BIO-ACIDIFICATION PRIOR P PRECIPITATION FROM SLUDGE (OPTIMISED STRUVIA™)

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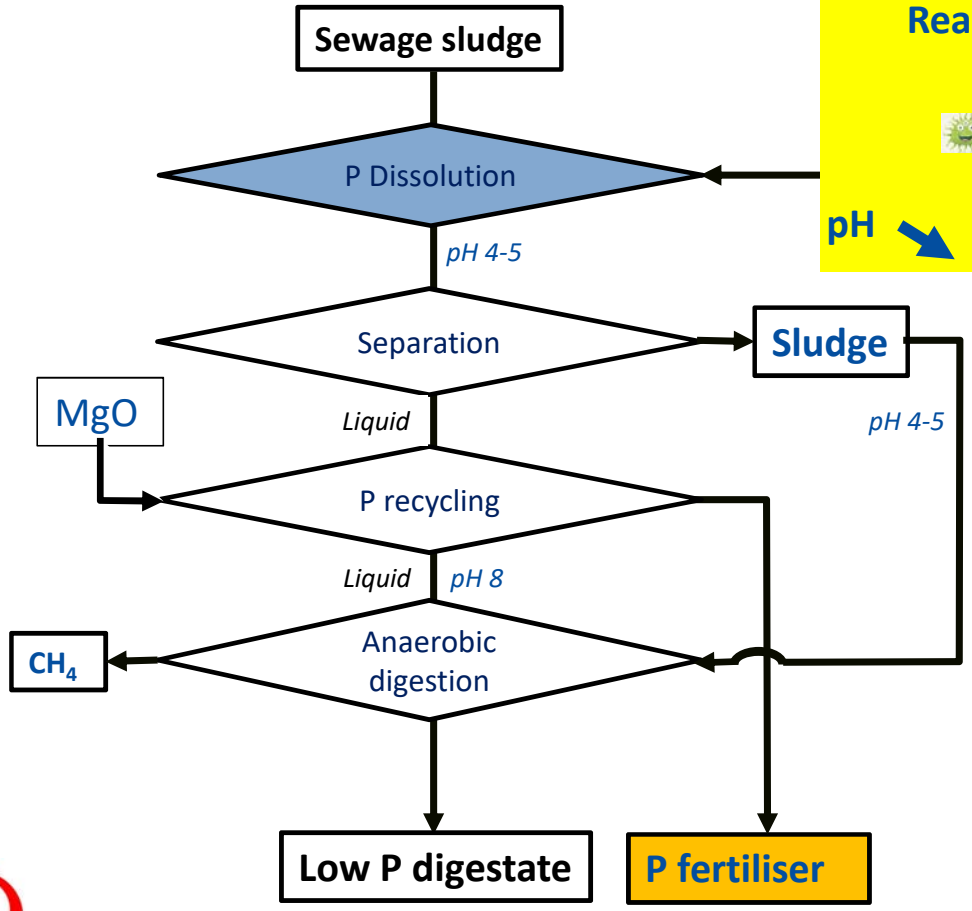
How does it work?

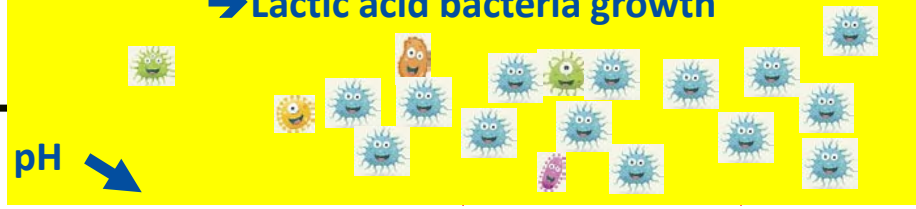
Endogeneous sludge bacteria are doing the job



Bio-acidification

Reactant = sugar rich waste or by-product

➔Lactic acid bacteria growth



Up to 75% of P dissolved in previous experiments(>> chemical pH1)

