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Life Cycle Assessment as Decision Support Tool for Development of a Ressource Recovery Technology

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1. INTRODUCTION

Current research promotes resource recovery through different technologies:

- Physic-chemical processes: metal salt addition for phosphorus precipitation [1]
- Biological processes: optimal green microalgal cultivation (TRENS) [2]

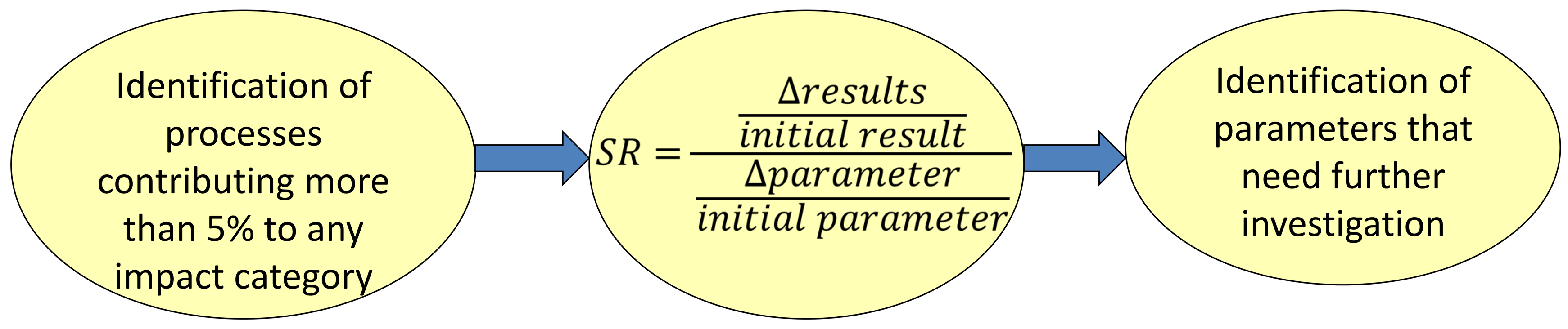
What is the environmental impact of these emerging technologies?

Objectives:

1) To use Life Cycle Assessment to assess the environmental impact of a resource recovery technology.
2) To use Life Cycle Assessment as a support tool for process design for the TRENS developers.

