

European Sustainable  
Phosphorus Platform



This project has received funding  
from the EU Horizon 2020  
research and innovation  
programme under grant  
agreement No. 690323



SMART-Plant

**ECOMONDO**  
THE GREEN TECHNOLOGIES EXPO

22<sup>a</sup> Fiera internazionale  
del recupero di materia ed energia  
e dello sviluppo sostenibile

Green & Circular Economy  
6-9 Novembre 2018  
Rimini Italy

IN CONTEMPORANEA CON  
**KEY ENERGY**

# *The role of nutrients in the bioenergy production*

Nicolás Morales – Aqualia

**3rd EUROPEAN NUTRIENT EVENT @ ECOMONDO 2018**

**8 - 9 November 2018, Rimini, Italy**

[www.smart-plant.eu/ENE3](http://www.smart-plant.eu/ENE3)



# aqualia

Efficient comprehensive water cycle management



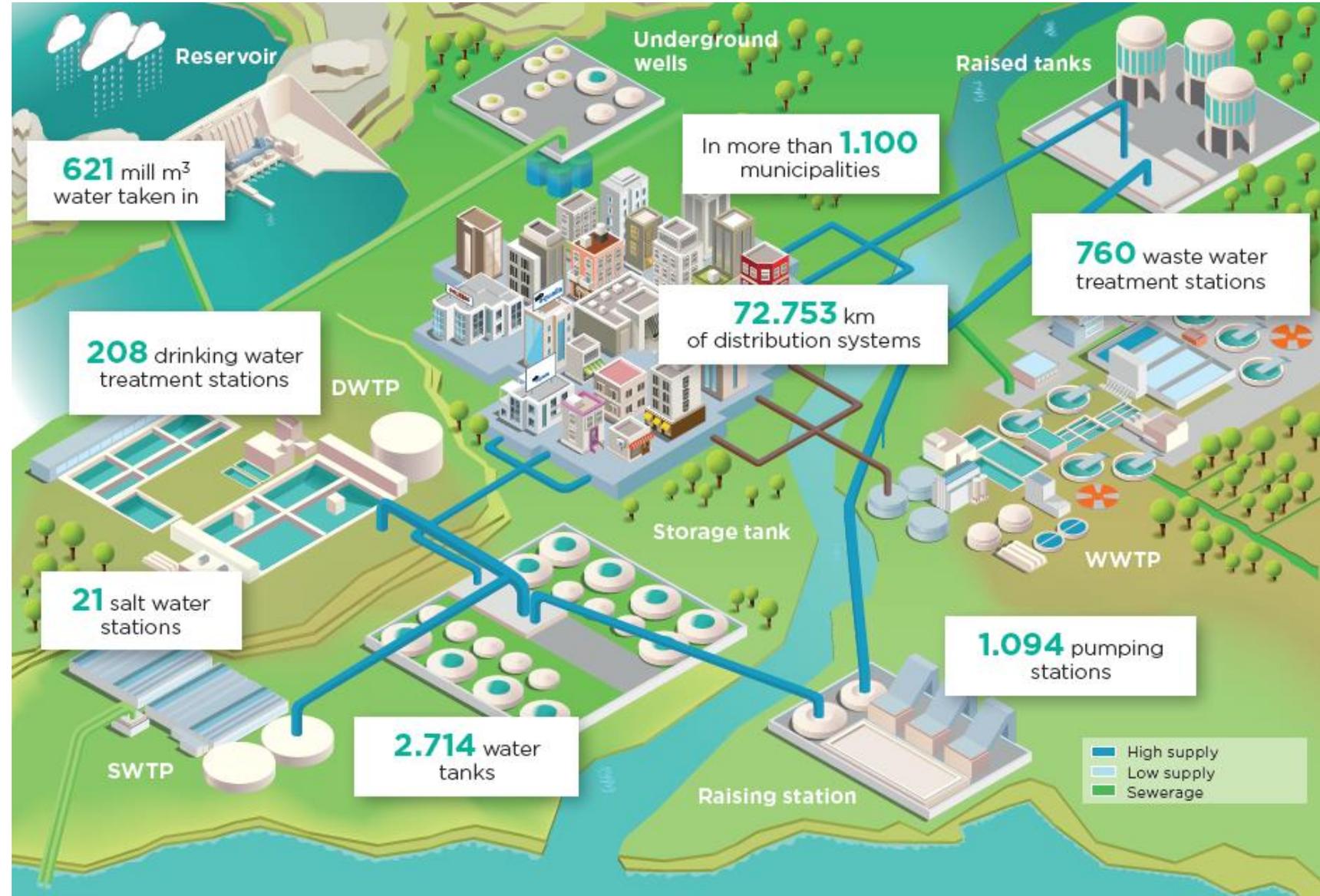
23,620,000 INHAB. POPULATION SERVED (GWI)



7,952 EMPLOYEES



22 COUNTRIES



# aqualia

## Innovation in the water cycle



20

Active RD&i projects



€4,100,302

Direct RD&i investment



10

Patents

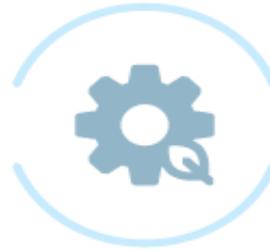
(2017)

### STRATEGIC LINES FOR R&D



#### SUSTAINABILITY

Reduction of energy consumption and emissions, use of waste water and wastes as resources and alternative technologies.