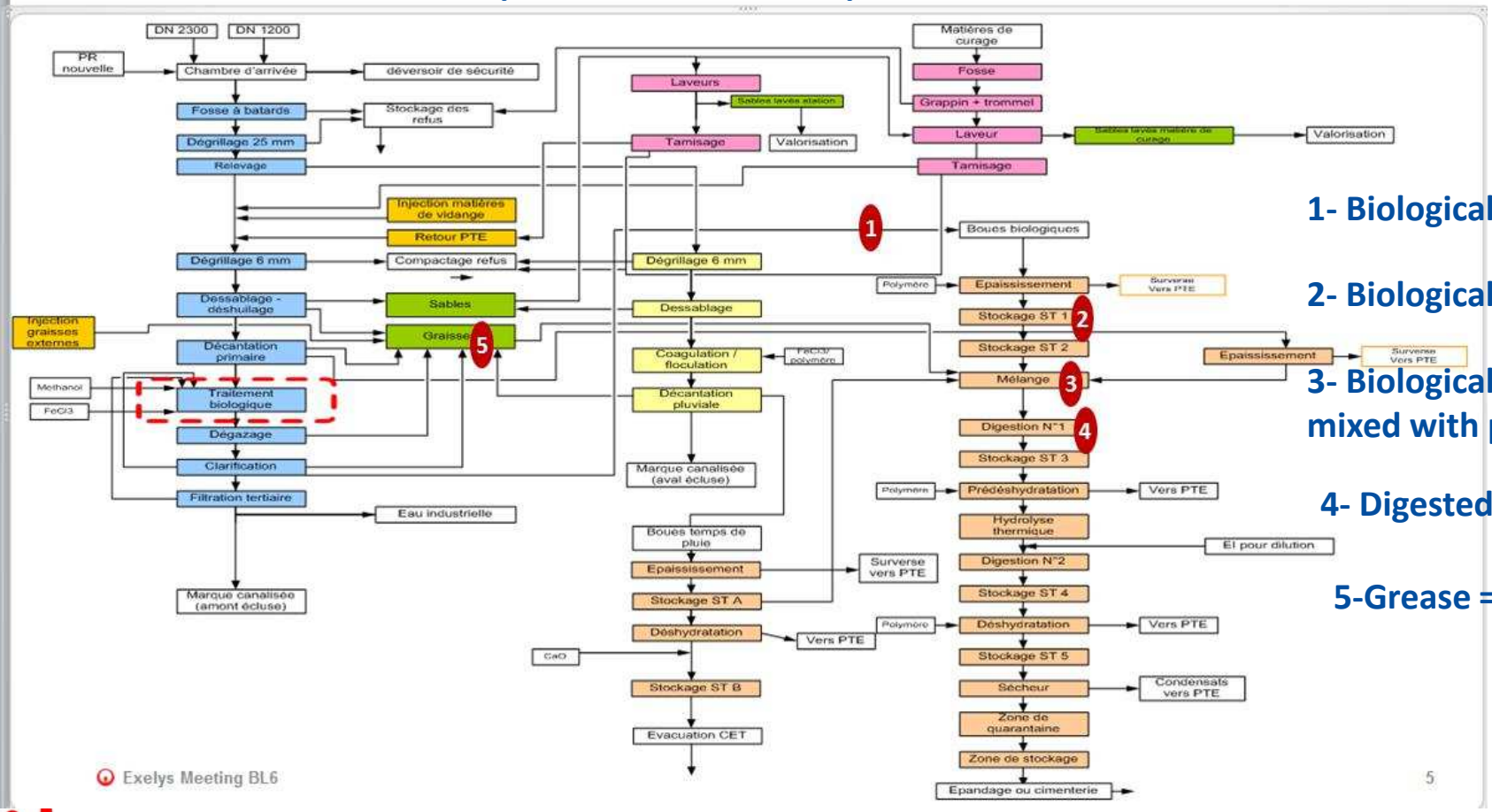
3 mechanisms expected

- P release by PAO thanks to fatty acids
- P salts (Fe or Ca) dissolution by pH decrease thanks to lactic acid production
- Reduction of Fe(III) to Fe(II) more soluble➔FeP dissolution

>90% of P in sludge-Struvite clogging in pipes and equipments

Demonstrator implementation: Where? Sampling for Labtest

Lille Marquette WWTP 600,000 p.e, EBPR+Al salts



1- Biological sludge before thickening

2- Biological sludge after thickening

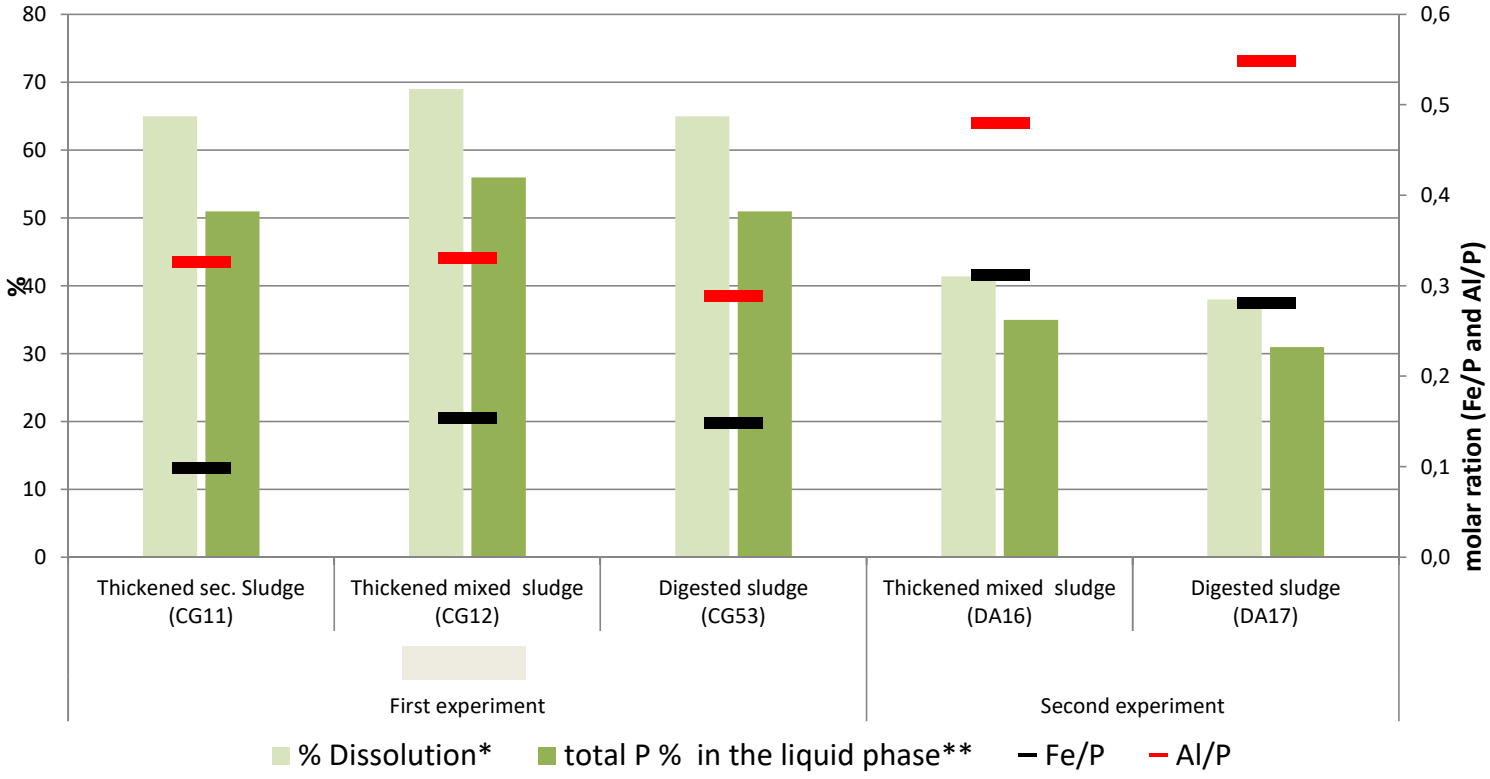
3- Biological sludge after thickening mixed with primary sludge

