LIFE DeNTreat

Decentralized innovative treatment of ammonium-rich urban wastewater

Life Cycle Assessment (LCA)

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LIFE DeNTreat FINAL EVENT – web meeting

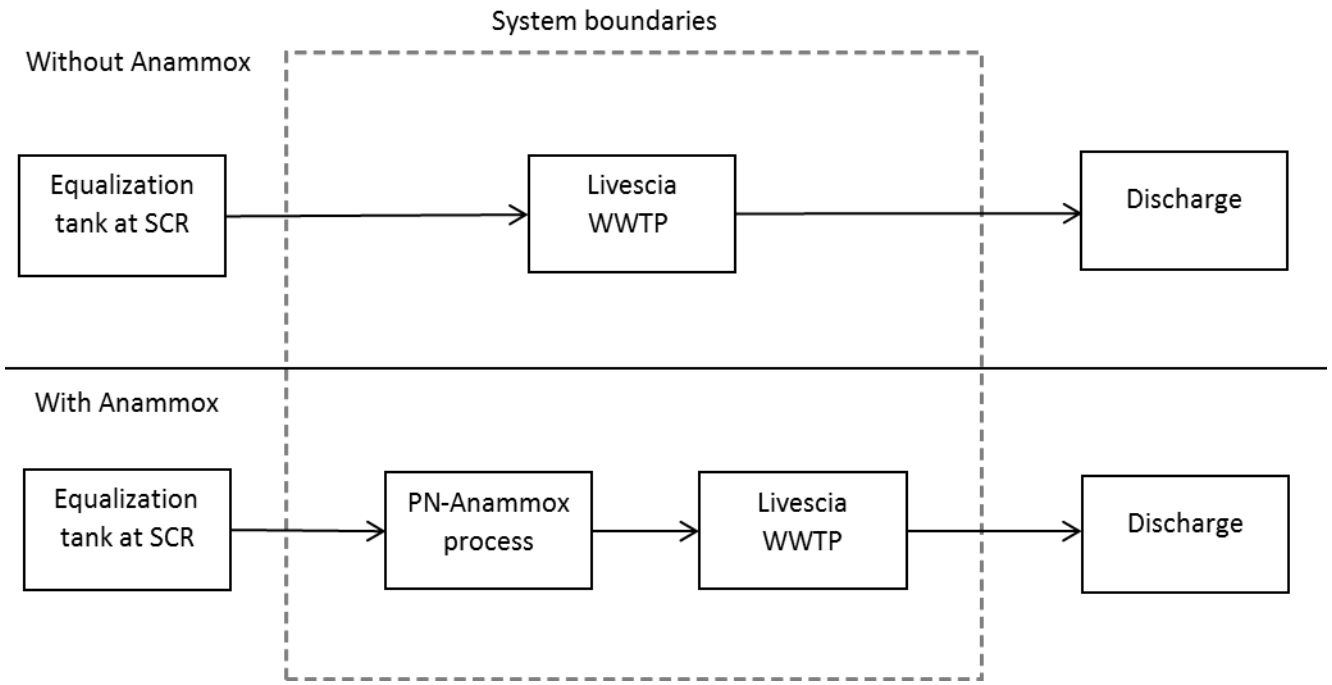
February 24th, 2021

The project has received funding from European Union´s LIFE Programme under Grant Agreement LIFE16 ENV/IT/000345

Goal and scope definition

- To assess the potential environmental impacts of using DeNTreat technology based on Anammox (Anaerobic ammonium oxidation) process for the removal of Nitrogen (N) from the effluent produced by digital textile printing industries
- Comparative LCA: Anammox method vs conventional method for the removal of nitrogen (→ only the process units that differ between the two scenarios were considered)
- Functional unit: the removal of 1 kg of Nitrogen

Goal and scope definition: the compared systems



When multi-functionality exists, it has been solved by applying the "system expansion with substitution" method