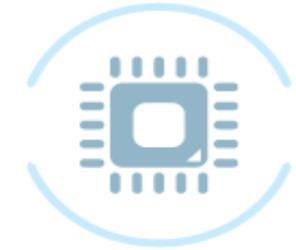
#### ECO-EFFICIENCY

Use of electricity from renewable sources, innovation to create new ecological fuels.



#### QUALITY

Standard indicators for drinking water, water re-use, desalination and analysis.



#### INTELLIGENT MANAGEMENT

Management systems, optimising of water resources and information and communication technologies.



**Aqualia treats 700 000 000 m<sup>3</sup>/year of urban WW**

**Electric consumption associated:**

$$0.5 \text{ kWh}_{el} / \text{m}^3 = 350 \text{ M kWh} = 35 \text{ M €}$$

**500 000 000 people in Europe x**

$$0.5 \text{ kWh}_{el} / \text{m}^3 \times 0.15 \text{ m}^3 / \text{PE} \cdot \text{d} = 37\,500 \text{ MWh/d}$$

$$37\,500 \text{ MWh} / 24 \text{ h} = \mathbf{1560 \text{ MW}}$$

**Potential energy content of urban WW is**

$$\approx 500 \text{ mg COD/L} \times 4 \text{ kWh/kg COD}$$

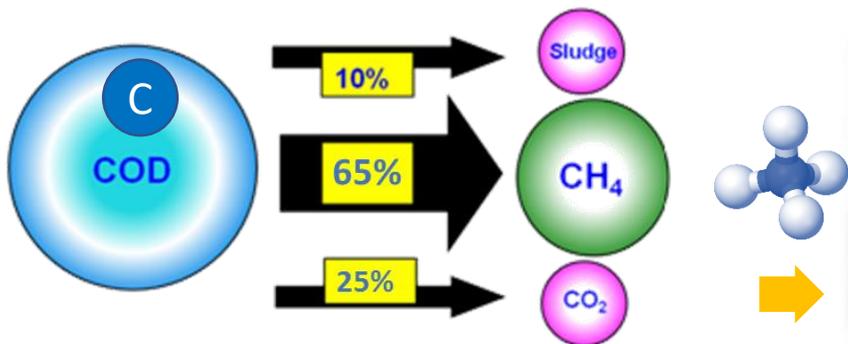
$$\approx 2 \text{ kWh}_{th} / \text{m}^3$$

