



Scale-up of low-carbon footprint material recovery
techniques in existing wastewater treatment plants
“SMART-Plant”

H2020 ULTIMATE seminar: Nutrient and biobased fertilizer recovery within H2020 SMART-Plant project

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Proud Partner of SMART Plant project



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of the European Union



Scale-up of low-carbon footprint material recovery techniques
in existing wastewater treatment plants
"SMART-Plant"



H2020-SC2-RUR-08B-2019 BBF and
TMF from animal manure (Coordinator)



H2020-MSCA-ETN-2018 (2
ESR Fellows). P-Recovery and
BBF production from dairy
industries (VWP Leader)



H2020-SC5-Water I b-2015
BBF production



H2020-SC2-RUR-08C-2020
BBF and TMF from fisheries
and aquaculture. (VWP Leader)



ENI-CBC-MED-2018
Community composting for
OFMSW recycling (Coordinator)



H2020-CE-SPIRE-07-2020.
Nutrient recovery and BBF and
biostimulants production from
food industries (VWP Leader)

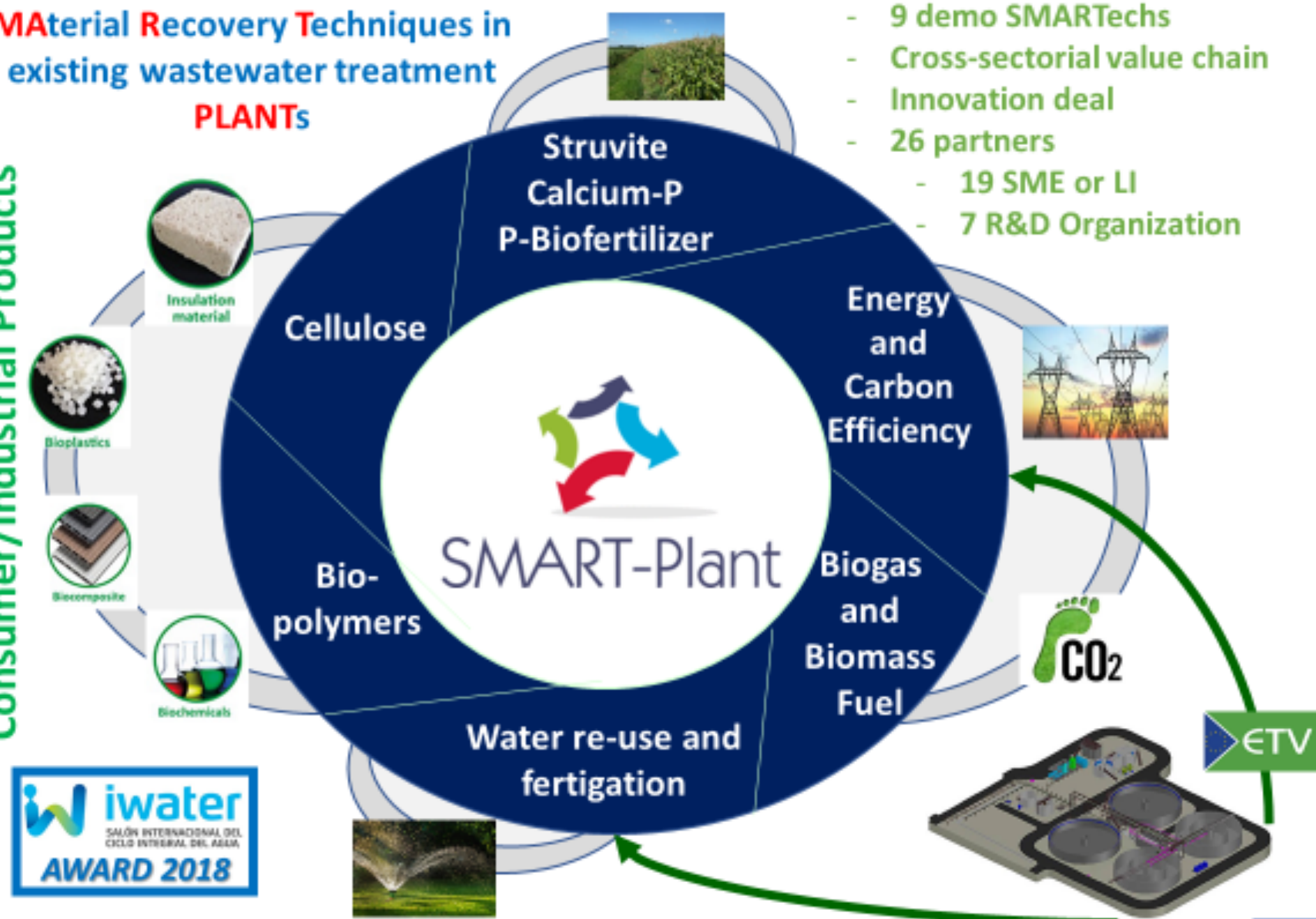


Scale-up of low-carbon footprint
MATERIAL RECOVERY TECHNIQUES in
existing wastewater treatment