Processes included in the LCA:

- additional partial nitritation (PN)/Anammox process
- variation in the generation of sludge
- variation in the amount of external carbon consumption necessary in the treatment
- variation in the consumption of electricity
- variation of N_2O emissions

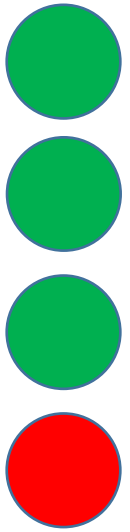
Goal and scope definition

- Impact assessment: Environmental Footprint (EF) method developed by the European Commission in the framework of the Product EF (PEF) initiative → 14 impact categories (Ionising radiation and Land use were excluded)

- Data source:
  - ✓ Where possible, primary data deriving by the tests carried out in this project
  - ✓ Data that could not be obtained via experimentation was estimated
  - ✓ For the background processes, ecoinvent v3.5 database

Inventory

	Livescia WWTP scenario	SCR PN/A process scenario	Variation
Sludge generation (kgSS/kgN removed)	1.1*	0.15***	-86.4%
Substrate usage (glycerol) (kg/kgN removed)	2.6*	0****	-100%
Electricity consumption (kWh/kgN removed)	14.82*	1.50***	-89.9%
N_2O emission (kgN_2O/ kgN removed)	0.0054**	0.0311*****	+475.9%

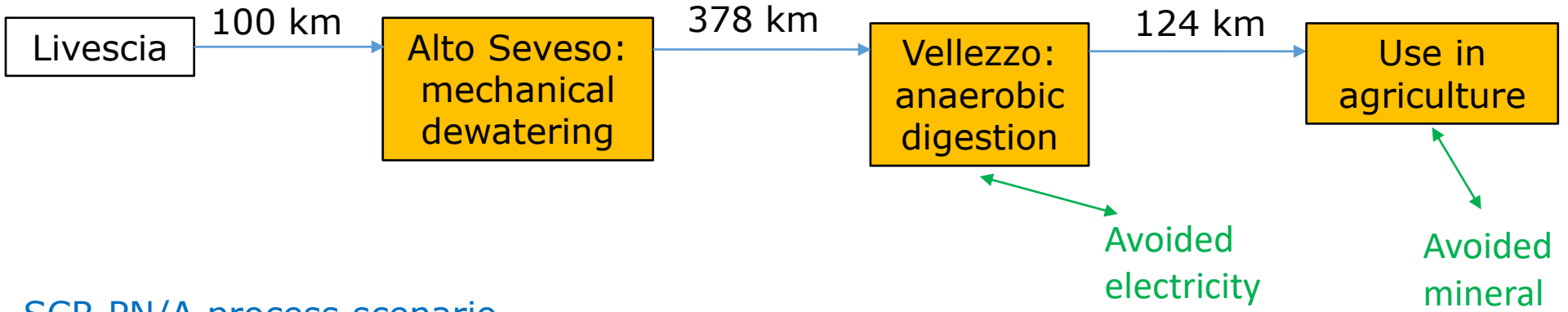


*Calculated from data obtained from Livescia WWTP
** Data from N_2O monitoring campaign
*** Estimated from literature
**** From the pilot plant
***** From the lab