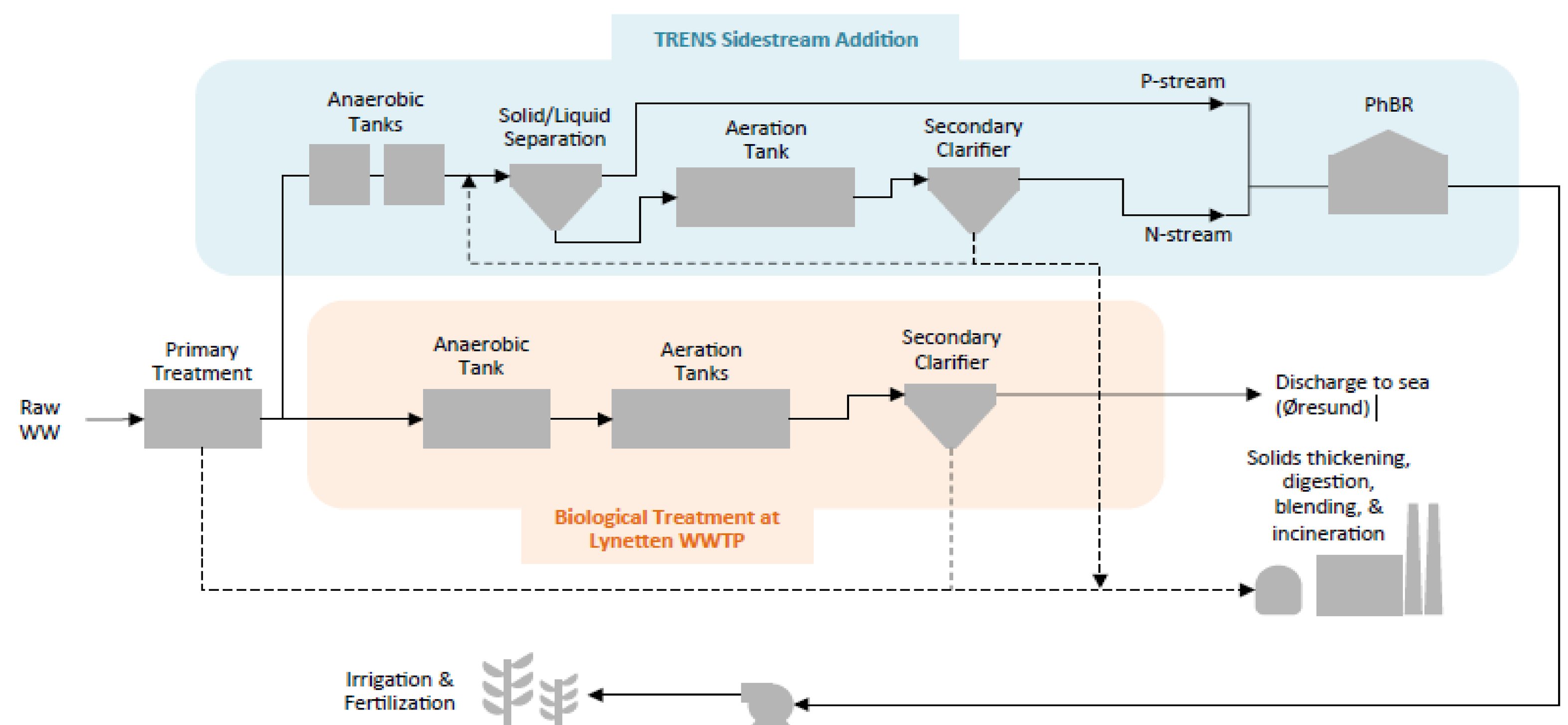
2. LCA METHODOLOGY

- Goal and scope: quantify environmental impact of wastewater resource recovery for fertigation using TRENS in Copenhagen. *Functional unit:* 1m3 of influent wastewater
- Life cycle inventory: operating reports for existing processes, databases and modeling studies using ASM-2d [3] for activated sludge processes and ASM-A [4] for algal-based processes.
- Impact assessment: International Reference Life Cycle Data System (ILCD 2011).
- Contribution and perturbation analysis: [5]

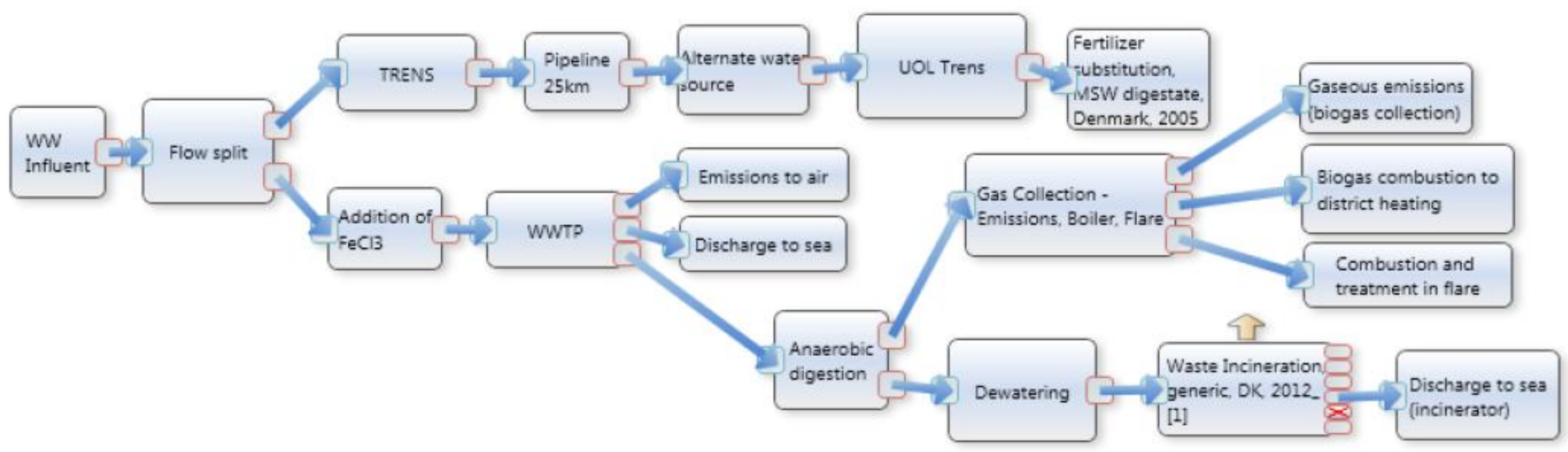


3. RESULTS: FERTIGATION SCENARIO

TRENS system flow diagram [2]



TRENS implementation in EASETECH [6]