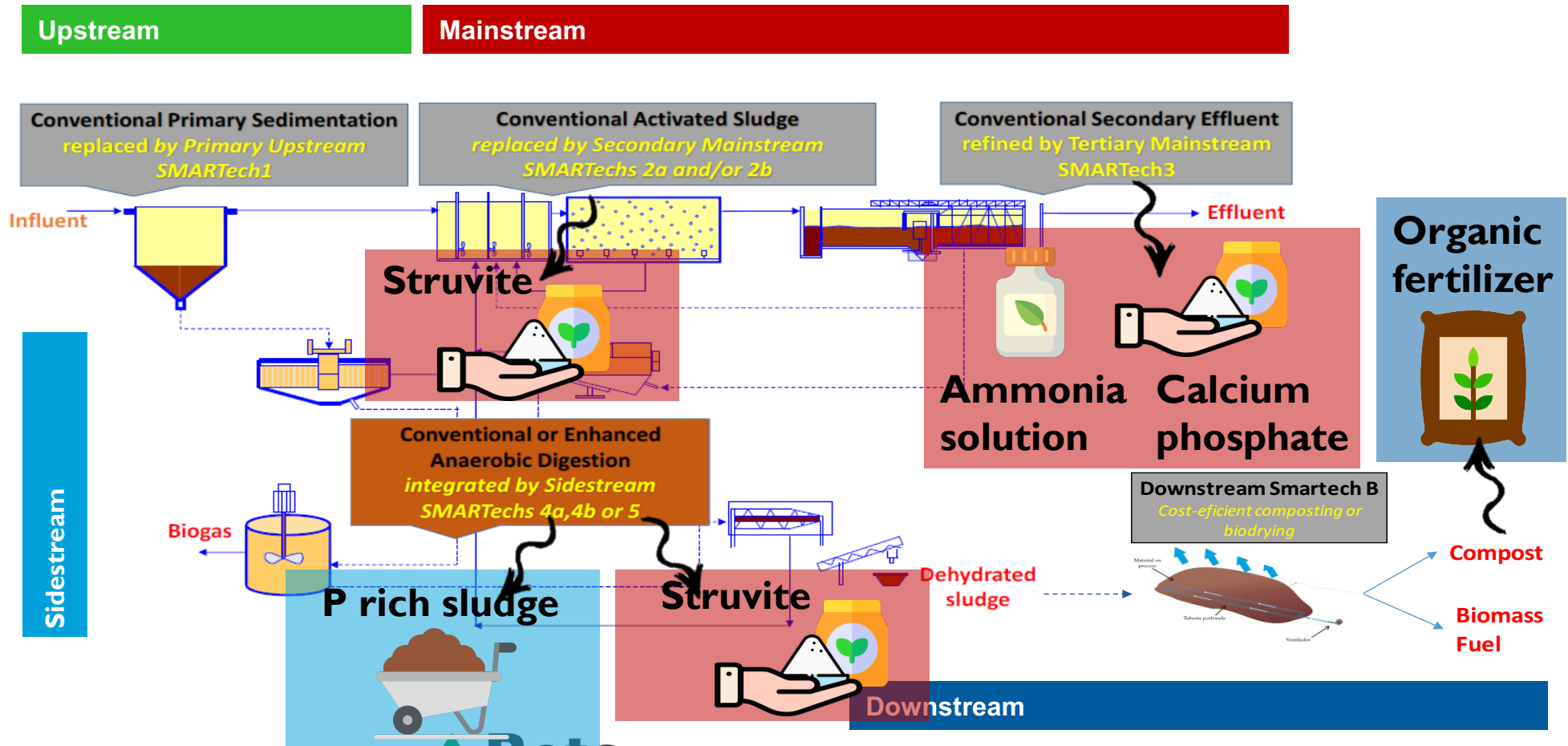
PLANTS

- Horizon2020 IA
- 9 demo SMARTechs
- Cross-sectorial value chain
- Innovation deal
- 26 partners
 - 19 SME or LI
