CETAQUA
WATER TECHNOLOGY CENTRE

LIFE ENRICH

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

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www.life-enrich.eu

LIFE16 ENV/ES/000375

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:

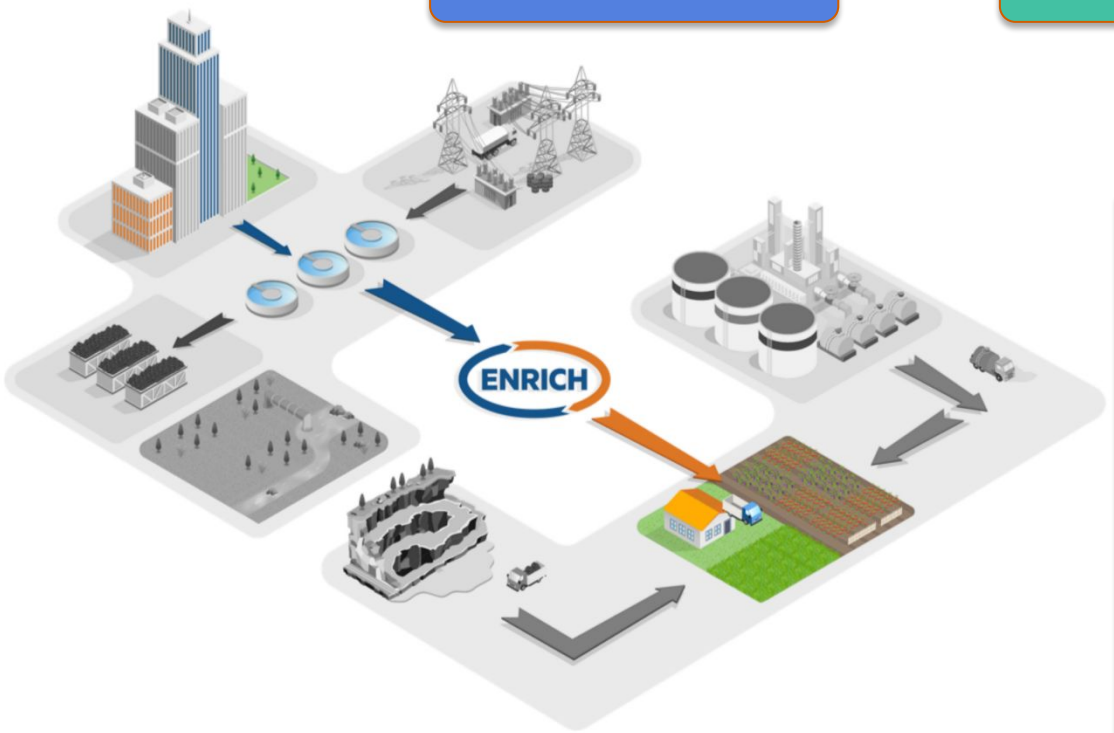
BUDGET: 2,770,781 € (funding = 1,662,467 €)