$$(\approx 0.7 \text{ kWh}_{el} / \text{m}^3)$$

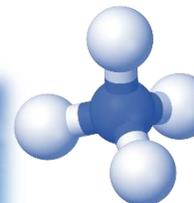


**Wastewater is Bioenergy!**

## Promote Anaerobic route



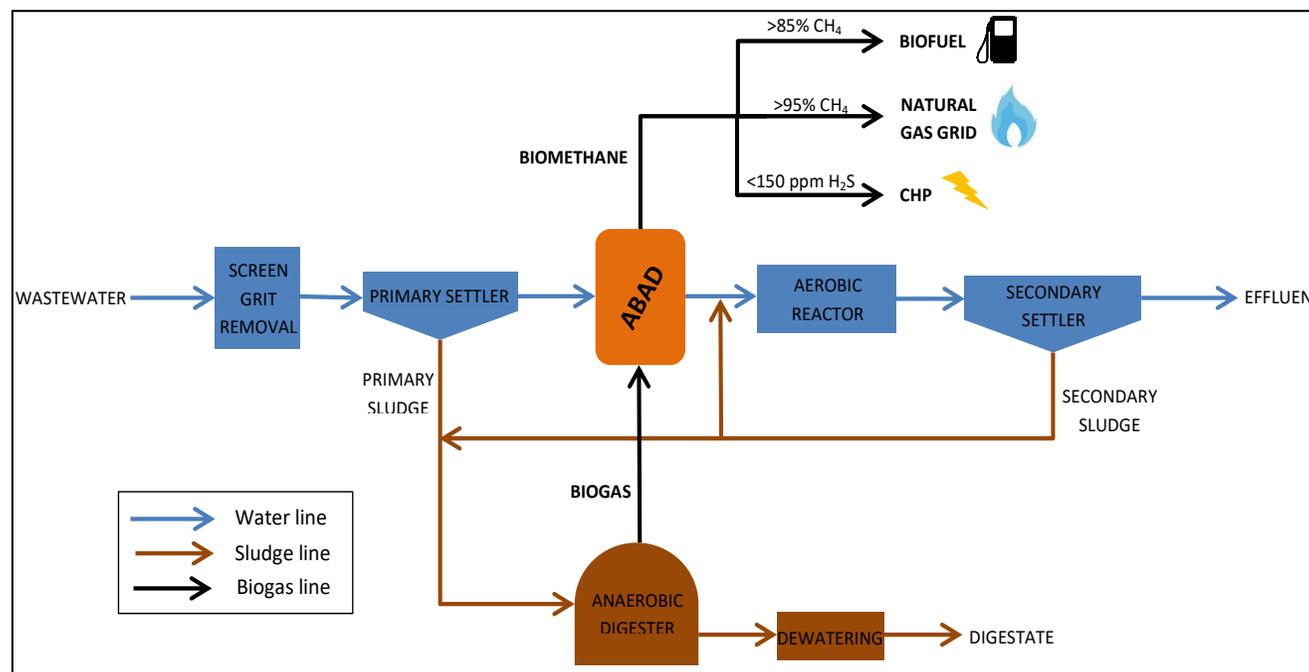
## ABAD Bioenergy® Biogas upgrading

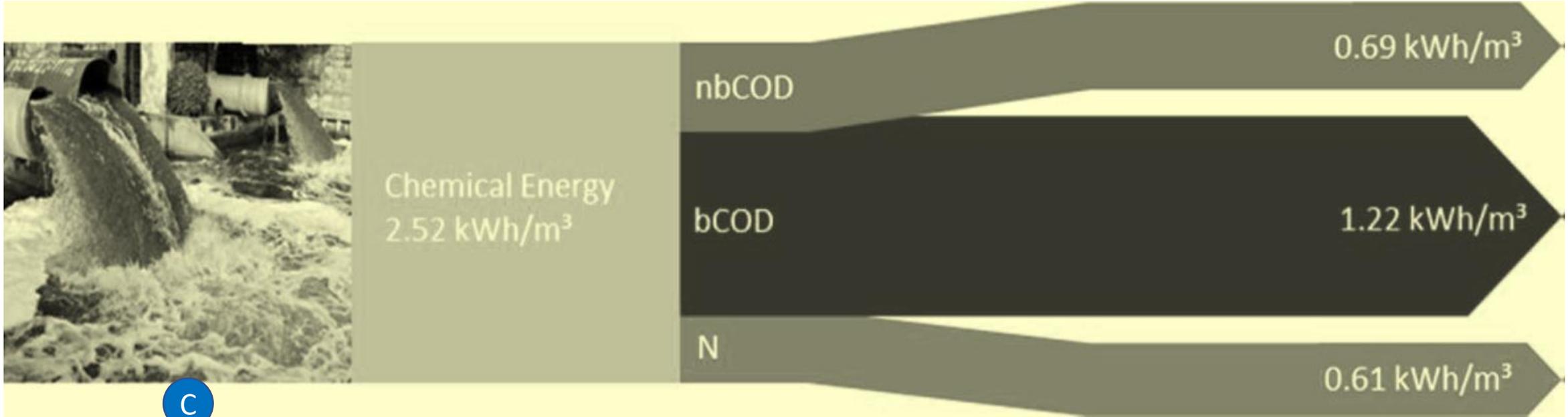


fleet vehicle quality

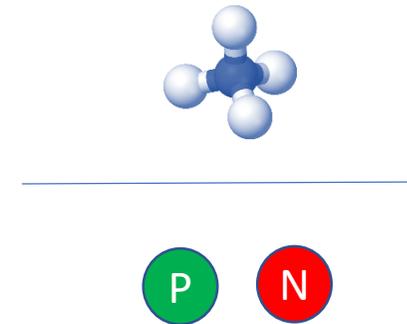
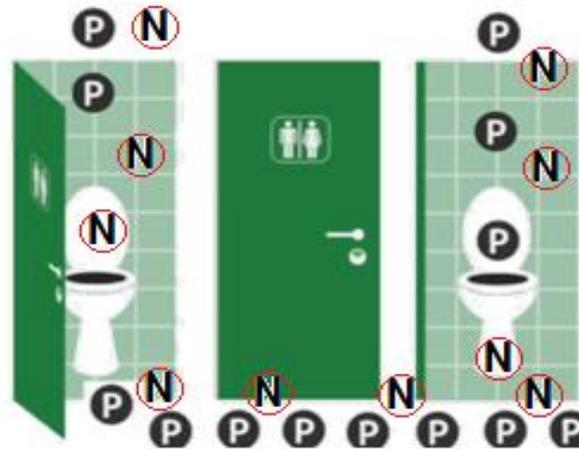


	Biogas	Biomethane
CH <sub>4</sub> [%-vol]	65.9 ±2.3	> 89.6
CO <sub>2</sub> [%-vol]	33.8 ±1.4	< 5
N <sub>2</sub> [%-vol]	2.4 ±1.5	< 6
O <sub>2</sub> [%-vol]	0.5 ±0.5	0.02
H <sub>2</sub> S + COS [mg S/Nm <sup>3</sup> ]	915 ±449	< 5
Siloxanes [mg Si/Nm <sup>3</sup> ]	5	0.3
Water content (ppm)	-	< 10