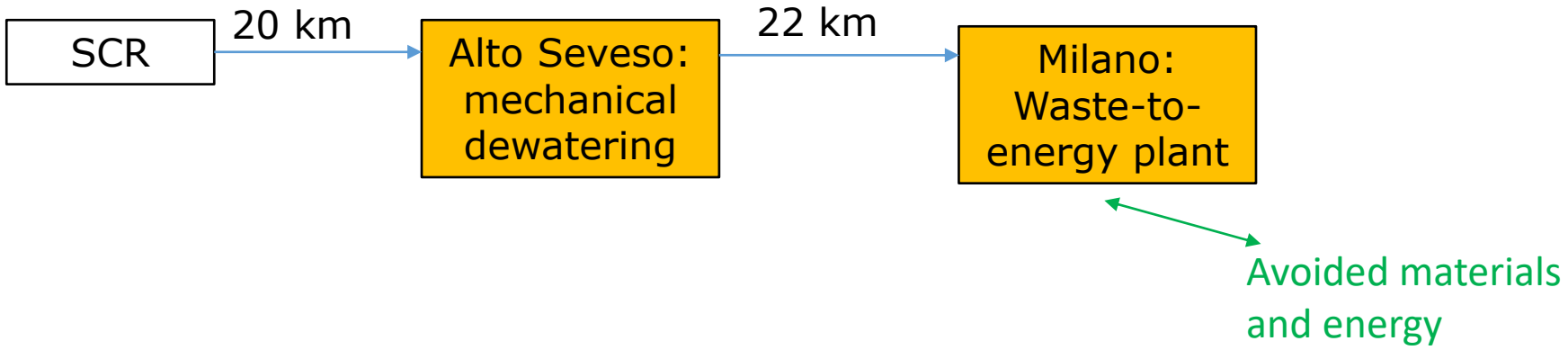
Process unit "additional PN-Anammox process": the amount of construction materials was estimated, but contribution negligible to the LCA → not included