LIFE ENRICH

WWTPs focused of nutrient removal for legislation compliance

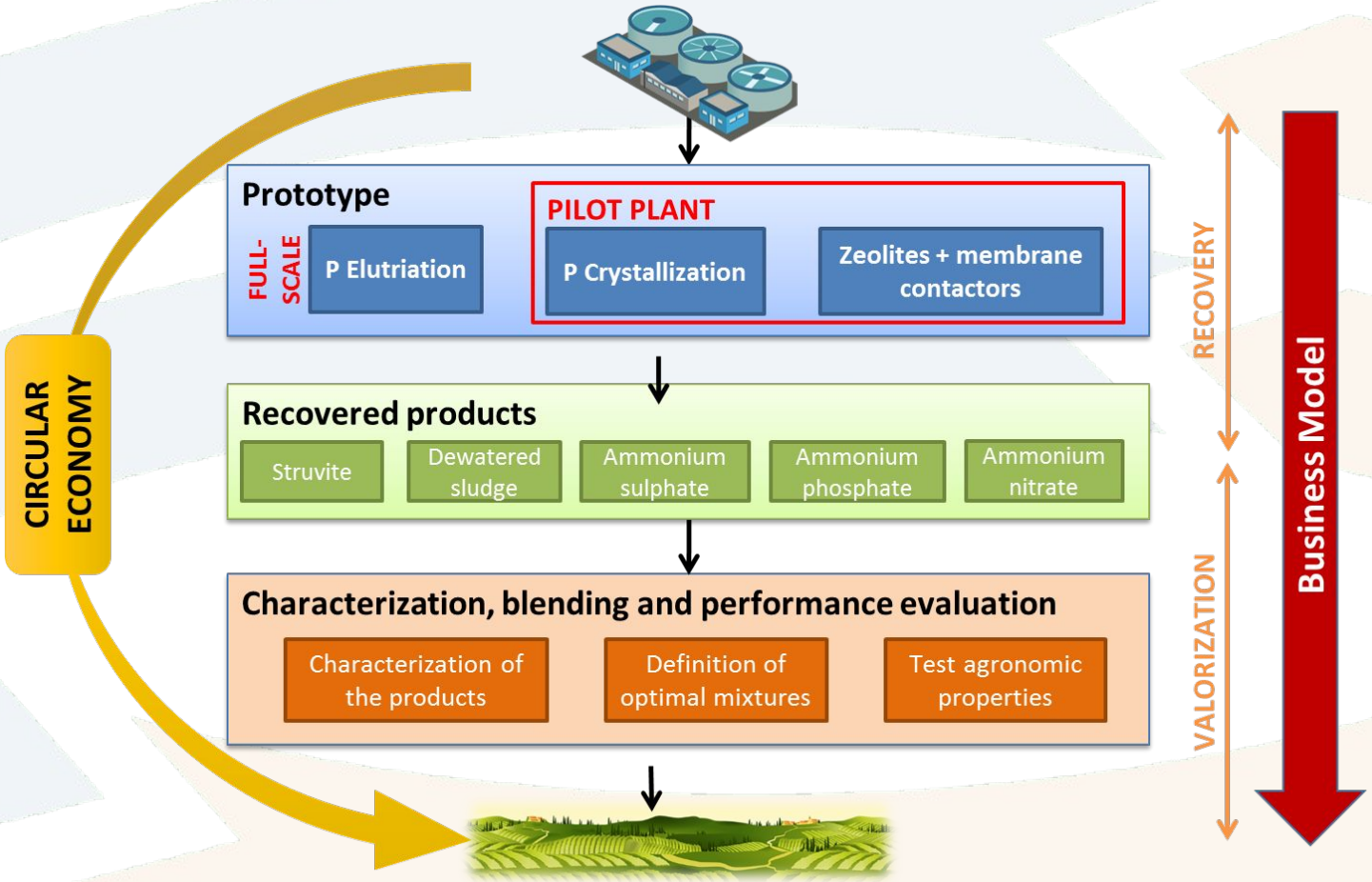
N-fertilizers are E intensive (GHG)
P-rock for P-fertilizers is a CRM
Increasing food demand