4- Digested sludge

5-Grease = co-substrates ?

Demonstrator implementation: where?

- Percentage of the dissolved P by bioacidification



Similar results with digested or non digested sludge
BUT

	Sugar		HCl 37 %	
	g / kg sludge	pH min	g_{HCl}/Kg sludge	pH min
MS1	11,6	4,1	2,0	4,1
DS1	17,7	4,6	4,4	4,1

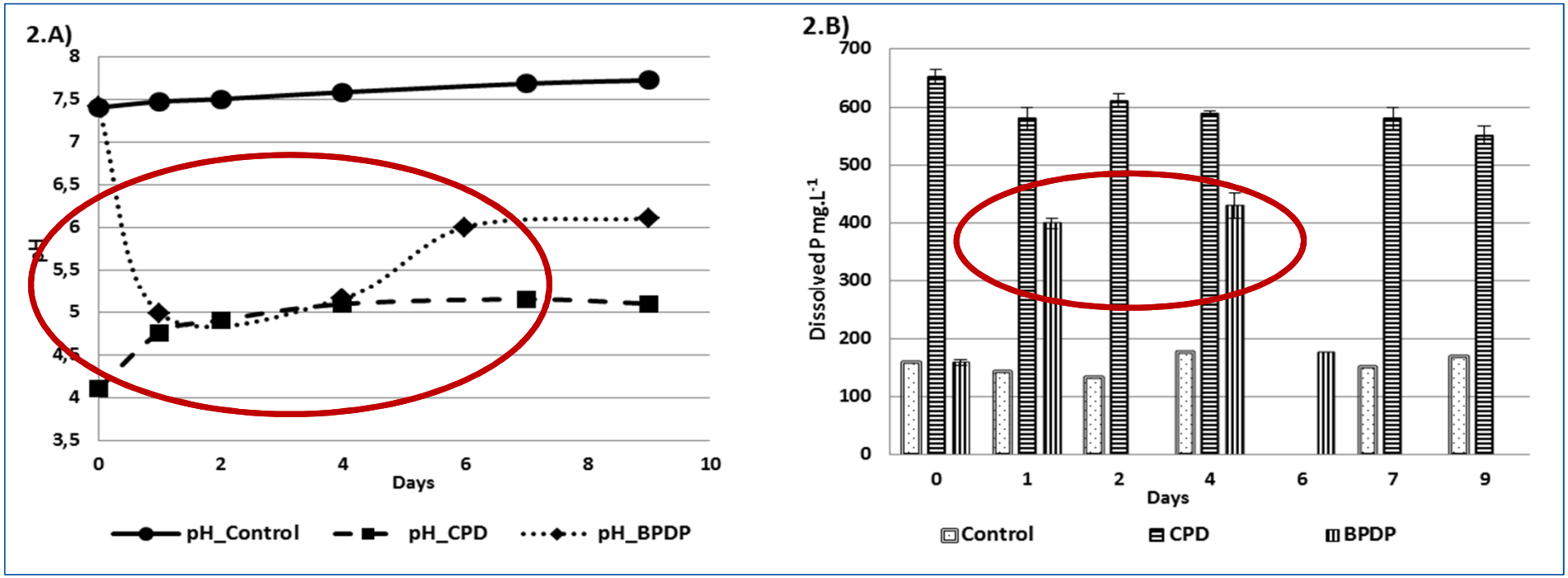
Much more reactant for acidification (bio or chemical)

The pilot will be upstream/ the digester

* % Dissolution= [Dissolved P]/[total P]