Inventory: modelling of sludge treatment

Livescia WWTP scenario



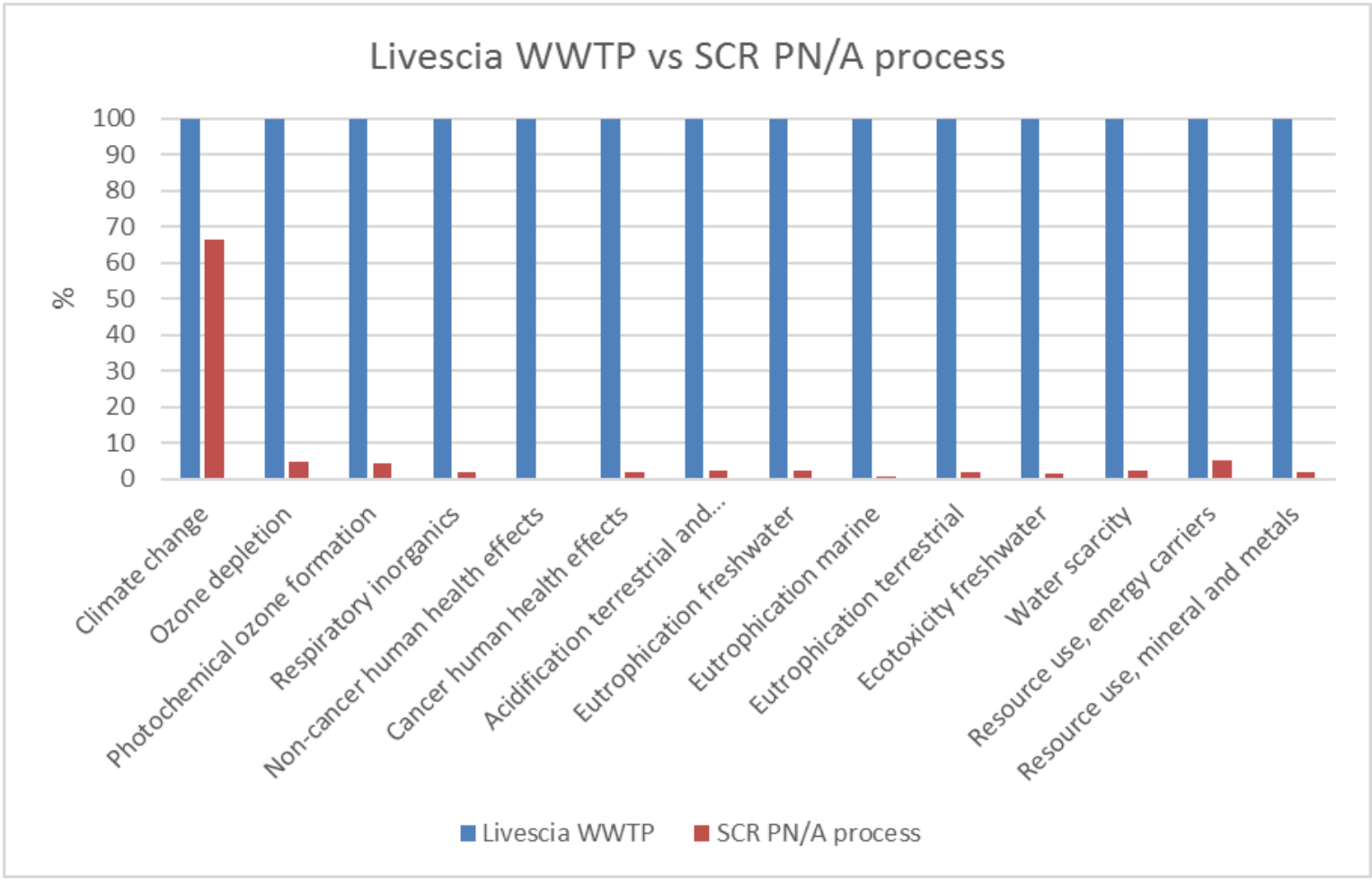
SCR PN/A process scenario



Inventory: electricity consumption

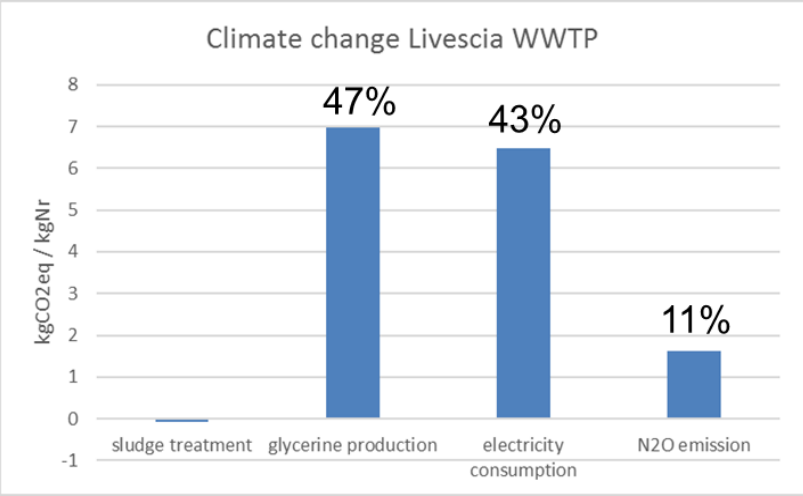
Scenario	Value (kWh / kgNr)	Modelling in the LCA software
Livescia WWTP	14.82	100% from the grid
SCR PN/A process	1.50	34.8% from the grid 9.5% from a photovoltaic plant 55.7% from a co-generative boiler fed by natural gas

