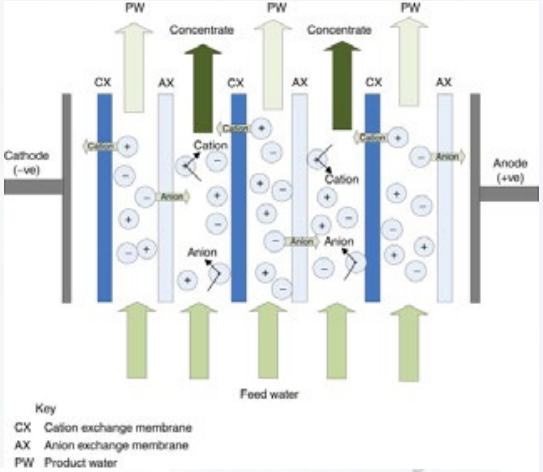

Application of **ELECTRODIALYSIS** for selective separation of sodium from wastewater followed by (UV) disinfection (proven technology, industrial standard for high tech greenhouses with recycling)

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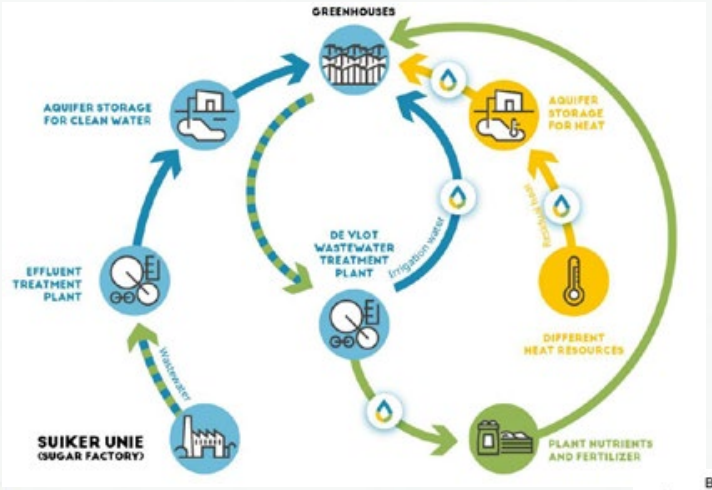

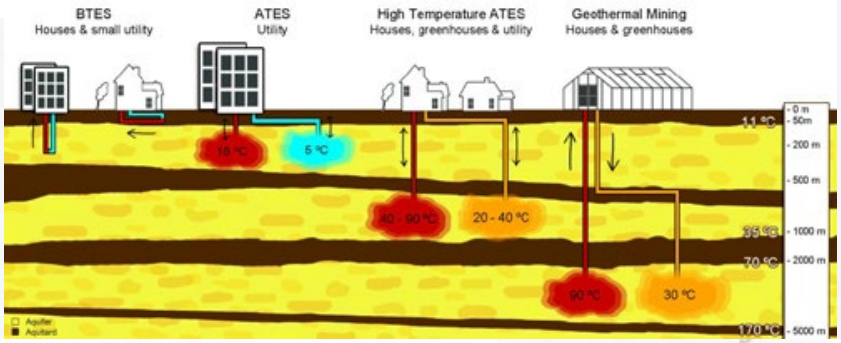

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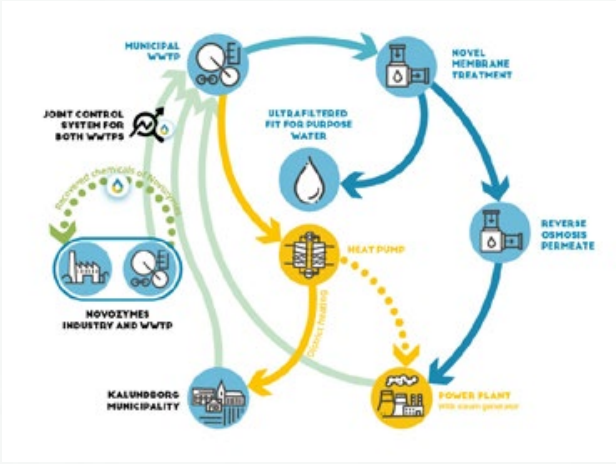
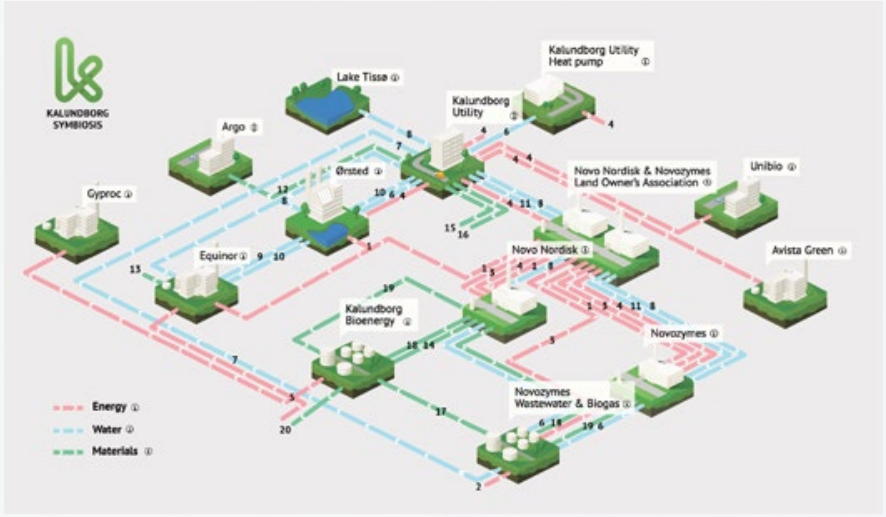
CS9, Kalundborg symbiosis plant