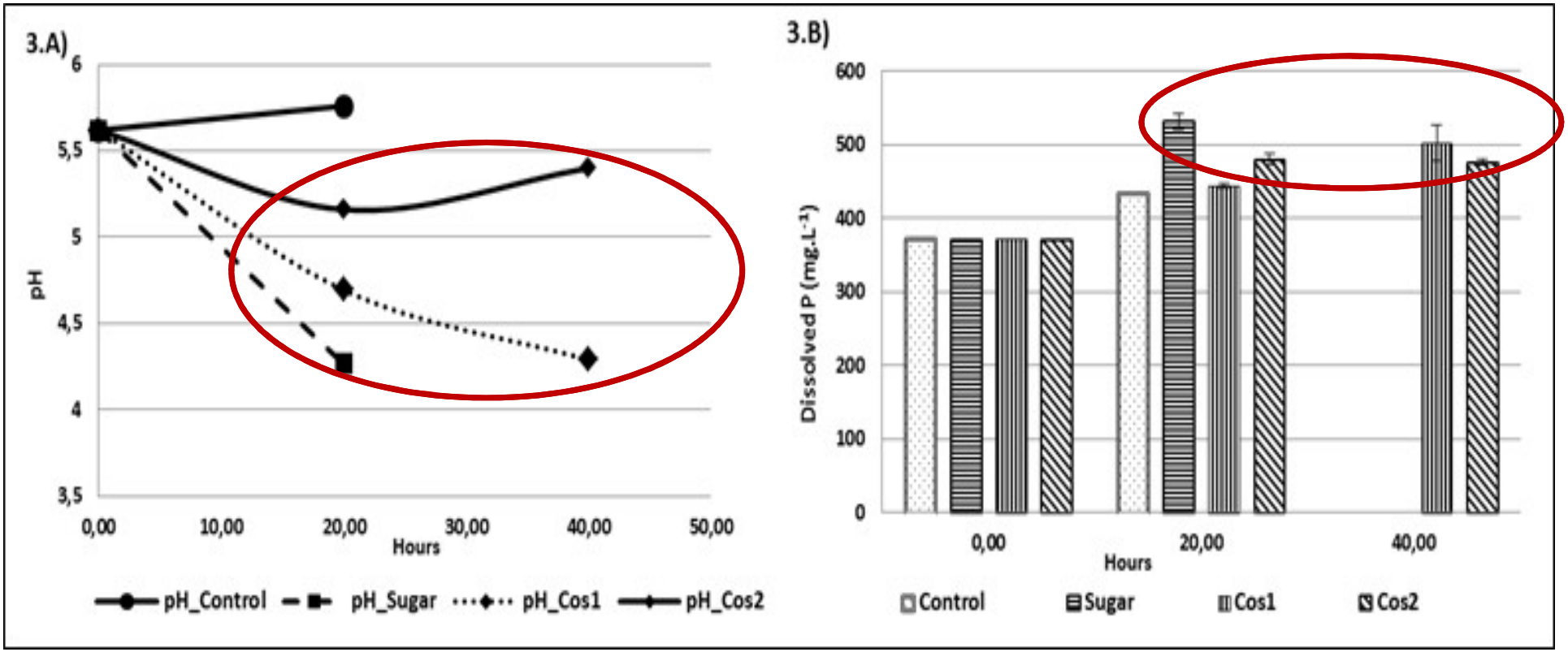
* Total P in the Liq= [Dissolved P] l_{iq} * M_{liq}+ [Dissolved P]$_{solid}$* M_{solid} /[total P]*(M_{liq}+M_{solid}),
While: M_{liq} is Mass of the liquide phase and M_{solid} is the Mass of the solide phase

Demonstrator implementation: How long?



24-72h were sufficient to dissolve P

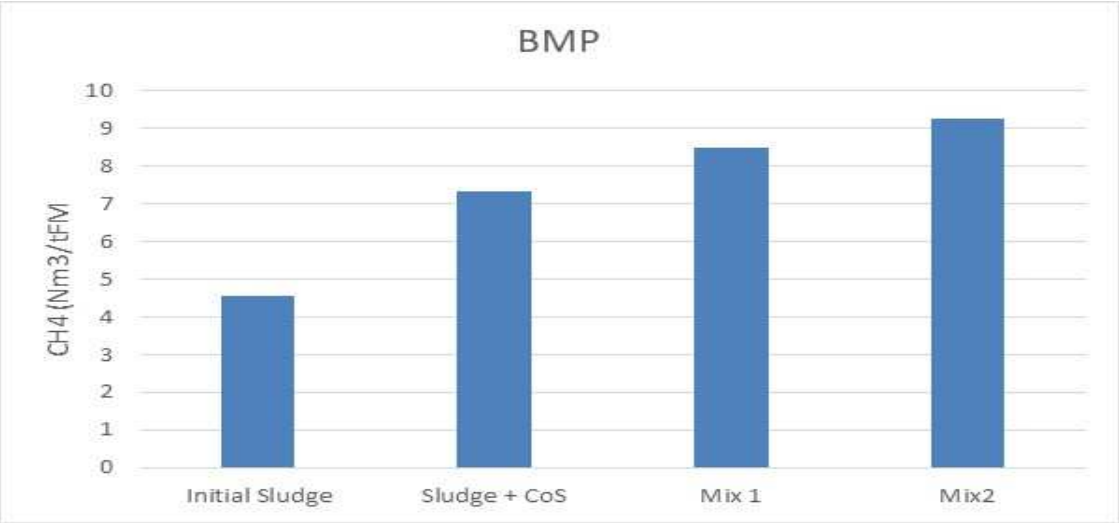
Demonstrator implementation: Which co-substrate?