Nutrient recovery ...for... New sustainable fertilizers

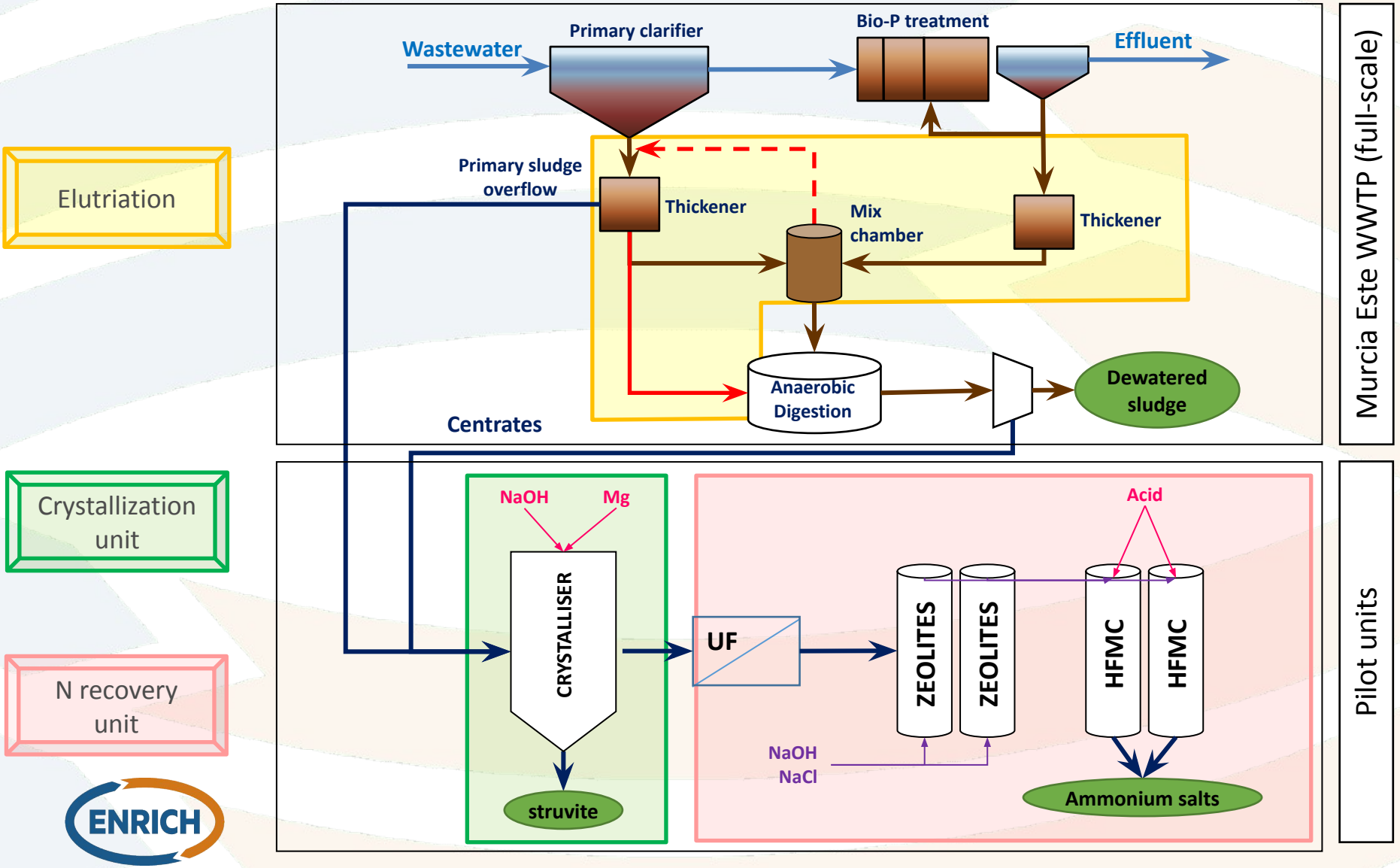


The objective of LIFE ENRICH project has been to establish a **link between the wastewater treatment sector and the agricultural sector** by contributing to the conversion of wastewater treatment plants into **biorefineries** through the **recovery of nutrients and their valorization in agriculture**.