**N fixation  
Haber-Bosch Process  
10 kWh/kg N**



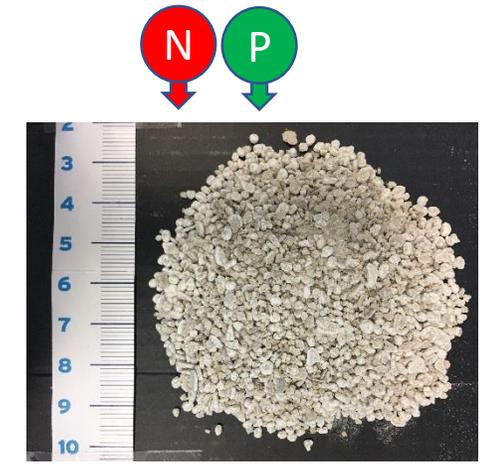
# Advanced WWTP



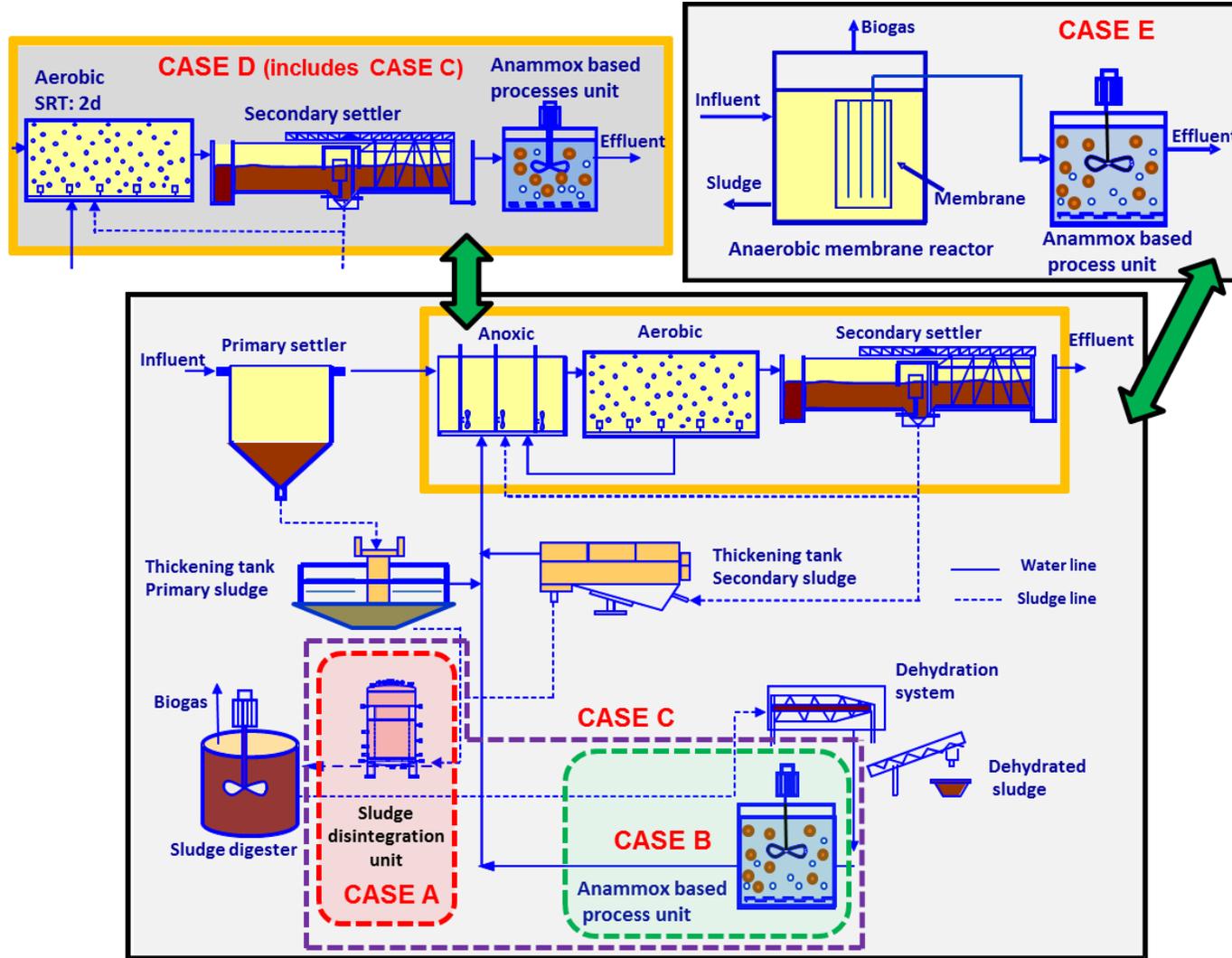
## ELAN<sup>®</sup> Process (*EL*iminación *A*utótrofa de *N*itrógeno, Autotrophic Nitrogen Removal)

PN/Anammox in one stage with granular biomass

Processes	O <sub>2</sub> consumption (kg O <sub>2</sub> / kg N)	COD consumption (kg COD /kg N)	CO <sub>2</sub> emission (kg CO <sub>2</sub> /kg N)	Yield (kg VSS/kg N <sup>1</sup> )
Nitrification-Denitrification	3.18	4.9	3.52	2.11
ELAN <sup>®</sup>	1.83	0	3.26	0.12