 - 7 R&D Organization

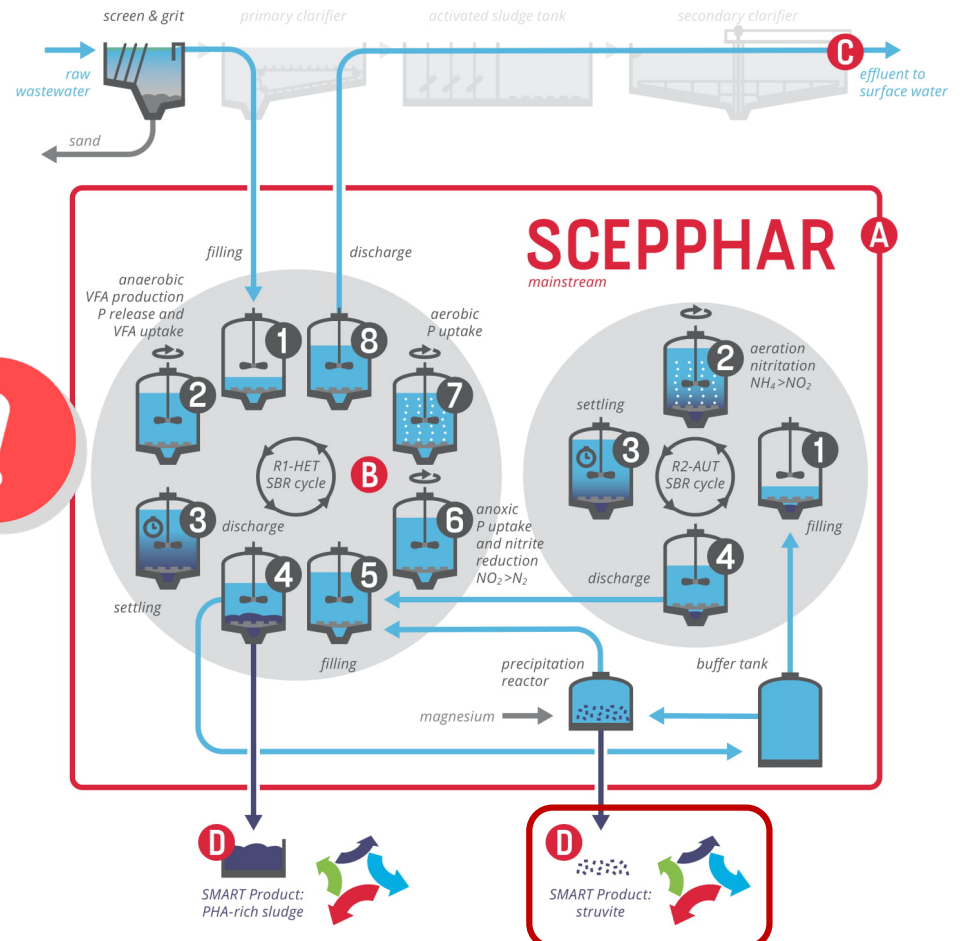
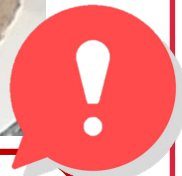
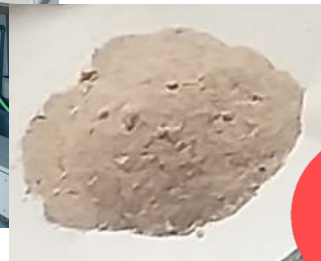
Consumer/Industrial Products