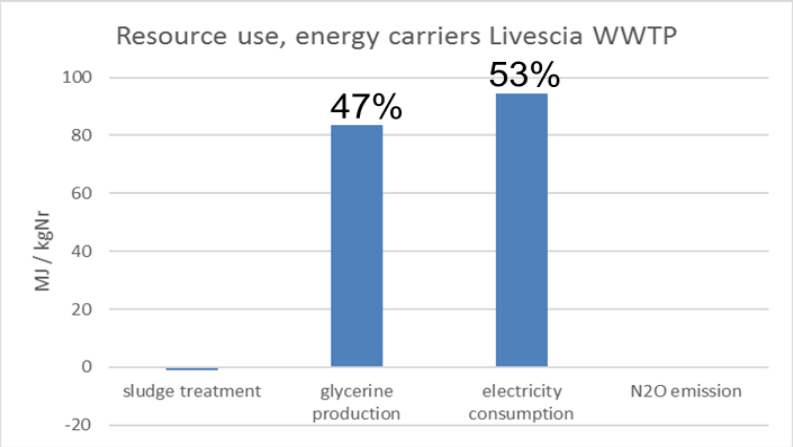
Results



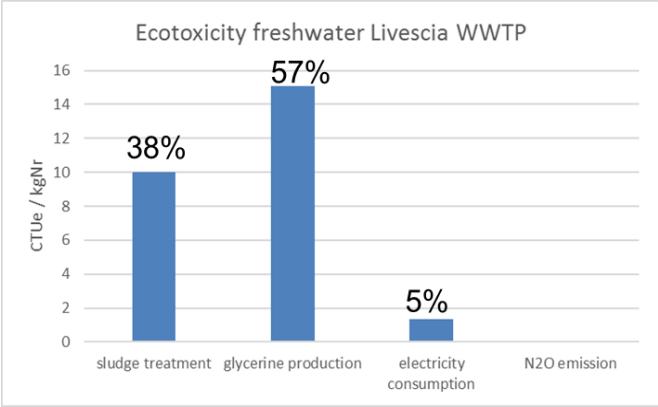
In all the impact categories, the SCR PN/A process scenario performs substantially better than Livescia WWTP scenario (impacts of SCR PN/A process scenario between 0.3% and 5.1% except for climate change (66%))