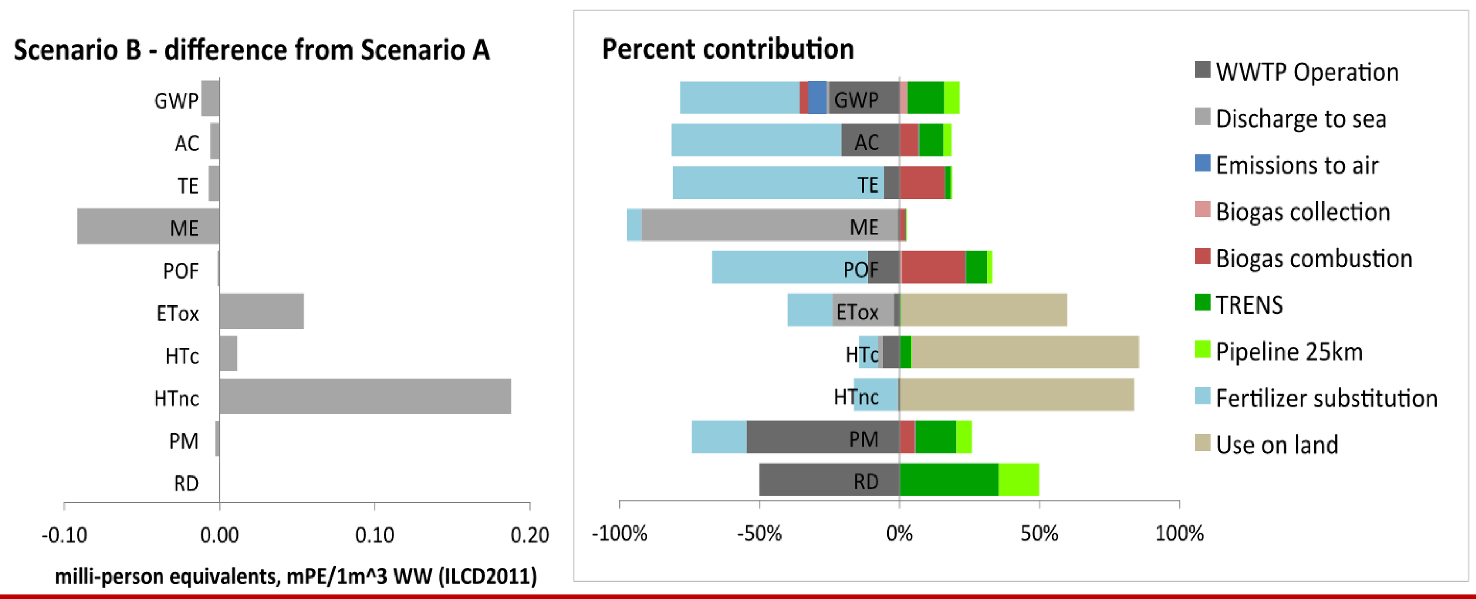
Scenario Description

TRENS system implemented as a side-stream process of Lynetten WWTP:

- System boundaries: **from the influent** to the treatment plant **to the final end use**, including the WWTP, side-stream TRENS and pressurized pipeline.
- **10% of the influent** is diverted **through the TRENS side-stream** process to accomplish with the irrigation demand by farmers in the region.
- **Lynetten** is a **large and centralized WWTP** which environmental impacts are consistent with literature.