CoS1- modified starch sold for denitrification; CoS2: industrial food waste

A food industry co-product can be used as a co-substrate

Demonstrator implementation: Impact on sludge valorization?



	Limiting factor	M³/ha
Without P recovery	P	50
With P recovery	N	80

The biomethanogenic potential is increased (X2) due to the co-substrate and of the hydrolysis of the sludge

The spreading area is reduced (-40%)

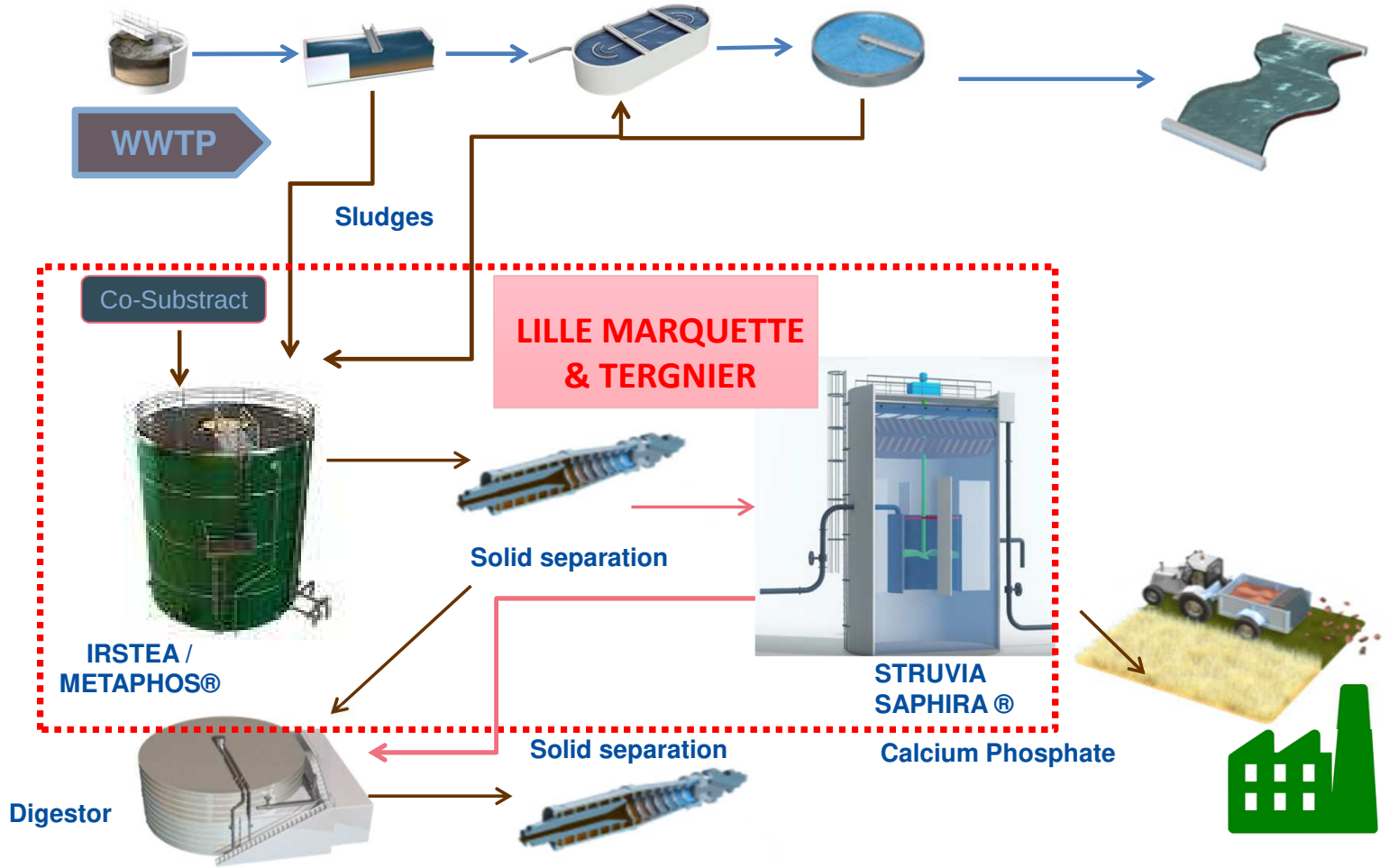
Interreg North-West Europe
Phos4You
European Regional Development Fund

Much more work about iron recovery, continuous/semi continuous process, dark fermentation for P recovery combined with H2 or specific molecules production, modeling…
See the technical report

Now
Demonstrator ready to go!