Interpretation of the results: Livescia WWTP scenario

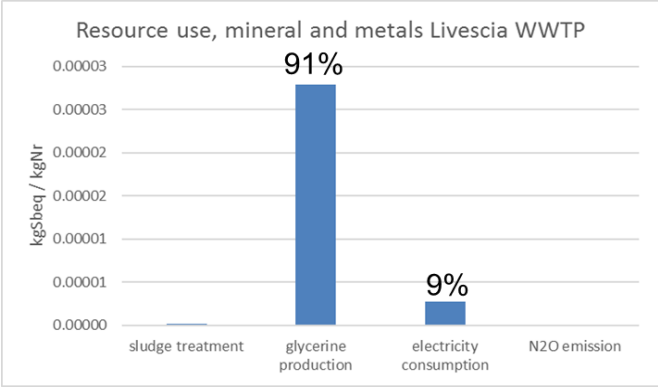




Similar behaviour for Water scarcity

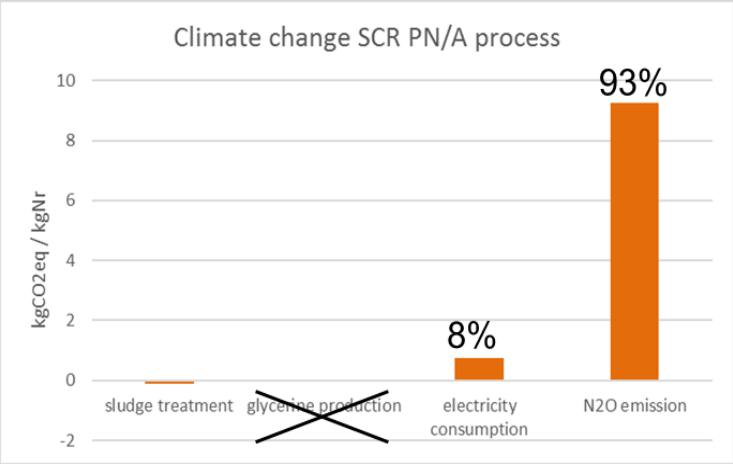


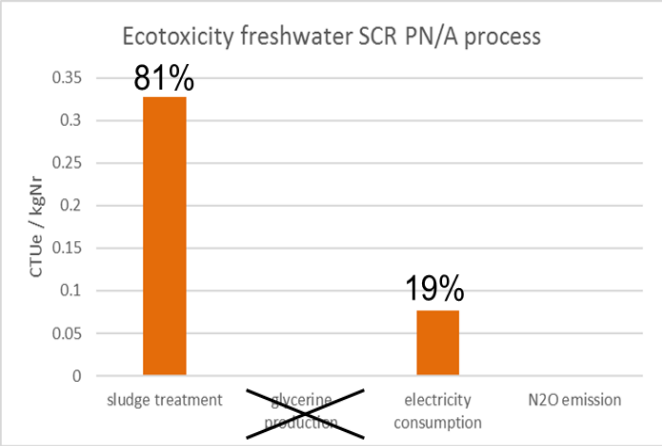
Similar behaviour for Cancer human health effects



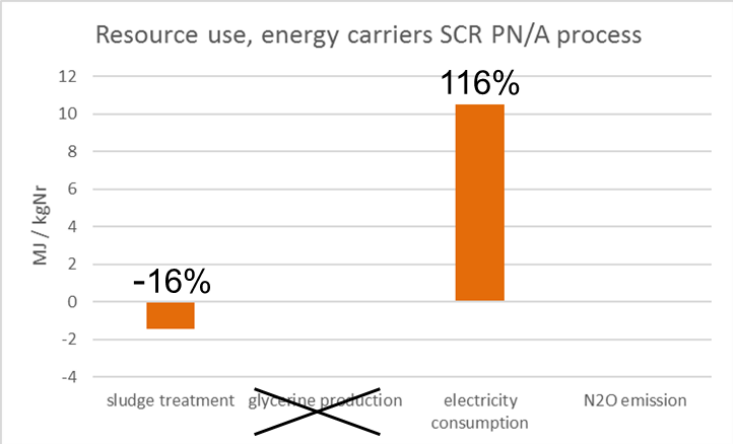
Similar behaviour for Ozone depletion, Photochemical ozone formation, Respiratory inorganics, Non-cancer human health effects, Acidification terrestrial and freshwater, Eutrophication freshwater, Eutrophication marine, Eutrophication terrestrial

Interpretation of the results: SCR PN/A process scenario

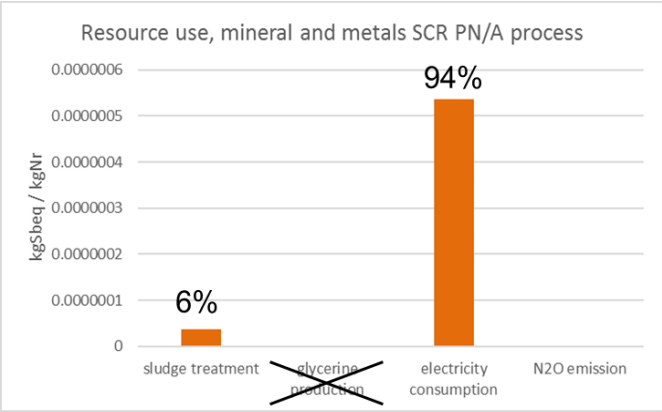




Similar behaviour for Cancer human health effects



Similar behaviour for Ozone depletion



Similar behaviour for Photochemical ozone formation, Respiratory inorganics, Non-cancer human health effects, Acidification terrestrial and freshwater, Eutrophication freshwater, Eutrophication marine, Eutrophication terrestrial, Water scarcity

Conclusions and recommendations

- The SCR PN/A process scenario performs substantially better than Livescia WWTP scenario in all the analyzed impact categories
- This is especially thanks to the fact that PN/A process does not require a carbonaceous substrate
- The N2O direct emission gives an important contribution to Climate change of SCR PN/A process scenario and so it is recommended to keep it measured
- Some of the data used in the modelling of SCR PN/A process are estimates taken from literature: it is recommended to repeat the LCA when real data will be available

Thank you!

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