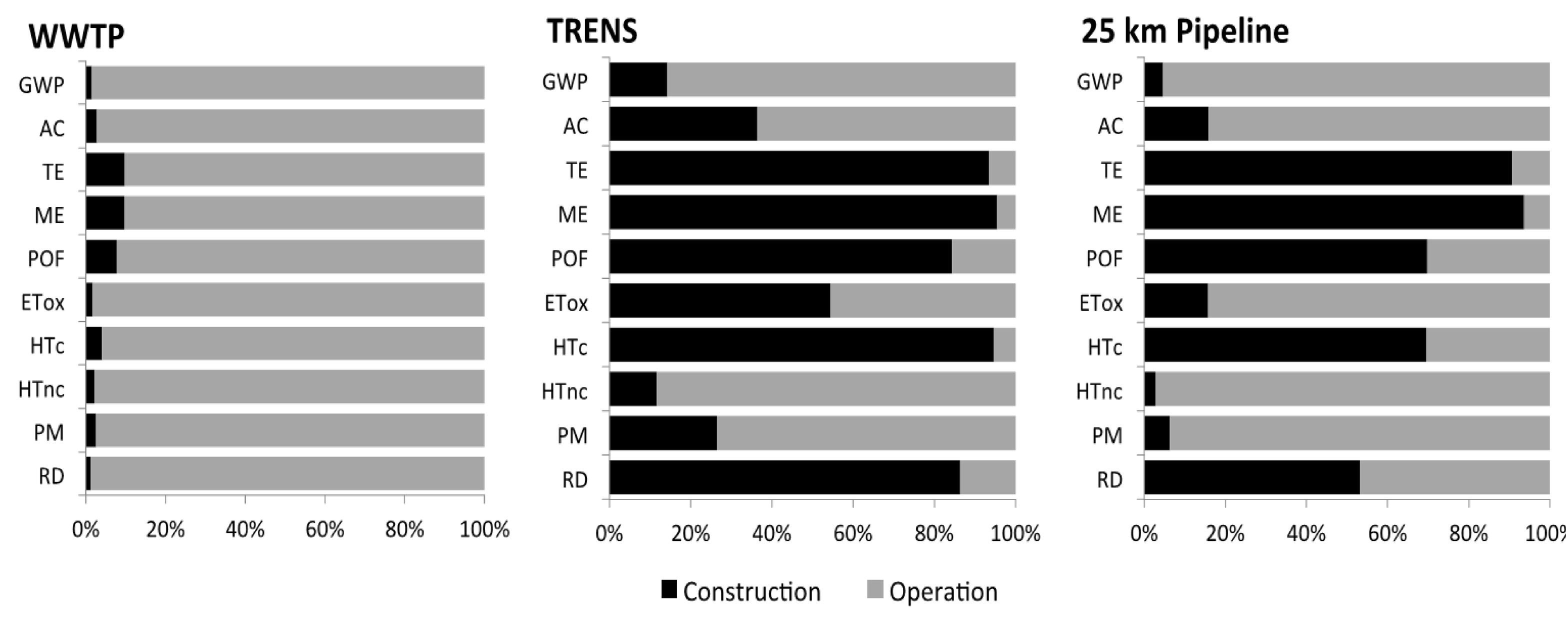
Impact Assessment

- **Small changes** on the environmental impact due to the design of a **side-stream system** (0-0.2 mPE/m3)
- **Use on land** plays a large part in the **toxicity impacts**
- **Reduced** impacts:
  - Reduced flow through the secondary treatment of WWTP: **less N2O emissions** (-15% GWP) and **nitrate discharge** to the sea (-9% ME)
  - Offset of mineral fertilizer production
- **Increased** impacts:
  - **Land application** of the algal suspension: **heavy metals** disposal on land (+290% in HTnc)
  - **Energy consumption** of the TRENS system and pressurized pipeline
  - **Emissions** from **increased biogas** combustion



Construction vs Operation

- **WWTP** environmental impacts driven by **operating phase**
- **TRENS system** environmental impacts driven by **construction phase**:
  - Higher use of **plastic materials** for the photobioreactor (PBR) and the pipeline
  - **Shorter service life** of the PBR



Contribution and Perturbation Analysis

- **Contribution analysis** reveals specific areas where **TRENS is competitive**, e.g. reduction of $FeCl_2$ by substituting chemical precipitation
- **Perturbation analysis** highlights that the **reduction in marine eutrophication** may be **lost** if the **nutrients leach** from the algae

Feedback to TRENS developers

Further research for TRENS developers should address:

- **Fate of heavy metals** in the TRENS system
- Applicability of green **microalgae** as natural **fertilizer**, paying attention to the **nitrogen mobility**
- Characterization of **N2O emissions** in the **PBR**

4. RESULTS: AQUIFER RECHARGE SCENARIO

- **HTc** impact increases due to AlCl3 production for pre-infiltration
- Compared to the fertigation scenario:
  - **Increased impacts** due to the **lack of nutrient recovery**: GWP, AC, TE and POF
  - **Decreased impacts** by **avoiding** the disposal of **heavy metals**: HT
- **Conclusion: end use matters when developing resource recovery technologies!**

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DTU INWATECH KAIST

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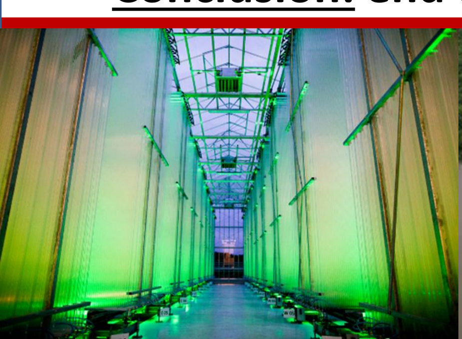

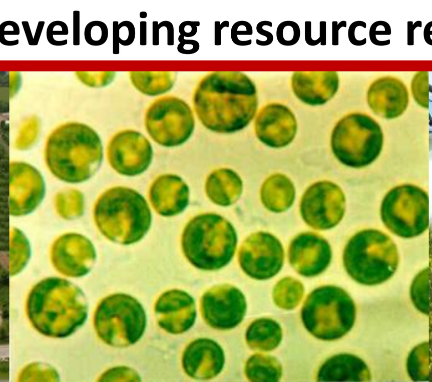


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