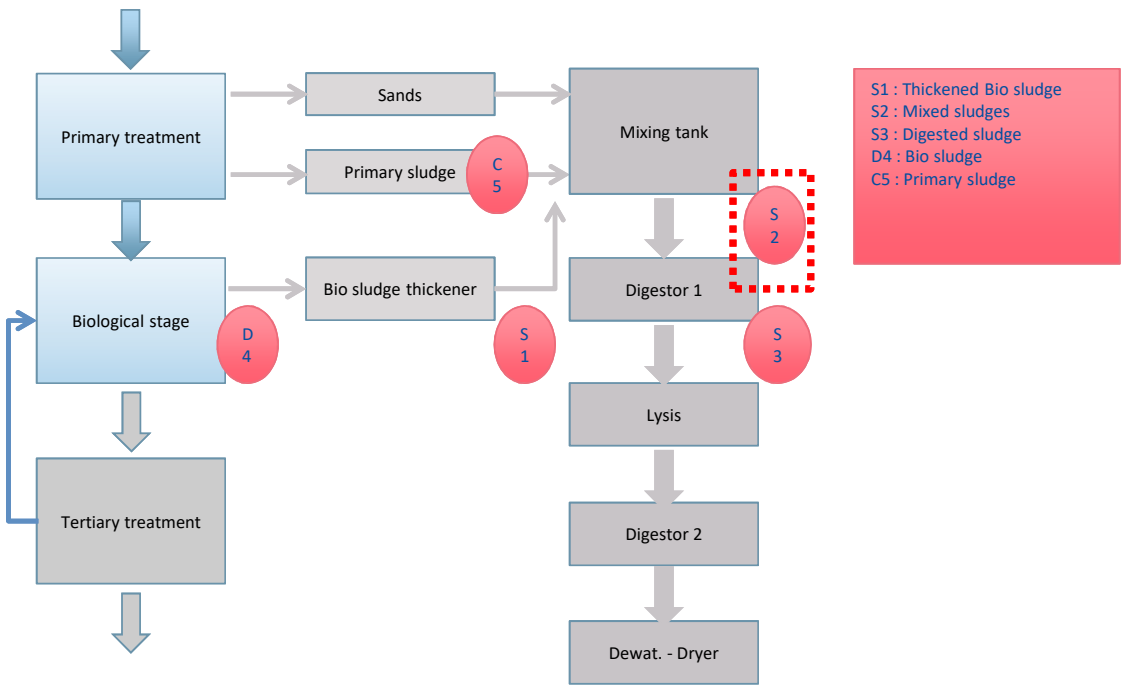
INRAE

WWTP Schematic

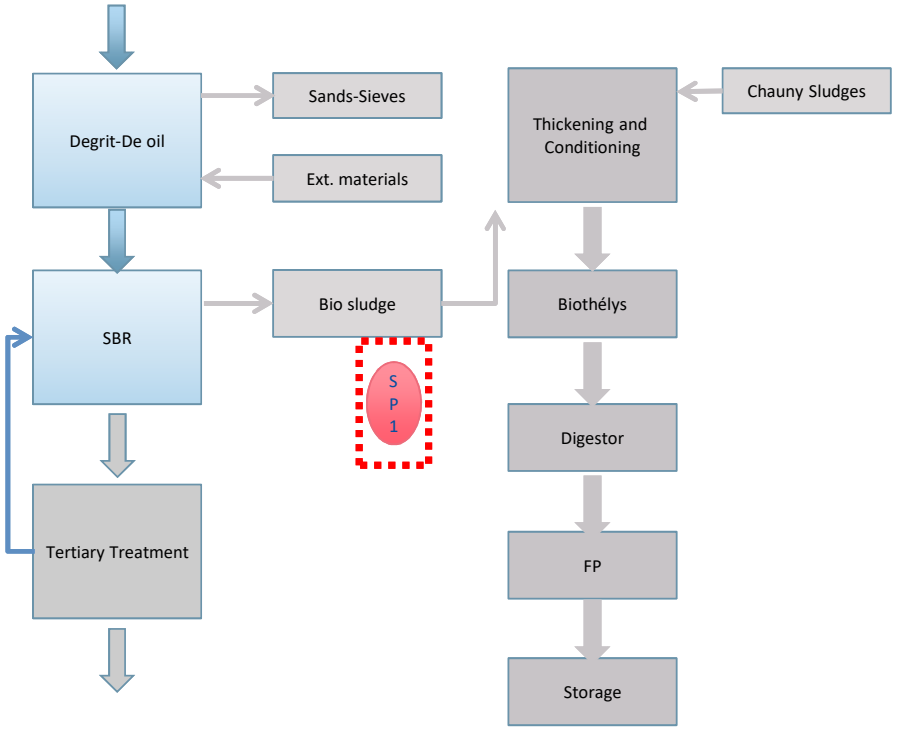


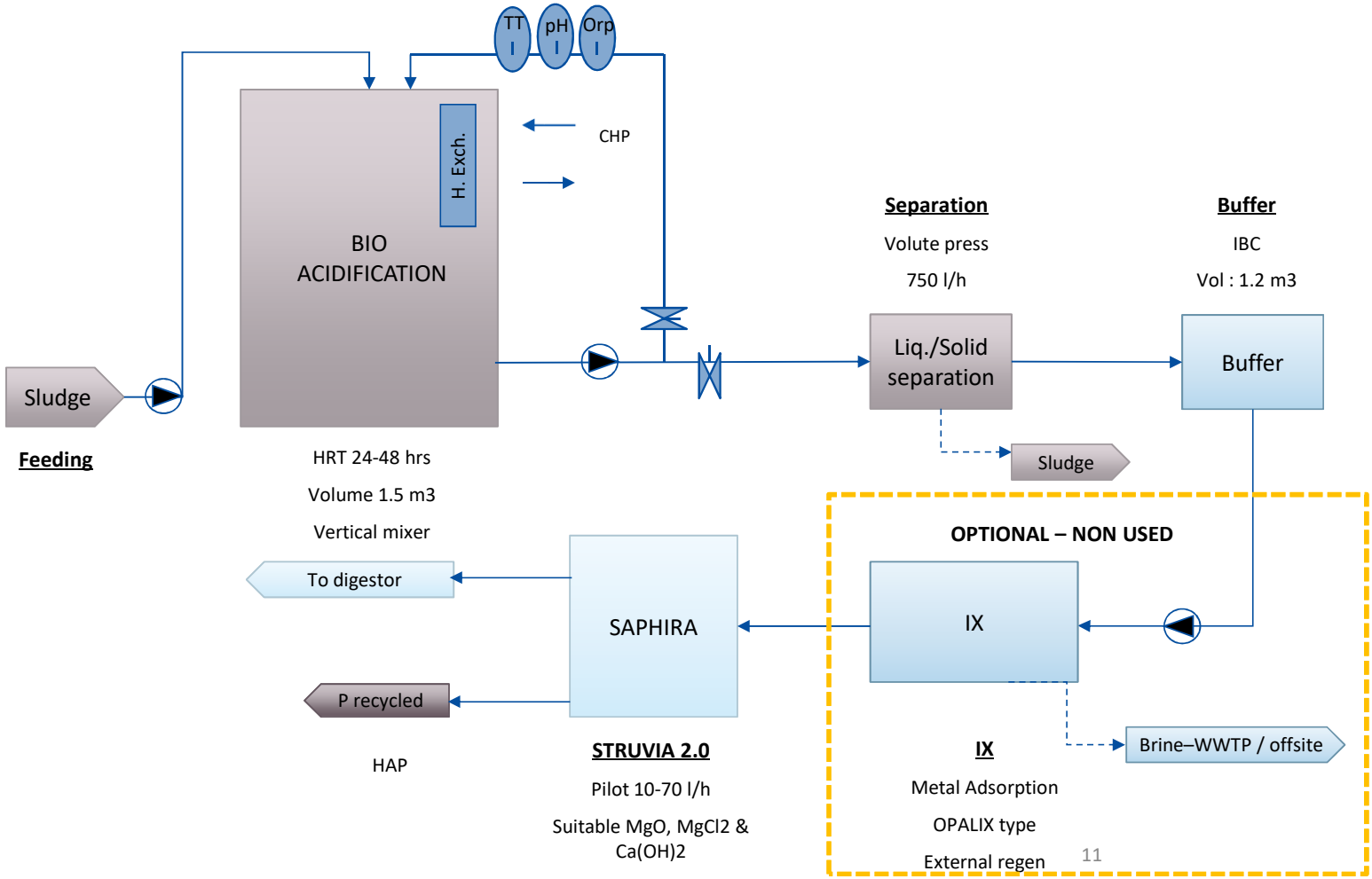
- Sludges' sample have been collected on Lille Marquette plant, at different treatment stages :