Nutrient recovery within SMART Plant



SMARTech 2b: mainstream SCEPPHAR



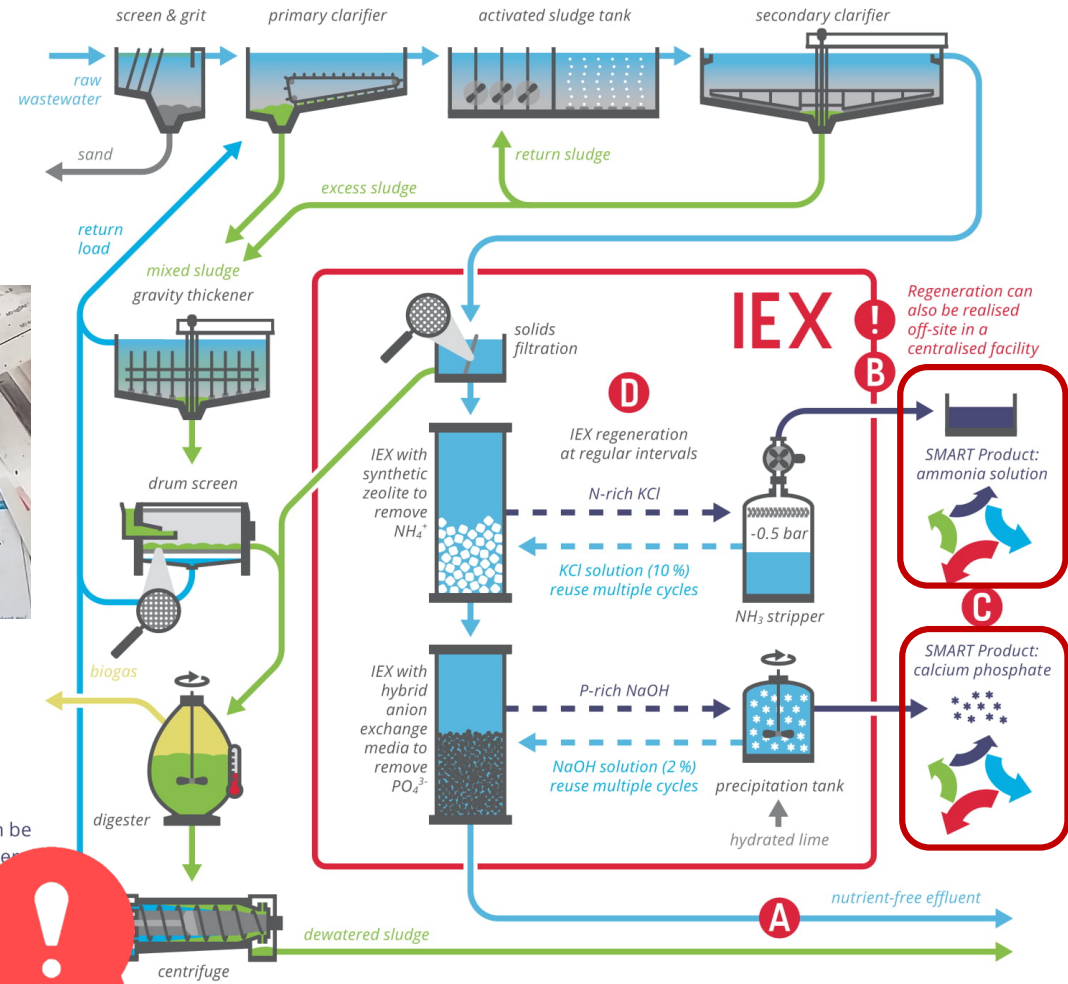
Unique Selling Points

- A** Reduced energy demand and operational costs
- B** No external carbon source or metal salt needed
- C** High effluent quality (P < 1 mg/L, N < 10 mg/L)
- D** Recover 50% of phosphorus as struvite and sludge with 30% PHA content



86% N removal
96% P removal
6.6g/m³ struvite production

SMARTech 3: IEX



Unique Selling Points

- A** Achieves tight nutrient discharge limits by removing NH_4^+ and PO_4^{3-} to very low concentrations (< 5 mg N/L and < 0.5 mg P/L)
- B** High recovery rates: up to 97% of ammonia and 95% of phosphorus
- C** High quality products which can be used in the chemical and fertilizer industry
- D** Multiple use and recovery of regenerants leading to an economically feasible IEX technology in the wastewater industry