From: http://www.symbiosis.dk/

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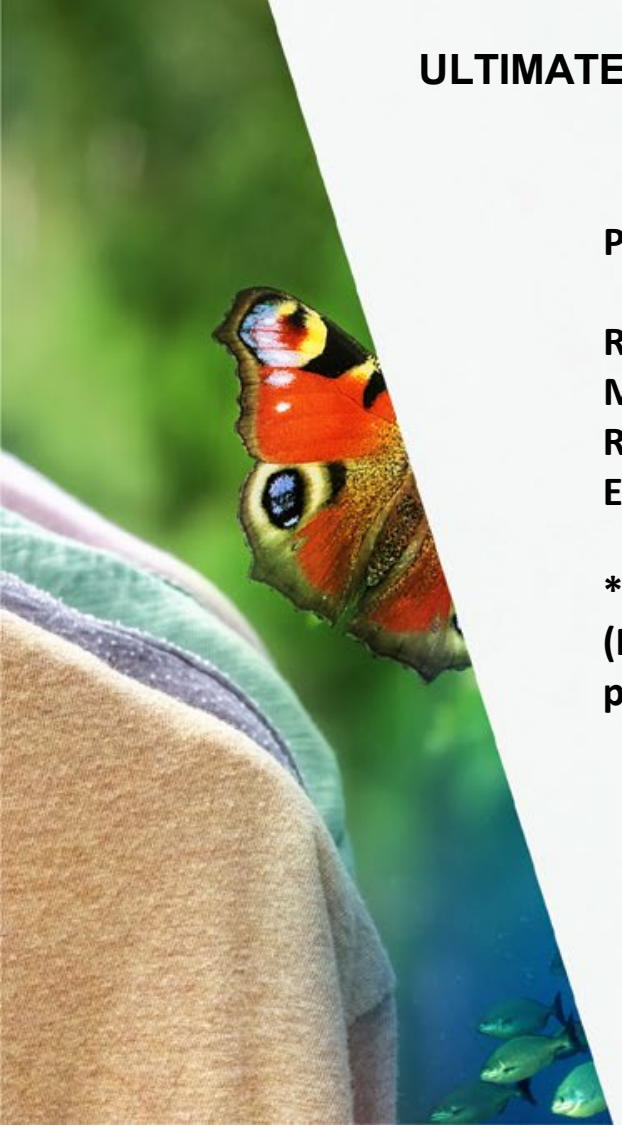

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Projected reduction and re-use after upscaling:

Reduction in Freshwater reuse	**10 - >90 %**
Materials recovery*	**10 - 80 %**
Reduction in energy demand	**10 - 25 %**
Energy recovery	**15 - >60 %**

***Wide variety of recovered materials, incl nutrients (P+N), bentonite and peracetic acid, antioxidants, polyphenols, organic S, metals**