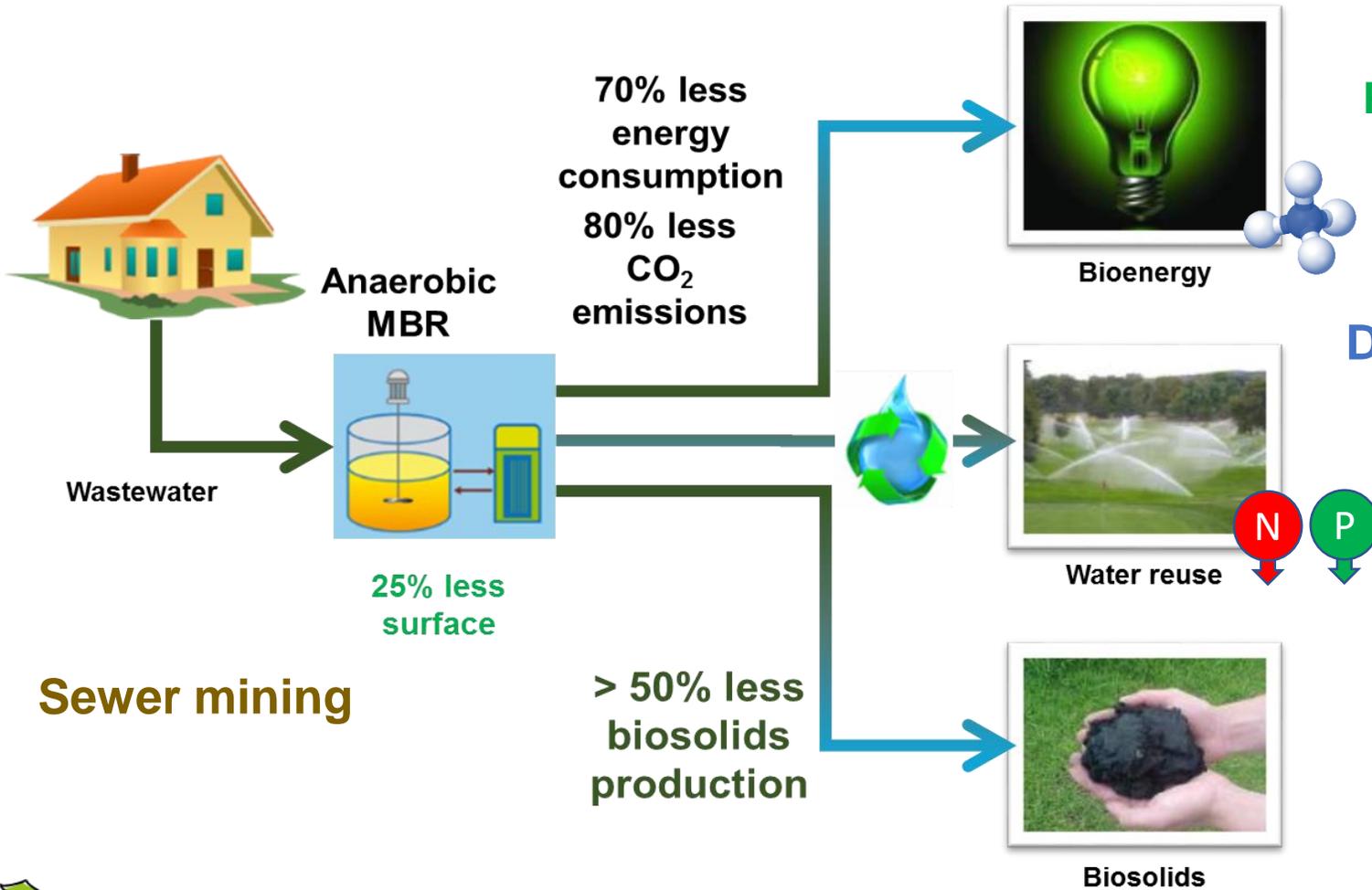
# Advanced WWTP: ELAN process in the mainstream



Parameter	Case A Sludge disintegration unit	Case B Anammox in the sludge line	Case C A+B	Case D C + Anammox in the water line	Case E Anaerobic MBR and Anammox
Aeration requirements (%)	+13	-26	-25	-50	-86
Biogas production (%)	+15	+18	+51	+67	+250
Sludge generation (%)	-24	+17	-1	+9	+4
N <sub>2</sub> O emissions (%)	+3	-22	-22	-83	-83
Saving costs (%)	6	7	19	28	68