Value Chain

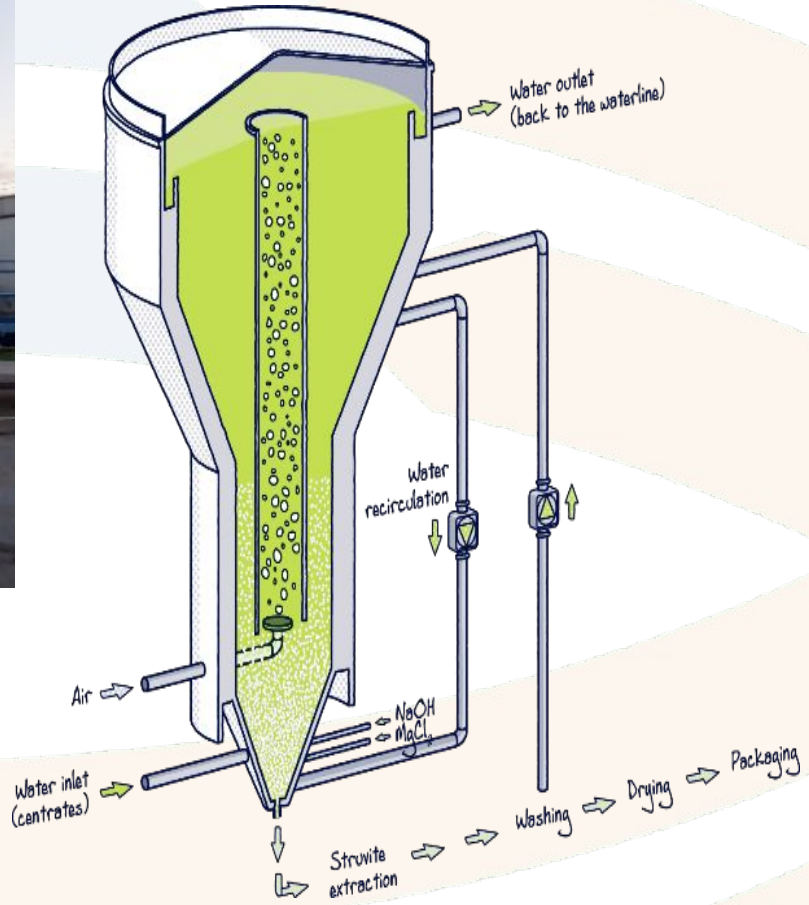

CIRCULAR ECONOMY
Prototype
FULL-SCALE
P Elutriation
PILOT PLANT
P Crystallization
Zeolites + membrane contactors
Recovered products
Struvite
Dewatered sludge
Ammonium sulphate
Ammonium phosphate
Ammonium nitrate
Characterization, blending and performance evaluation
Characterization of the products
Definition of optimal mixtures
Test agronomic properties
RECOVERY
VALORIZATION
Business Model

P&N recovery layout



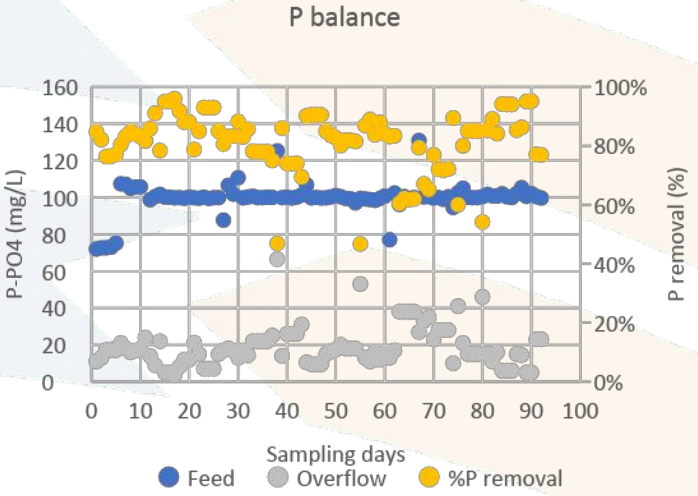
Crystallization unit - reactor

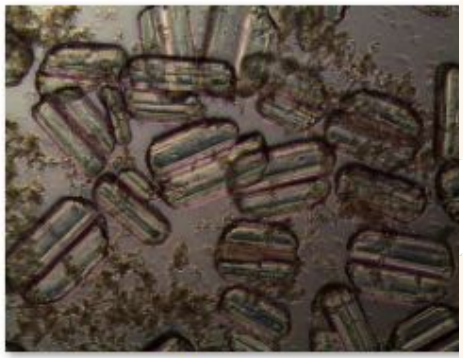
- Supernatant from primary thickening (after elutriation) as feed
- Supernatant good quality: low TSS (<400 mg/L) in inlet
- Continuous production of 5-6 kg/day of struvite (100 mg/L PPO4, nominal capacity: 0-3-1 m3/h)