92% of NH_4 recovery



95% of P recovery as CaPO_4

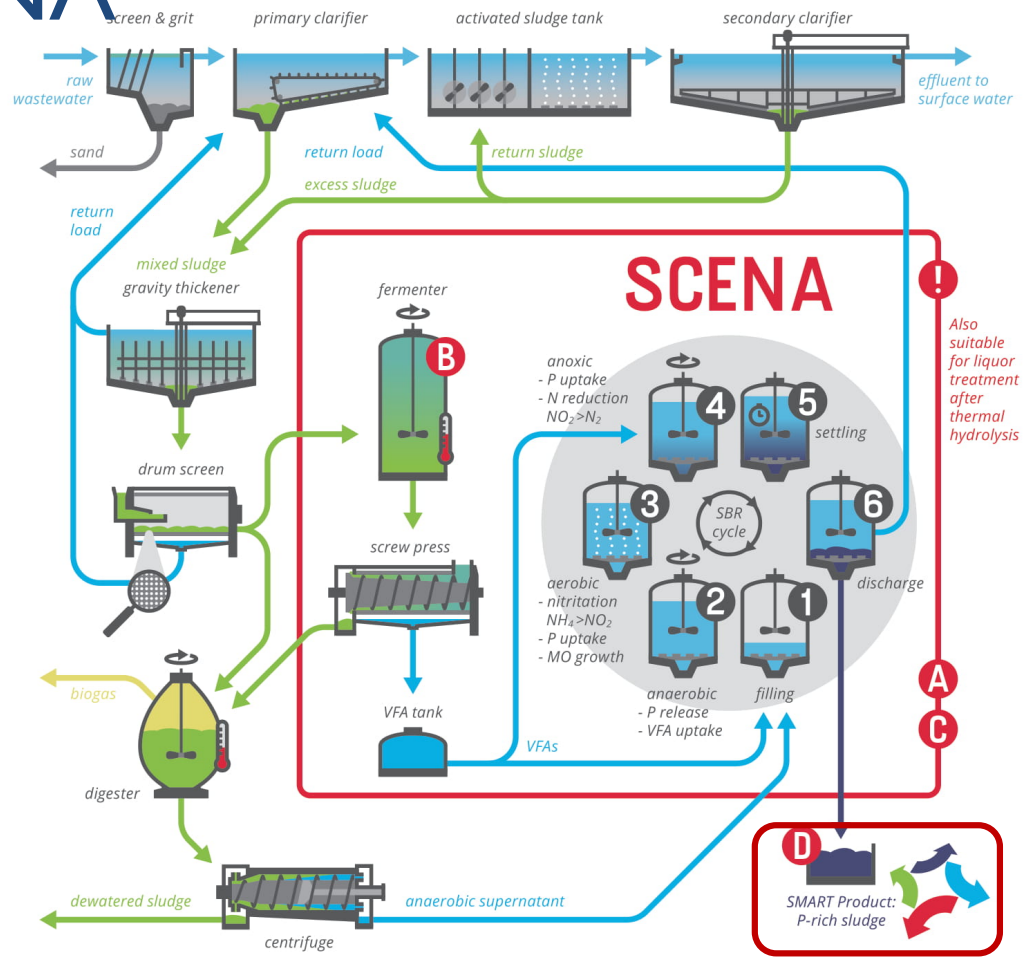


SMARTech 4a: SCENA

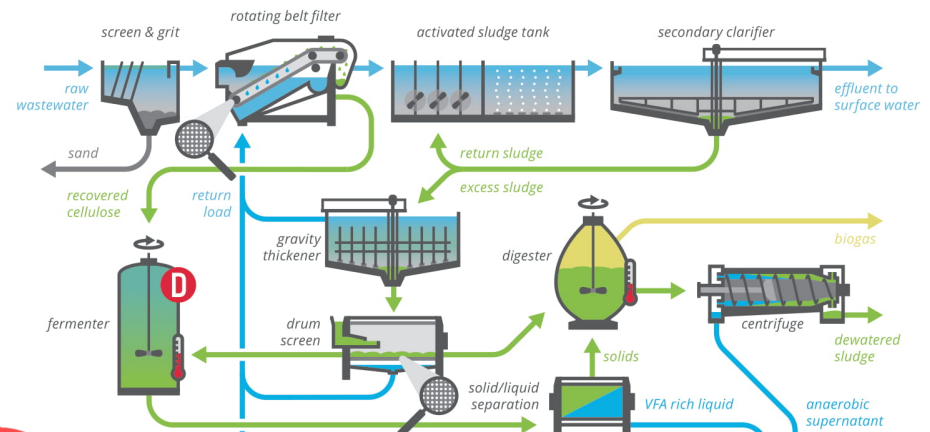
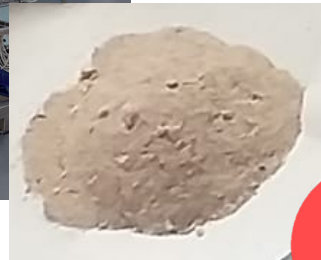
92% of P removal and recovery through P rich biomass. Dewatered SCENA sludge contains up to 5% (d.b) phosphorus



- Unique Selling Points**
