Social life cycle assessment of brine effluent. A case study of a large scale demonstration plant in the Energy Port and petrochemical cluster of Rotterdam Port, involving local large industries

According to United Nations, water is the primary medium through which we will feel the effects of climate change. Water availability is becoming less predictable in many places, and increased incidences of flooding threaten to destroy water points and sanitation facilities and contaminate water sources. In some regions, droughts are exacerbating water scarcity and thereby negatively impacting people's health and productivity. Ensuring that everyone has access to sustainable water and sanitation services is a critical climate change mitigation strategy for the years ahead.

The chemical industry comprises the most water-intensive industry accounting, in many countries, for more than 30% of industrial water consumption. According to Global Water Intelligence, other major industrial water users are the mining sector, pulp& paper, power and food & beverage. The water consumed by these industries is transformed into the brine effluent that is the focus of this project. Brine discharges are recognized as one of the major threats to the aquatic environment, according to the United Nations Environment Programme. The concept of the ZERO BRINE project is to close the loop of these particularly problematic effluents and thus: (a) ensure compliance of industry with existing and upcoming regulations; (b) protect the environment; and (c) recover the materials that are currently leaking from our economies. This MSc thesis project will concern the social performance of such a brine effluent system based on the Social Life Cycle Assessment methodology.

Sustainable development is the international community's most urgent priority, and the core aim of the post-2015 development agenda of United Nations. Sustainable development consists of three pillars, economic, social and environmental. Among the three pillars, the Social Life Cycle Assessment (S-LCA) is a methodology with the objective of promoting improvement of social conditions and of the overall socio-economic performance of a product, system or service throughout its life cycle for all of its stakeholders. As one underlying goal of using the results of S-LCA is to stimulate improvement of social (and socioeconomic) conditions, dialogues among stakeholders, decision makers and commissioners of the S-LCA study are highly important.. The methodology is standardized by the ISO standard. The intended application of a S-LCA could be, for instance, learning about and identifying social "hot-spots" and the options for reducing the potential negative impacts and risks through product development and substitution in the supply chain, establishment of purchasing procedures or specifications, marketing, reporting and labeling, strategic planning, or development of public policies

TU Delft under the Horizon 2020 funding platform has formed a consortium with universities, public authorities and companies in order to demonstrate new, economically sound and industrially relevant solutions for materials recovery from process industry brines. A demo plant will be built which will be able to treat part of the brine effluents generated by the industry water supplier (EVIDES), while waste heat will be sourced. In addition, three large-scale pilot plants will be developed in other process industries, providing the potential for immediate replication and uptake of the project results by neighbouring factories for industrial symbiosis. The consortium includes salt producers (such as EUROPIREN), construction management and O&M companies (WITTEVEEN+BOS, TYPSA, FACSA), SME Technology suppliers (SEALEAU, LENNTECH, ARVIA), universities (TU DELFT, NTUA, UNIPA, POLSL,

ABDN), applied research institutes (CTM, ECPI, IVL, DLR), public authorities (ROTTERDAM PORT), European Technology Platforms (WssTP, ISPT) and SMEs for dissemination (REVOLVE MEDIA).

In this MSc graduation project the aim is to investigate the social performances of the brine conversion. The social impacts under focus are the health risks, acceptability, stakeholder involvement, legislation and permitting procedures. In addition, The database information will be extended combined with empirical inputs from the consortium, especially in terms of involvement of local stakeholders, investment patterns etc. Main research questions are:

- What are the social aspects and/or benefits of the Zero Brine project after achieving circular economy?
- What are the social effects of using only renewable electricity in the chemical plant?
- What are the social-economic benefits of the applied industrial symbiosis?
- Which are the hot-spots of such S-LCA systems that can be improved and influence the results significantly?

The MSc. Graduation topic will include having interviews with relevant stakeholders and modelling. The S-LCA system boundaries will be determined including upstream manufacturing of necessary chemicals and the supply of necessary energy carriers, and downstream, the final disposal or use of brine and other process residues. The final deliverable will be a report that and the student will have to present his/her work in the group.

Further reading:

- United Nations Environment Programme, Society of Environmental Toxicology and Chemistry. (2009). Guidelines for Social Life Cycle Assessment of Products. Social and socio-economic LCA guidelines complementing environmental LCA and Life Cycle Costing, contributing to the full assessment of goods and services within the context of sustainable development . 978-92-807-3021-0
- Xevgenos D., Moustakas K., Malamis D. and Loizidou M. (2016). An overview on desalination & sustainability: renewable energy-driven desalination and brine management. Desalination and Water Treatment 57: 5. https://doi.org/10.1080/19443994.2014.984927
- Xevgenos D., Michailidis P., Dimopoulos K., Krokida M. and Loizidou M. (2015). Design of an innovative vacuum evaporator system for brine concentration assisted by software tool simulation. Desalination and Water Treatment 53: 12. https://doi.org/10.1080/19443994.2014.948660
- Xevgenos D., Vidalis A., Moustakas K., Malamis D. and Loizidou M. (2015), Sustainable management of brine effluent from desalination plants: the SOL-BRINE system. Desalination and Water Treatment 53: 12. https://doi.org/10.1080/19443994.2014.933621
- Zero Brine Project, European Commission, CORDIS Projects and Results
- Parent J., Cucuzzella C. and Revéret J.P. (2010). Impact assessment in SLCA: sorting the sLCIA methods according to their outcomes. Int J Life Cycle Assess 15:164–171

Start date	Continuous but as soon as possible
Location	Internal
Theme	Circular economy, closing the material loop, Zero Brine project, zero waste
Methods	Social life cycle assessment (S-LCA) modelling
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Expiration date	10/01/2019