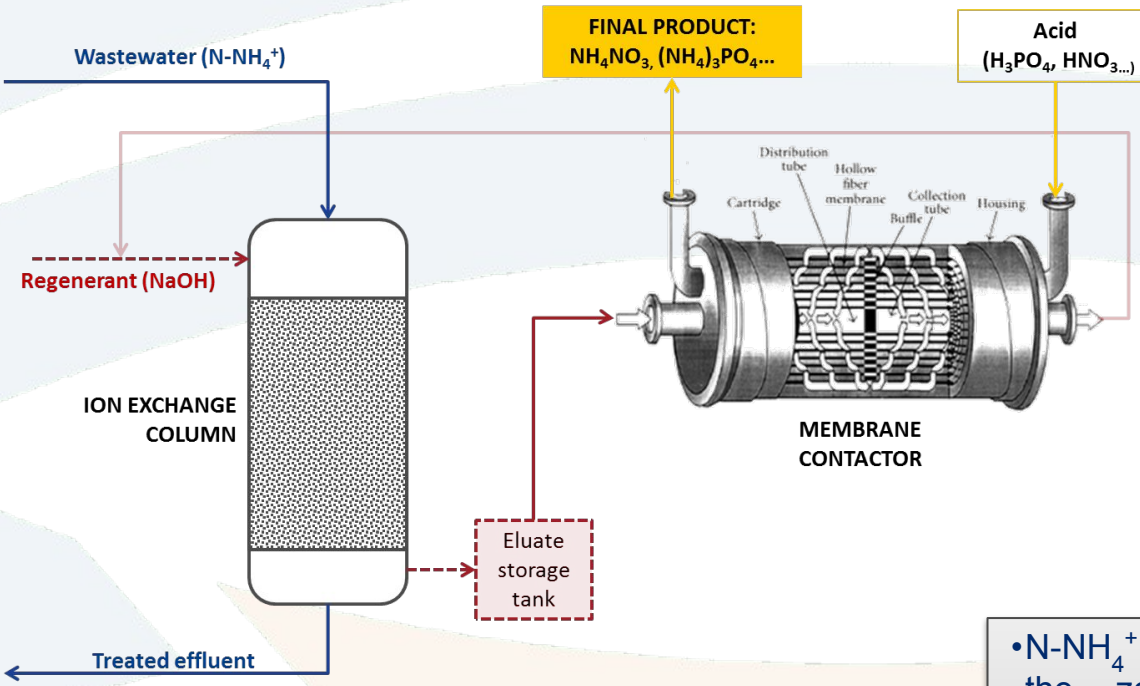
Crystallization unit - results

- ✔ 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**





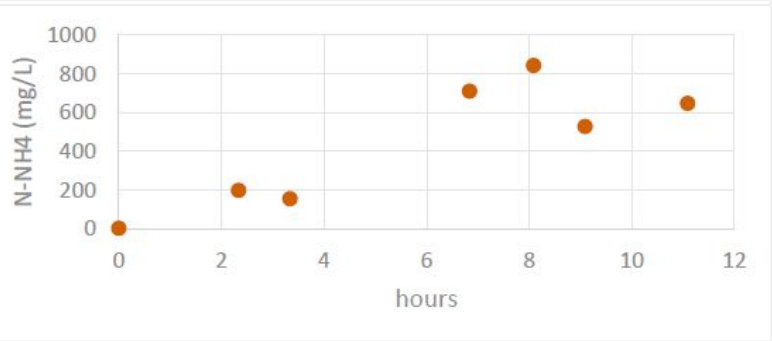
N recovery train: the process



- $N\text{-}NH_4^+$ is removed from WW and accumulated in the zeolites. WW from 600-800 to <150 mg/L $N\text{-}NH_4$
- 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 $N\text{-}NH_4^+$ salts are produced.
- The reuse of the regeneration solution is possible.

N recovery train - results

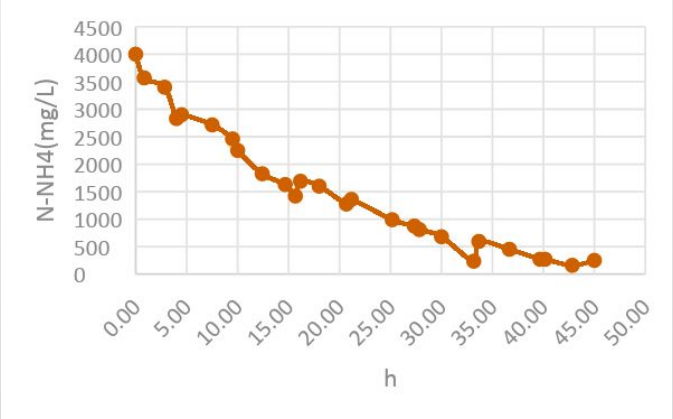
- Zeolites' adsorption



The breackthrough 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



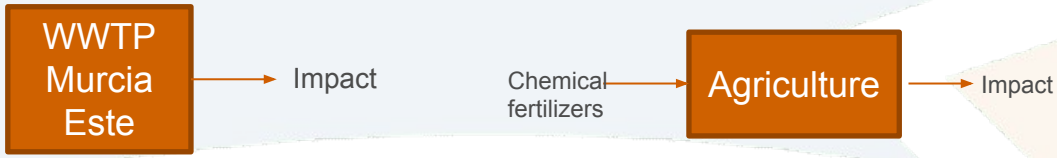
	$N\text{-}NH_4$ (g/L)	$N\text{-}NO_3$ (g/L)	Nt (%)
1	9,7	67,30	7,7
2	22,6	235,46	25,8
3	15,3	95,04	11,0
4	8,2	65,79	7,4
5	12,4	101,40	11,4
6	14,4	140,46	15,5
7	13,2	69,33	8,3
8	18,4	148,01	16,6
9	12,3	127,12	13,9