BIO – P WWTP: LILLE LEZ MARQUETTE

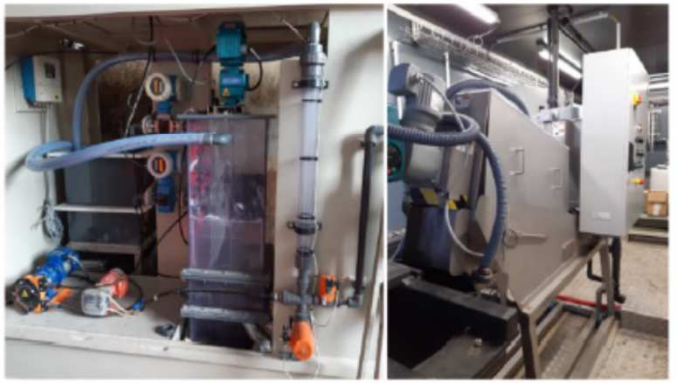


PHYSICO-CHEMICAL P WWTP: TERGNIER

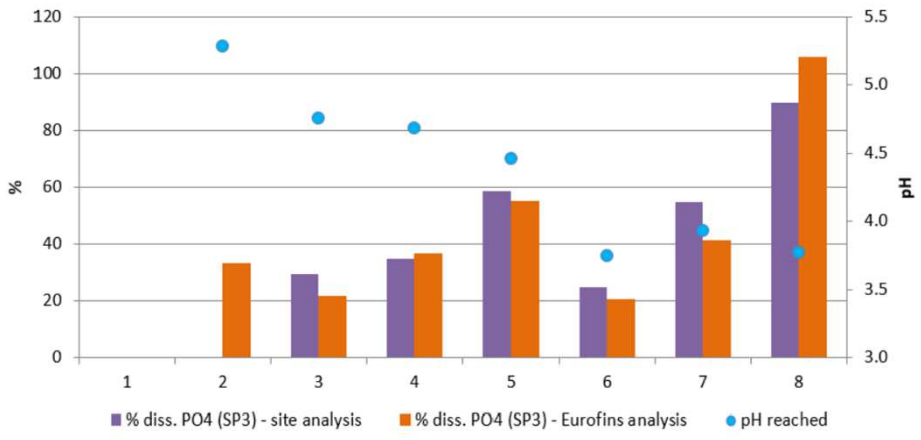
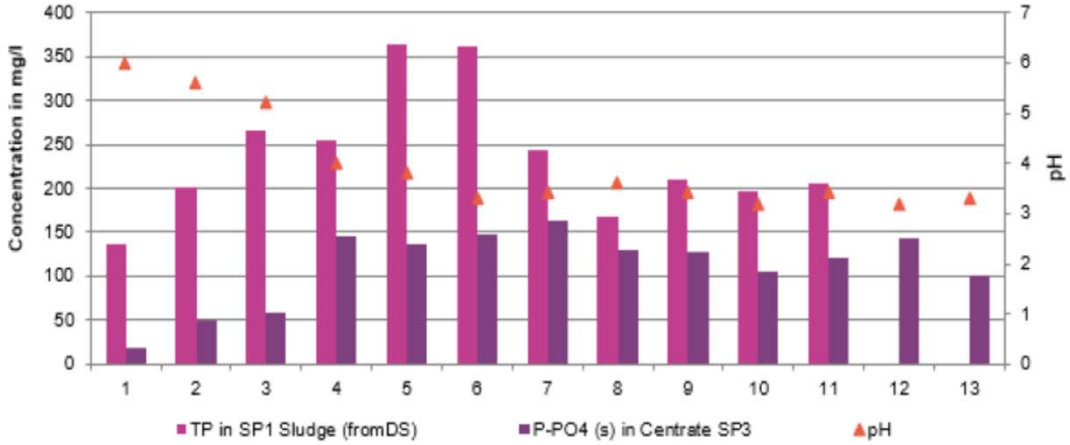



