LIFE ENRICH

Turning wastewater treatment plants into biorefineries: global value chain from bioresources to valuable products

Claudia Pastor, CETAQUA

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General data

ACRONYM: LIFE ENRICH

TITLE: Enhanced Nitrogen and phosphorus Recovery from wastewater and Integration in the value cHain

DURATION: 51 months (4,25 years): 01/09/2017 – 30/11/2021

PARTNERS:

STAKEHOLDERS:

BUDGET: 2,770,781 € (funding = 1,662,467 €)
The objective of LIFE ENRICH project has been to establish a link between the wastewater treatment sector and the agricultural sector by contributing to the conversion of wastewater treatment plants into biorefineries through the recovery of nutrients and their valorization in agriculture.

N-fertilizers are E intensive (GHG)
P-rock for P-fertilizers is a CRM
Increasing food demand

Nutrient recovery

New sustainable fertilizers

WWTPs focused on nutrient removal for legislation compliance
Value Chain

Prototype
- Full-scale: P Elutriation
- Pilot Plant: P Crystallization, Zeolites + membrane contactors

Recovered products
- Struvite
- Dewatered sludge
- Ammonium sulphate
- Ammonium phosphate
- Ammonium nitrate

Characterization, blending and performance evaluation
- Characterization of the products
- Definition of optimal mixtures
- Test agronomic properties

CIRCULAR ECONOMY

Business Model

RECOVERY

VALORIZATION
P&N recovery layout

Wastewater → Primary clarifier → Bio-P treatment → Effluent

Primary sludge overflow → Thickener

Centrates

Anaerobic Digestion

Dewatered sludge

Elutriation

Crystallization unit

N recovery unit

NaOH, Mg → CRYSTALLISER → struvite

UF → ZEOLITES

HFM C, HFMC → Ammonium salts

Acid, NaOH, NaCl
Crystallization unit - reactor

- Supernatant from primary thickening (after elutriation) as feed
- Supernatant good quality: low TSS (<400 mg/L) in inlet
- Continuous production of 5-6 kg/day of struvite (100 mg/L PPO4, nominal capacity: 0-3-1 m3/h)
Crystallization unit - results

- Stable P-PO4 recovery >85% - overflow~15-20 mg/L PPO4
- SSI 2.4  pH 8.2, Mg/P 1.3, N-NH4/P 4
- Struvite pellets 0.5-2 mm, metal-free, low TOC content<2%, complying with EU FRP 2020
N recovery train: the process

- N-NH$_4^+$ is removed from WW and accumulated in the zeolites. WW from 600-800 to <150 mg/L N-NH$_4$.
- Once zeolites are exhausted, they are regenerated with NaOH. The N-rich eluate is stored.
- The eluate reacts with an acidic solution in the membrane contactor, where N-NH$_4^+$ salts are produced.
- The reuse of the regeneration solution is possible.
N recovery train - results

- Zeolites’ adsorption

The breakthrough curves for zeolites adsorption as this one, showed that ammonium was successfully removed from the inlet water.

- ✔ Up concentration from 600 mg/L to 4-6g/L (CF between 6-10)
- ✔ Cation exchange capacity= 20-25 g N-NH4/kg Zeolite
- ✔ 77% N recovery

- Membrane contactor

- ✔ 70% N recovery
- ✔ Fertilizer free of metals & OMP

As it can be seen membranes allows to reduce ammonia concentration from 4 g/l to less than 150 mg/L, which in most cases it implies a rate of removal around 90%)

<table>
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<th>N-NH4 (g/L)</th>
<th>N-NO3 (g/L)</th>
<th>Nt (%)</th>
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</table>
Life cycle analysis

- **Base case**: nutrient removal at WWTP, application of chemical fertilizers

  - WWTP Murcia Este → Impact → Chemical fertilizers → Impact → Agriculture

- **Full ENRICH case**: P & N recovery at WWTP through struvite and ammonium salts, full P & N fertilization from recovered fertilizers.

  - WWTP ENRICH → Ammonium salts (N) → Impact → Agriculture
  - WWTP ENRICH → Struvite (P & N) → Impact → Agriculture

Full Enrich case projection will produce 1100 t/y of struvite and 1937 t/y of ammonium nitrate (21%w), which accounts for 42% of P recovery and 11% of N recovery of total P and N present in wastewater influent.

- -20% sludge production
- -27% polymer consumption (dewatering)
- -18% dewatering energy
- -85% antiscalant consumption and centrifuges external cleanings (uncontrolled P precipitation)
- -7.4% aeration energy (reduction of N load to biological reactors; 1.17 kWh/kg N)
Payback 19 years (considering OPEX, savings, fertilizer selling)
Total OPEX reduction 3.3%

The Global warming and mineral resource scarcity are the most representatives indicators.
- Global warming is mostly related with energy consumption in N-fertilizers production.
- Mineral resource scarcity is related to the consumption of phosphatic rock to produce P fertilizers
General conclusions

1. **LIFE ENRICH solution** has demonstrated **technical and environmental viability** to recover nutrients and valorize them as fertilizers.

2. Fertilizers tested in crop trials have been proven as an **alternative to conventional fertilizers**.

3. Two sustainable business models have been developed and financial projections have revealed that it is possible to obtain **revenues under certain scenarios**.

4. **LIFE ENRICH solution** has shown **high replicability potential** due to its flexibility to be implemented under different WWTP conditions.

5. **LIFE ENRICH solution** has shown great **potential transferability** to other EU countries **considering different specific contexts**.

EDAR Murcia Este | Virtual tour generated by Panotour (captura3d.es)
LIFE ENRICH

Enhanced Nitrogen and phosphorus Recovery from wastewater and Integration in the value Chain

Claudia Pastor, CETAQUA
claudia.pastor@cetaqua.com

Adriana Romero, CETAQUA
adrianalucia.romero@cetaqua.com

www.cetaqua.com/en/home

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www.life-enrich.eu
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LCC

CAPEX Full ENRICH  6.156.561 €
OPEX Full ENRICH  1.092.698 €
Savings Full ENRICH  235.107 €
Revenues* Full ENRICH  1.179.416 €
Margin Full ENRICH  321.825 €

LCA

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