- ✔ 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%)

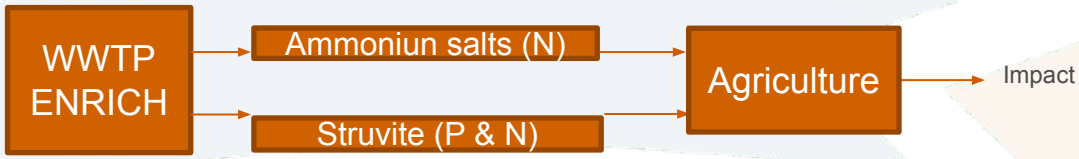
- ✔ 70% N recovery
- ✔ Fertilizer free of metals & OMP

Life cycle analysis

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



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



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

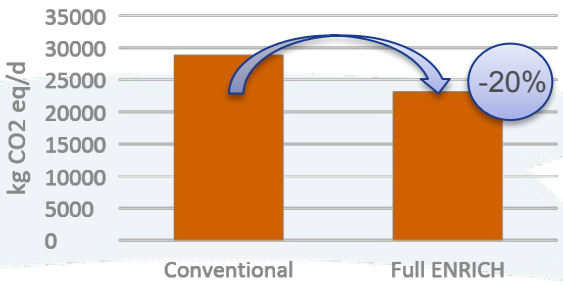
- -20% sludge production
- -27% polymer consumption (dewatering)
- -18% dewatering energy
- -85% antiscalant consumption and centrifuges external cleanings (uncontrolled P precipitation)
- -7.4% aeration energy (reduction of N load to biological reactors; 1,17 kWh/kg N)

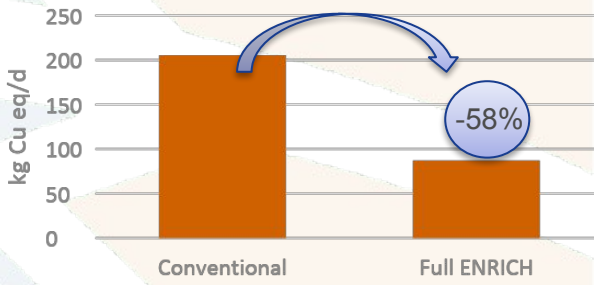
LCC

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 €

Payback 19 years (considering OPEX, savings, fertilizer selling)
Total OPEX reduction 3,3%

LCA





The Global warming and mineral resorcue scaricity are the most representatives indcators.

- 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 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**

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

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Thanks to the organization for the opportunity to present the LIFE ENRICH project in the 9th Conference on Sustainable Solid Waste Management

Thank you!

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		Cost (€/y)	
CR	$MgCl_2$	7.003 €	3%
	NaOH	118.848 €	59%
	Electricity	75.816 €	38%
		Cost (€/y)	
Z+CM	NaOH	115.130 €	13%
	HNO_3	485.541 €	54%
	Electricity	69.549 €	8%
	Zelolites	220.811 €	25%

Payback 19 years (considering OPEX, savings, fertilizer selling)
Total OPEX reduction 3,3%

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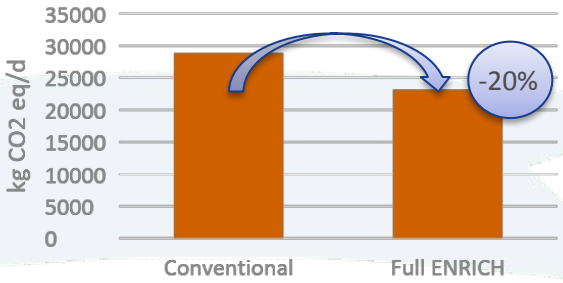

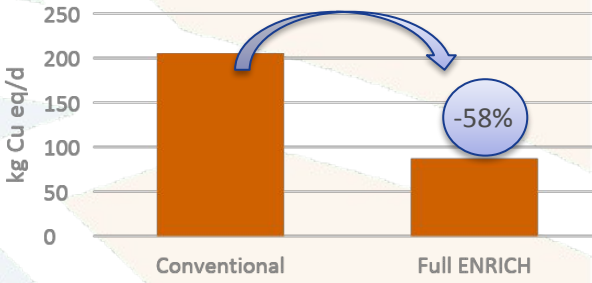

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