# Anaerobic Membrane Bioreactor AnMBR

Life Memory:  
Membrane for ENERGY and WATER RECOVERY



Potential Net Energy production of > 0.1 kWh/m<sup>3</sup>

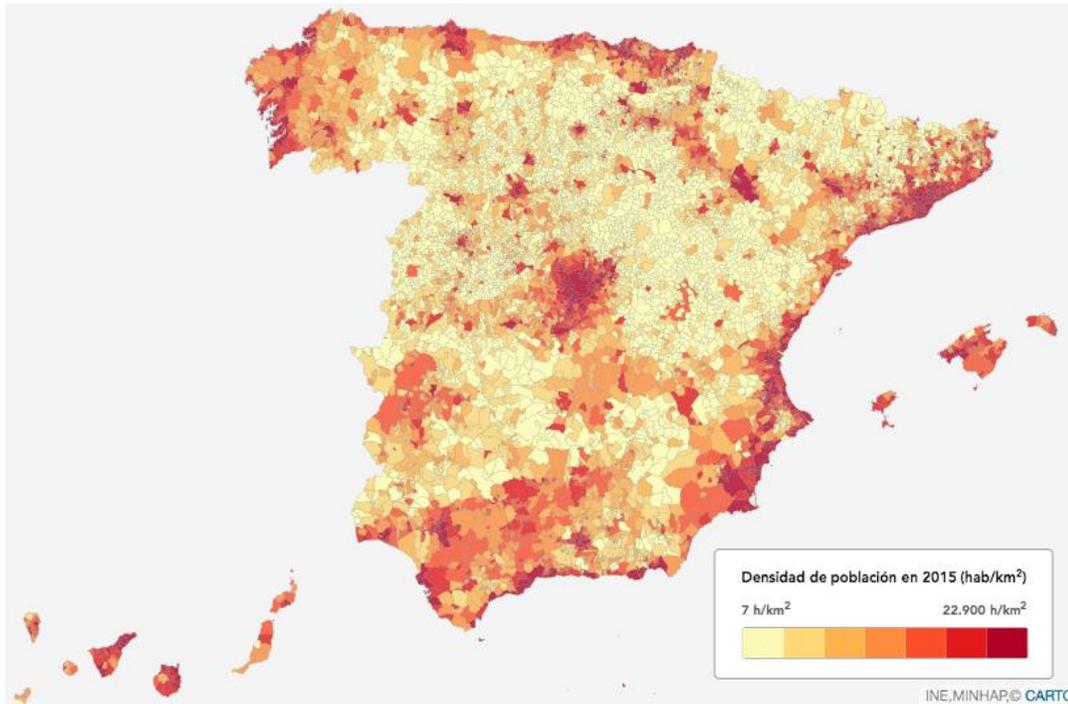
Disinfected Nutrient Rich Water for Irrigation

Sewer mining



## Centralized treatments?

## Decentralized alternatives

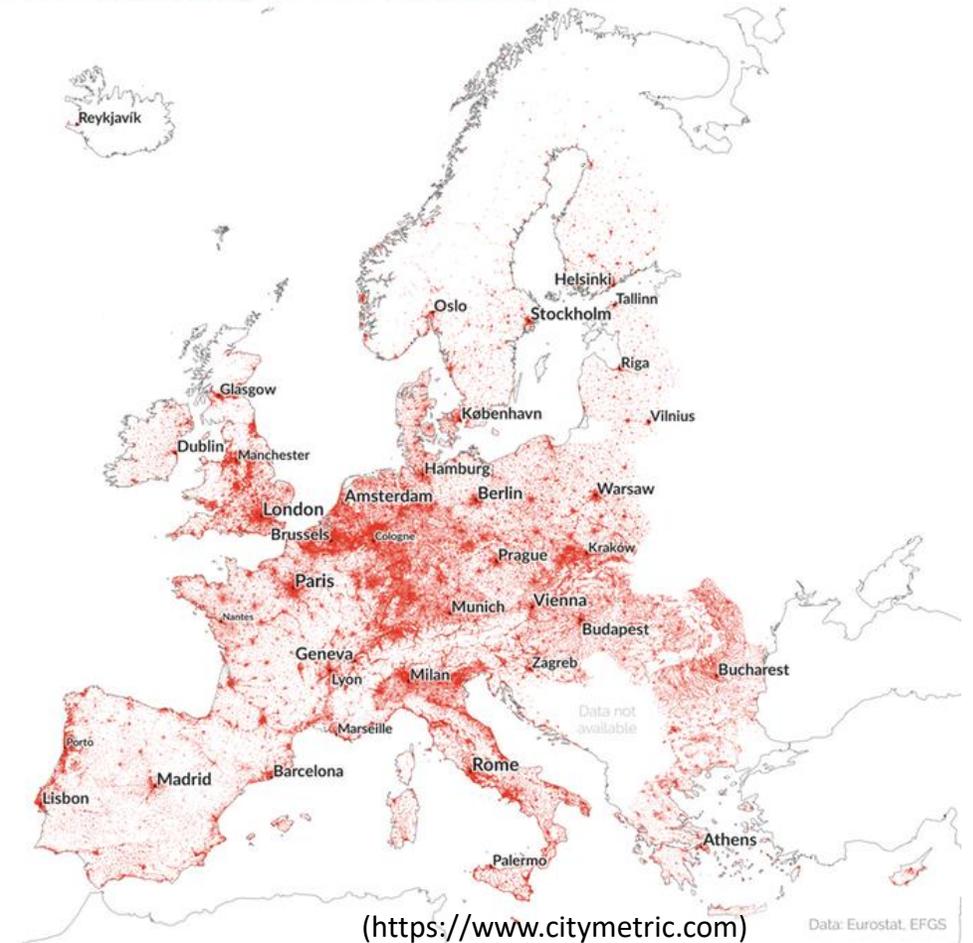


Population density in Spain (avg: 90 hab/km<sup>2</sup>)

73% of municipalities < 2 000 inhabitants

## POPULATION DENSITY IN EUROPE

Areas with 250 people or more, per sq. km.



