Case study factsheet

Kalundborg, Denmark (RECREATE: since 2024)

Last update on 2026-11-11

Project RECREATE

Denmark



Description

The Kalundborg Industrial Symbiosis Association links 17 private and public companies. Various water, energy and materials circular economy approaches have already been implemented. A new industrial area is now being developed in the north-eastern part of Kalundborg. New companies will become part of the Kalundborg Industrial Symbiosis, which not only creates opportunities for the local economy, but also challenges to ensure the sustainable use and reuse of resources such as water. Currently, the biotech sector uses groundwater and treated surface water sources and operates a large industrial wastewater treatment plant. Wastewater is treated in the industrial wastewater treatment plant (WWTP) and the effluent is then sent to the municipal WWTP for further treatment. The WWTPs are interconnected and controlled by an innovative joint control system for an energy efficient operation (Schütz et al. 2024).

To meet the projected water demand in the future (a double increase from today), to make the industrial water supply more climate resilient and to provide redundancy for a save water supply, the use of several different water sources is envisaged, including reclaimed water, desalinated seawater, stormwater, and existing sources such as lake water and groundwater. In the ULTIMATE project, a suitable treatment train to reclaim water from the muncipal WWTP effluent was successfully piloted (Jährig et al. 2025). Different water supply scenarios will be modelled (UWOT) and evaluated (QMRA, QCRA and LCA) in order to propose an appropriate water management strategy for the future.

Outcome of assessments

Quantitative microbial risk assessment: seawater desalination

Seawater desalination is planned in order to provide the industry with drinking water. A quantitative microbial risk assessment (QMRA) was conducted based on very conservative assumptions regarding pathogen concentrations. The results showed that a treatment process consisting of coagulation, flocculation, filtration and a cartridge filter (MF), as well as reverse osmosis and UV disinfection, is required to achieve an acceptable annual infection probability. As rotavirus concentration is the critical parameter, this should be analysed in the intake region of the future seawater desalination plant in order to design an effective, energy-efficient treatment process. Furthermore, technology-specific log removal values should also be used to validate the results. More details can be found in RECREATE D1.3.

Quantitative microbial risk assessment: water reclamation

QMRA was used to assess different treatment trains for water reclamation. The exposure scenarios investigated were the inhalation and ingestion of water during car washing, and the inhalation of aerosols from evaporated cooling tower water. The results showed that, for the car washing scenario, a treatment train consisting of ultrafiltration, UV treatment and RO is required if the effluent from quaternary treatment (consisting of ozonation and granular activated carbon filtration) is used. With a two-stage RO system, failures lasting between 15 and 30 minutes can occur 100 and 10 times per year, respectively, without exceeding the tolerable risk level for annual infection. The next step should be to validate the results using technology-specific log removal values and measured pathogen concentrations instead of default values. More details can be found in RECREATE D1.3.

Application of the early warning exposure assessment to investigate requirements on brine management

The probabilistic early warning exposure assessment (EWEX) model compared four scenarios for 2035: no AWR (reference), reclamation brine, desalination brine and both combined and assessed their influence on the wastewater treatment effluent quality and on the receiving water. Seven parameters (four micropollutants, nitrogen, phosphorus and PFAS-25) were selected based on the wastewater treatment plant (WWTP) discharge permit and marine environmental quality standards (EQS). Local monitoring and literature data informed the model. Risk quotients (RQs) were assessed for the WWTP effluent, except PFAS-25, which was evaluated in the receiving water considering background concentrations and dilution.

Brine streams did not substantially affect predicted effluent quality or RQ classifications. Nitrogen and phosphorus remained below discharge limits across assessed percentiles, whereas some micropollutants exceeded their limits at higher percentiles in all scenarios. PFAS-25 exceeded the EQS in the reference and combined AWR scenarios, due to existing background contamination in the receiving water. Triethanolamine (TEA) and EDTA were identified as the most critical, yet manageable, substances regarding potential accumulation, and TEA was selected for sensitivity analysis. Limited TEA accumulation at reclamation brine shares up to 10% of WWTP influent indicates potential for a substantially larger reclamation plant under the assumed conditions. Thus, the planned capacities of 500 m^3/h and 50 m^3/h for the seawater desalination plant and the water reclamation plant, respectively, do very likely not require additional brine management measures to comply with the WWTP discharge limits and environmental quality standards for the assessed parameters. More details can be found in RECREATE D1.3.