- A** Low-energy nutrient removal from sludge liquor
 - B** Biological N and P elimination without chemicals or external carbon source
 - C** Stable and robust operation compared to other biological processes
 - D** P-rich sludge can be valorized as organic fertilizer



SMARTech 5: sidestream SCEPPHAR

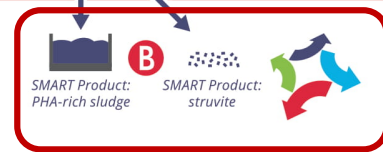
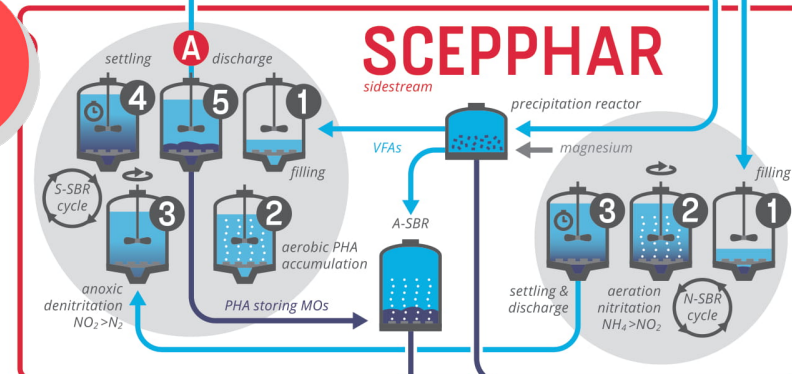