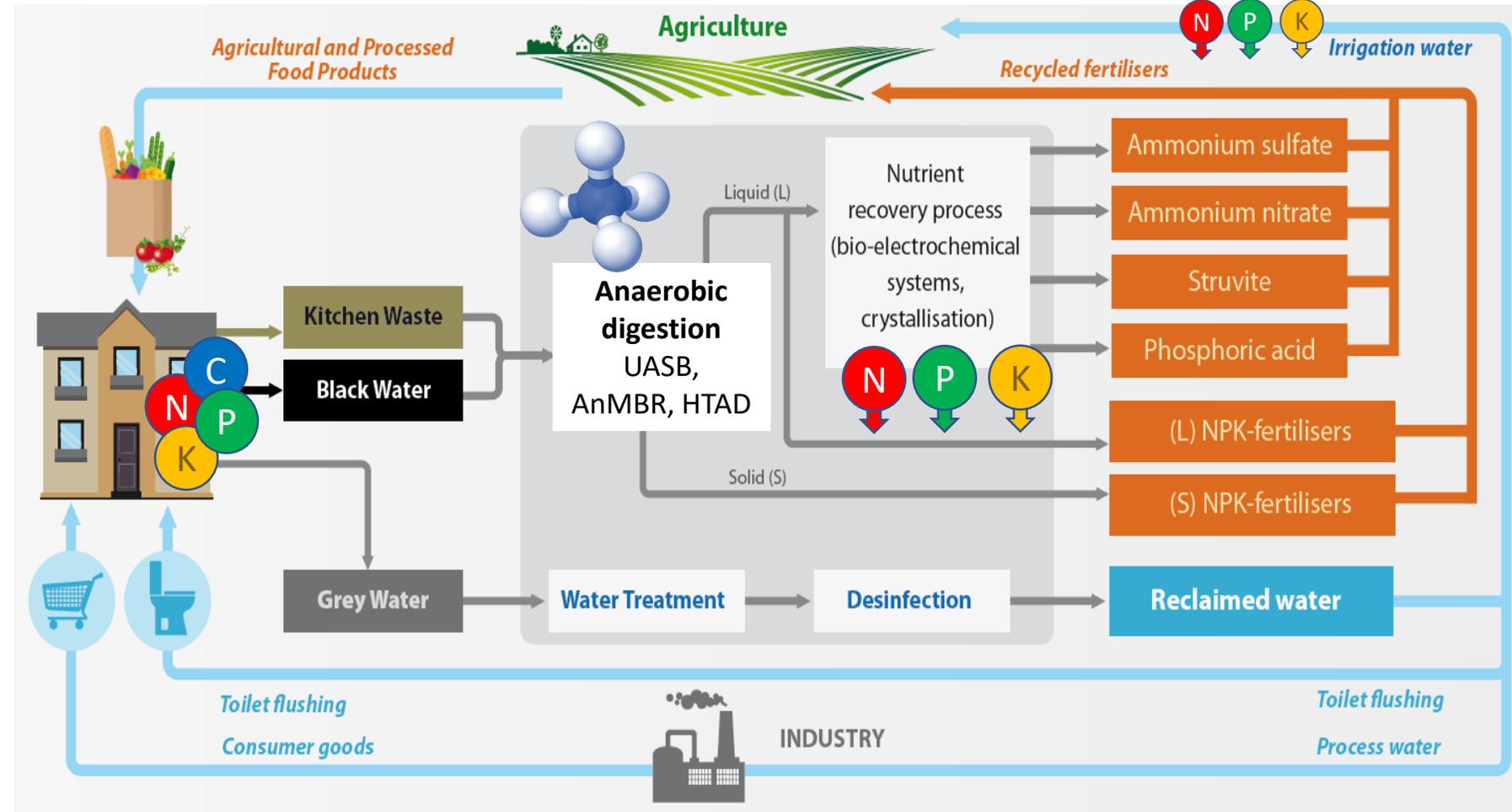
Central and Eastern Europe: 90% of settlements have less than 2 000 inhabitants



Recovery and Utilization of Nutrients

4 Low Impact Fertilizer

- **Domestic wastewater:** important nutrient carrier not currently exploited
- **Decentralized nutrient recovery** from wastewater at the **source**