Key lessons

Future water strategy modelling using the urban water optioneering tool (UWOT)

The urban water optioneering tool (UWOT) results show that Kalundborg can substantially improve future water-supply security by current conventional sources, Lake Tissø and groundwater, with alternative water resources, particularly seawater desalination, while reclaimed wastewater and harvested runoff provide complementary contributions. Under moderately growing demand (SSP2), supply deficits in 2035 can only be avoided by alternative water resources. Towards 2050 and 2075, additional treatment capacity for seawater desalination and/or wastewater reclamation would be needed. Synergies arise from fit-for-purpose water allocation and from linking planned wastewater-treatment upgrades with future water reclamation, helping to reduce treatment and energy requirements. The overall approach, combining industrial water reuse, multiple water sources and scenario-based modelling, is transferable to other industrial regions seeking more resilient water-supply strategies. More details can be found in RECREATE D1.4.

Legislation and policy recommendations

The most important Danish regulations on drinking water and water production are the Danish Act on Water Supply (2020) and the Executive Order on Water Quality and Supervision of Water Supply Installations (2010). The Water Supply Act (2020) focuses on the utilisation and protection of water bodies, their appropriate use, ensuring a satisfactory water supply, and setting quality requirements to protect human health. The Executive Order on Water Quality and Supervision of Water Supply Installations (2010) defines water quality standards for drinking water, requires water quality testing and the monitoring of abstracted water volumes, and supervises water supply systems. Both regulations have been amended recently, allowing for the use of surface water for drinking water production.

The Seawater Executive Order (Havvandsbekendtgørelsen) permits the use of seawater desalination for producing drinking water came into force in December 2025. Furthermore, the production of drinking water by mixing groundwater or surface water with desalinated seawater is also foreseen, as is the use of drilling wells for this purpose.

Another act came into force in July 2025, called the 'Act on Technical Water Supply'. This Act permits the production of technical water from sources other than groundwater, such as treated wastewater or water from polluted groundwater. According to the act, the technical water cannot be used for drinking purposes, but for other uses such as providing feedwater to Power-to-X (PtX) plants. A Power-to-X plant converts surplus renewable electricity into various energy carriers or products. The X can stand for hydrogen for example.

Based on the revised UWWTD (EU 2024/3019), an amendment to the Danish UWWT Act is being prepared. The Danish parliament has agreed to include very strict discharge thresholds for 17 vulnerable areas in Denmark. One of these areas is located at the northern Great Belt near Kalundborg. The currently being discussed thresholds for phosphorus and nitrogen emissions are 0.1 mg P/L and 2.5 mg TN/L, respectively. This is very strict compared to the current discharge thresholds of 1.5 mg P/L and 8 mg N/L. In contrast, the revised EU UWWTD proposes for sensitive areas and especially for WWTPs >150,000 PE, 0.5 mg P/L or 90% removal and 6 mg N/L or 85% removal.

Although the European Water Reuse Regulation (EU 2020/741) has not yet been applied in Denmark, the country is no longer opting out.

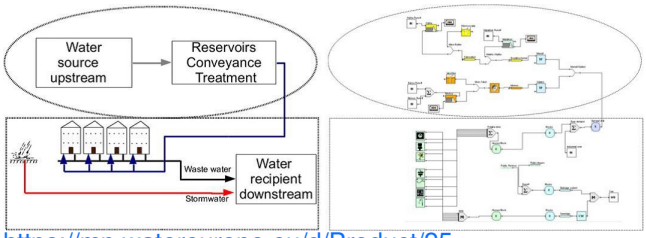
See also D1.2 RECREATE (Kleyböcker et al. 2024)

Applied technologies

- **Desalination technologies**
- **Joint control system for two wastewater treatment plants**
- **Rainwater harvesting systems**
- **Ultrafiltration & nanofiltration membranes as pre-treatment for reverse osmosis**

Applied products

Urban Water Optioneering Tool



https://mp.watereurope.eu/d/Product/25

KWB Life cycle solutions

KWB

Life Cycle Solutions

Sustainable wastewater treatment plants and alternative water resources solutions in the era of climate change

https://mp.watereurope.eu/d/Product/296

KWB Risk assessments

KWB

Quantitative risk assessments

We provide consulting and support services to quantify and assess microbial and chemical risks.

https://mp.watereurope.eu/d/Product/295

Publications and references

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Scale

Operational scale of this case study related to the application of tools and technologyies

- Regional scale

Challenge

Challenge that is addressed through the application of tools and/or technologies to the case study

- Other

Related tags

Wastewater Treatment | rainwater harvesting | Water reuse | Seawater desalination

Contact data

Contact person

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Involved organisations

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3. KWB Kompetenzzentrum Wasser Berlin

   Kompetenzzentrum Wasser Berlin GmbH