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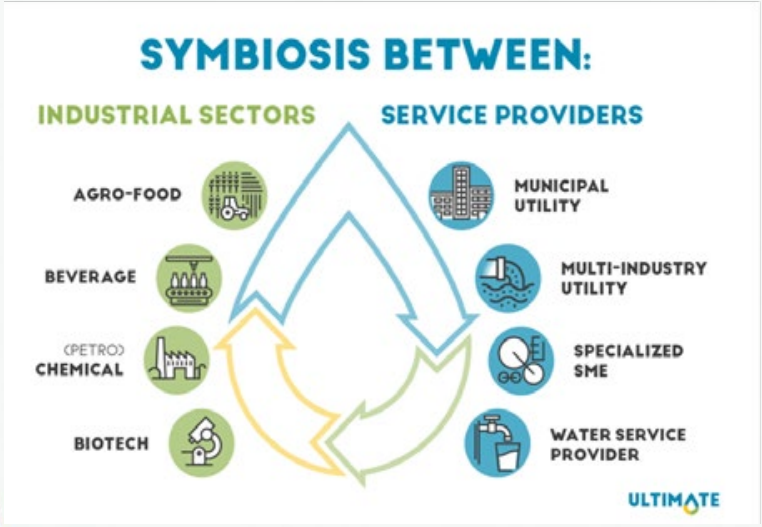

WSIS Exploitation/Valorisation schemes

Value chains for recovered resources are exploited by **symbiotic arrangements** between industries and water service providers:

- **Partnerships** between industries and municipal water utilities looking for symbiotic gains
- **Co-ownership** of water service providers by co-located industries to catalyse symbiosis
- **WSIS service provision** to industries by commercial companies of various scales: from niche SMEs (potentially spin offs) to multinational corporations
- Business transformation to WSIS is accelerated through active **stakeholder engagement** and supported by good **Governance**

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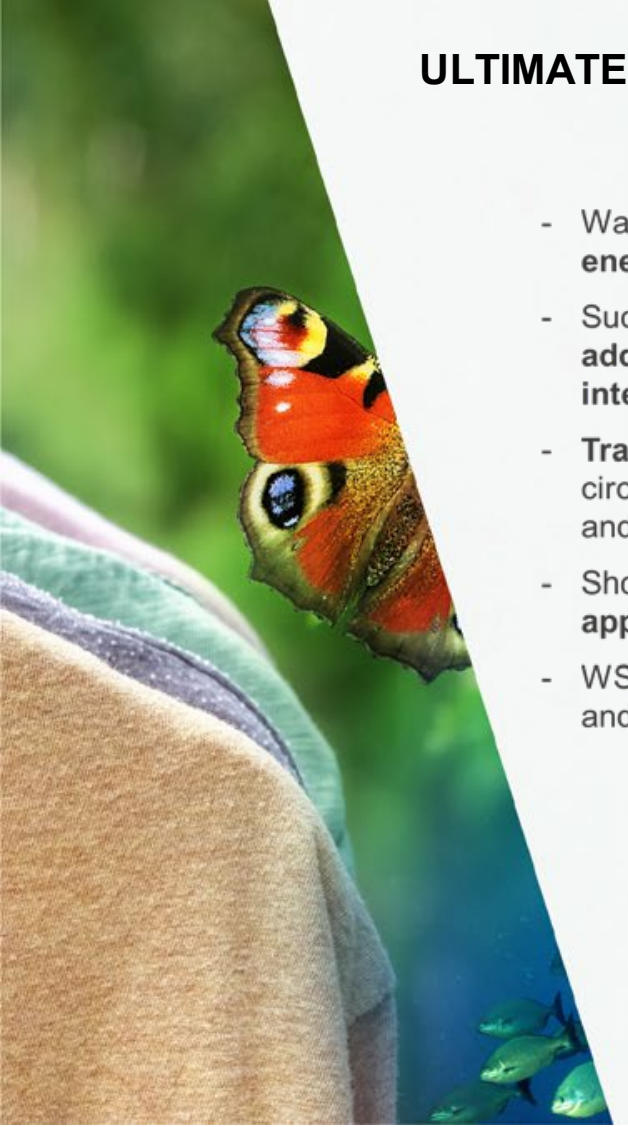

ULTIMATE: Circular water within the water-smart-urban-industrial symbiosis
Final Messages

- Water Smart Industrial Symbiosis (WSIS) is a special type of Industrial Symbiosis in which **water, energy and materials** from municipal and industrial wastewater **are recovered and reused**
- Successful circular transitions in urbanised industrialised regions depends on **systematically addressing technological, digital, socio-economic, governance and business systems interdependencies**.
- **Transformation** of linear production-consumption-disposal chains in industrial processes to circular systems may reduce the vulnerability to climatic changes and environmental degradation and **contribute to a more competitive industry**.
- Showcasing WSIS cases (in living labs) with emphasis on **cross synergies, transferability and applicability** of the concept may contribute to a further acceptance and understanding.
- WSIS application **contributes** to e.g. **the Circular Water 2050 goals** (in e.g. The Netherlands) and **the Green and Digital 'twin' transition** promoted by the EC in the EU and beyond.

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