TT
pH
Orp
H. Exch.
CHP
BIO
ACIDIFICATION
Sludge
Feeding
HRT 24-48 hrs
Volume 1.5 m3
Vertical mixer
Separation
Volute press
750 l/h
Liq./Solid
separation
Buffer
IBC
Vol : 1.2 m3
Buffer
Sludge
OPTIONAL – NON USED
IX
Brine–WWTP / offsite
IX
Metal Adsorption
OPALIX type
External regen
To digestor
SAPHIRA
P recycled
HAP
STRUVIA 2.0
Pilot 10-70 l/h
Suitable MgO, MgCl2 &
Ca(OH)2

In Marquette-lez-Lille



In Tergnier

BIO – P WWTP: LILLE LEZ MARQUETTE	PHYSICO-CHEMICAL P WWTP: TERGNIER
	
HRT= 20 to 60 hrs	
Co-Substrate dosing rate= 1 to 1.3 gCOD/gVS (active material)	
pH = 3.5 to 4 for optimum P release	
BioAcidification efficiency: up to 75% P release Overall P recovery (Bio-Sep-Cristal.): est. 54%	BioAcidification efficiency: 48 to 54% P release on chem sludge Overall P recovery (Bio-Sep-Cristal.): est. 40%

Tergnier (60KPE)	Struvite	HAP (14% P2O5)
Chemical		
o Lime	0	640 kg/d @ 92%
o MgCl2	1100 kg/d @ 32%	0
o NaOH	380 kg/d @ 30%	0
o Polymer	47 to 63 kg/d pure	47 to 63 kg/d pure
Sludge		
o Kg DS/DS produites	608 kg/d as struvite	1700 kg DS/j
o Dryness	85%	40%
Chemical & Energy cost		
o OPEX out of poly	279 EUR/d (150*1.1+0.38*300) Not considering NH4 addings	76.8 EUR/d (0.64*120)
Selling Cost		
o Revenue	79 EUR/d @ 130 eur/t (20 eur transport)	5 EUR/d @ 130 eur/t (20 eur transport)

Figure 3.3.14: P-product crystals after washing.

- Most « valuable and economical » product is HAP in this configuration
- Energy and fossil fuel recovered through Biogas extra production (90% recovery of co-substrate)
- Production of HAP reusable as a filler for blending industry or as raw material for chem P production

Economical balance: summary

- Calculation based on a 100 KPE Bio P WWTP

BioAcido Balance	Unit	Waste
Digestor CAPEX savings	[EUR]	0
Reduced ferric chloride consumption	[EUR/d]	95
Co-subtract consumption	[EUR/d]	-210
Lime consumption	[EUR/d]	-77
PAM consumption	[EUR/d]	-117
HAP-struvite sales income	[EUR/d]	9
BioAcido electricity costs	[EUR/d]	
Savings on Fe solution recycled	[EUR/d]	
Extra biogas sales income	[EUR/d]	318
Potential Fe recycled to process	[EUR/d]	5
Operational savings	[EUR/d]	23
Operational savings	**[EUR/y]**	**7,702**

- Co-substrate and polymer costs are balanced through biogas production and revenues (reuse of waste food product)
- No « by product » nor « difficult-to-sell » products
- Low grade product indeed, but fully reusable with no fossil fuel nor chemical extensive process

Conclusion

- HIGH REPLICABILITY AND ACCURACY BETWEEN LAB TEST AND ON-SITE TRIAL'S RESULTS
- EASY MODELLISATION AND SCALE-UP
- LOW CAPEX SYSTEM FOR MEDIUM SIZED WWTP NOT HAVING MONO-INCINERATION SYSTEM
- NO EXTRA WASTES GENERATED (NO « WET ASHES » NOR « BY-PRODUCTS » TO HANDLE)
- LOW ENERGY CONSUMPTION (REUSE OF WASTE PRODUCT FOR BIOGAS RECOVERY USE AND SELL)
- LIMITED IMPACT ON WWTP SCHEME, NO ADDED BURDEN TO CURRENT OPERATION AND NO CRITICITY IF UNAVAILABLE