# Symbiosis: Algae - Bacteria

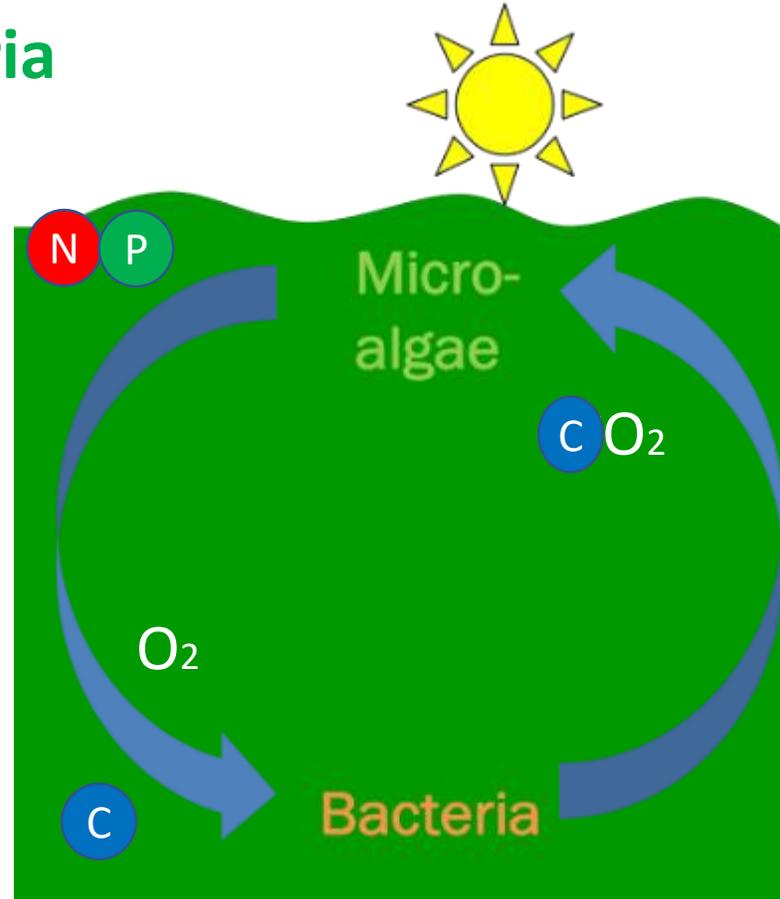
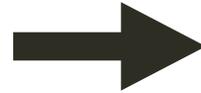
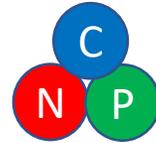
All-gas

SABANA  
Sustainable Algae Biorefinery for aquaculture and Aquaculture

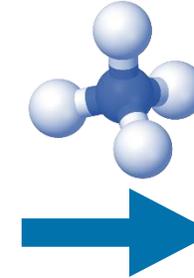
INCORVER  
Innovative Eco-Technologies for Resource Recovery from Wastewater

biosol  
water recycling

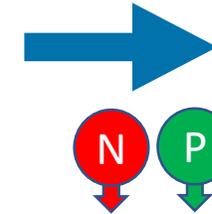
Wastewater rich in nutrients



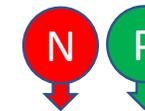
## Biomethane



## Water Re-use



## Bio-fertilizers



Images: Shutterstock

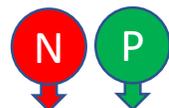
# 1 hectare cultivation



# 1 hectare cultivation

Bioestimulants and biopesticides;  
Antioxidants, peptides, fatty acids;  
Biofertilizers;  
Aquaculture;




 10 €/kg

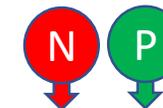
40-60 Ton/ year biomass

1000 m<sup>3</sup>/d WWT (0.2 €/m<sup>3</sup>)



950 m<sup>3</sup>/d reuse (0.3 €/m<sup>3</sup>)



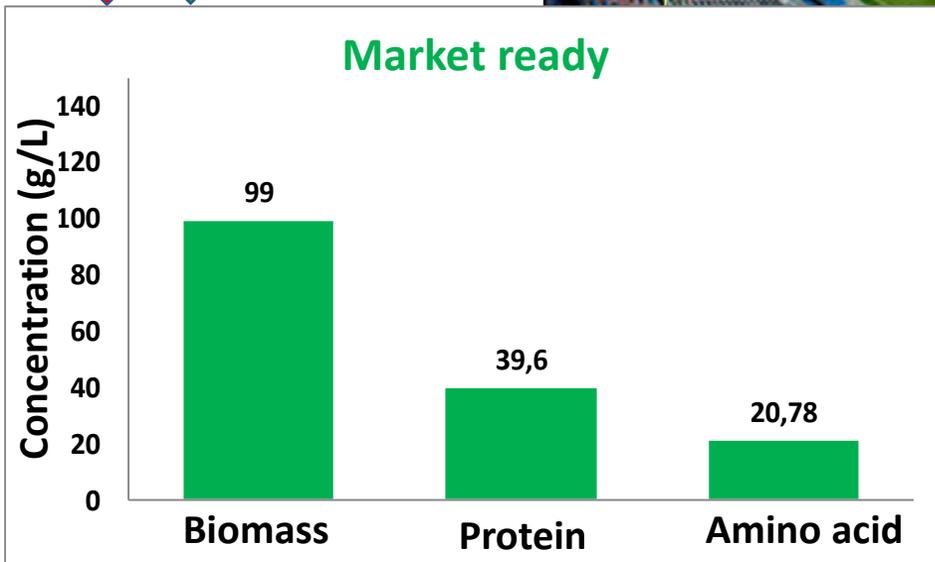




0.3 kWh/m<sup>3</sup> energy saving in WWT

106,800 kWh/year

100 Ton/ year



# Innovation in the water cycle

- Projects focus on the reduction/recovery of energy
- Decentralized treatments. Treatments at the source. Sewer mining.
- Nutrients recovery:
  - Water for reuse: Irrigation
  - Solid and liquid fertilizers from the treatment of concentrated streams
  - From the biomass/algae: bio fertilizers, bio stimulants...



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*Thank you for your attention*



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biosol  
water recycling



RUN4  
LIFE

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730285