Unique Selling Points

- A** High effluent quality due to effective N removal from sludge liquor
- B** Recovery of valuable products (PHA, struvite)
- C** Reduction of energy and operational costs
- D** Carbon source (VFA) for PHA production is gained in the process



85% P removal
225 g/d struvite
production



Unique Selling Points

Downstream SMARTechB



Unique Selling Points

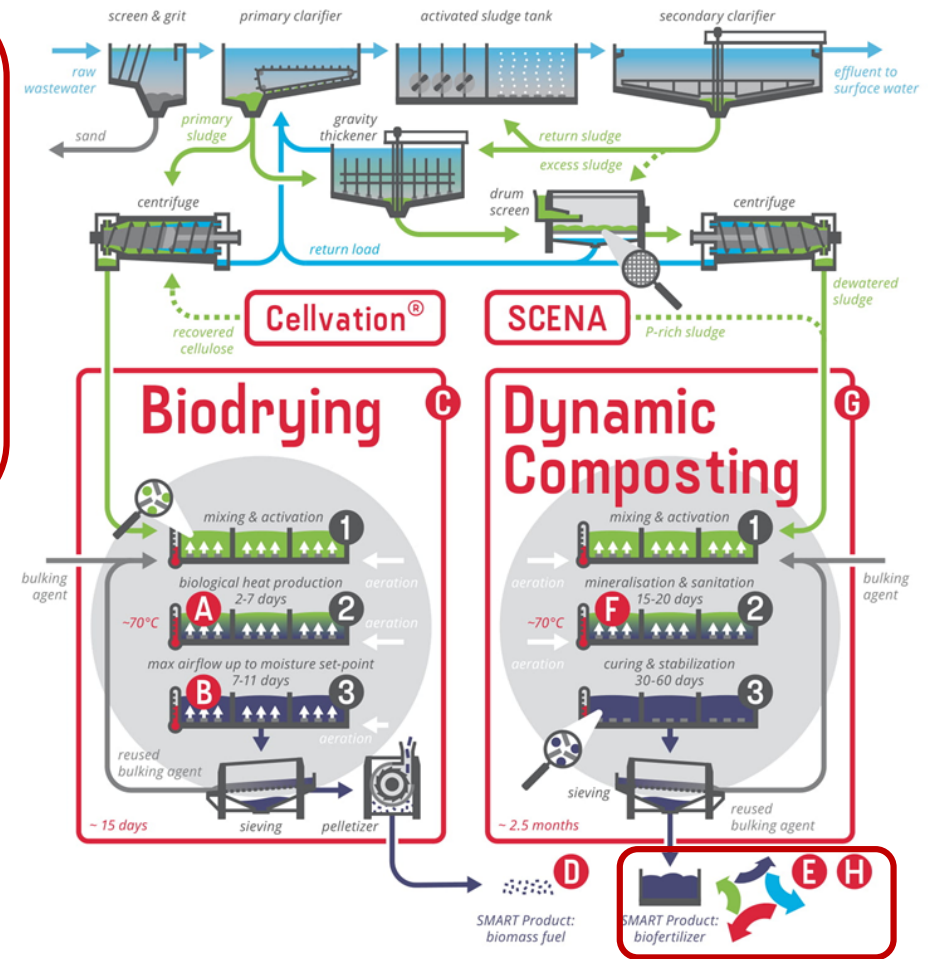


Compost SMART Biofertilizer
 Sustainable
 > 5%* N
 > 5%* P
 ~1%* K
 DRI < 1 gO₂.kgVS⁻¹
 AT4 < 50 gO₂.kgVS⁻¹

Satisfactory agricultural performance demonstrated



- E** Production of a biofertilizer with high stability + N and P content up to 5% DM
- F** Advanced aeration control for an optimal organic carbon mineralization by maximizing the biological activity
- G** Reduction of GHG emissions and energy consumption for aeration
- H** Opportunity for tailor made fertilizers

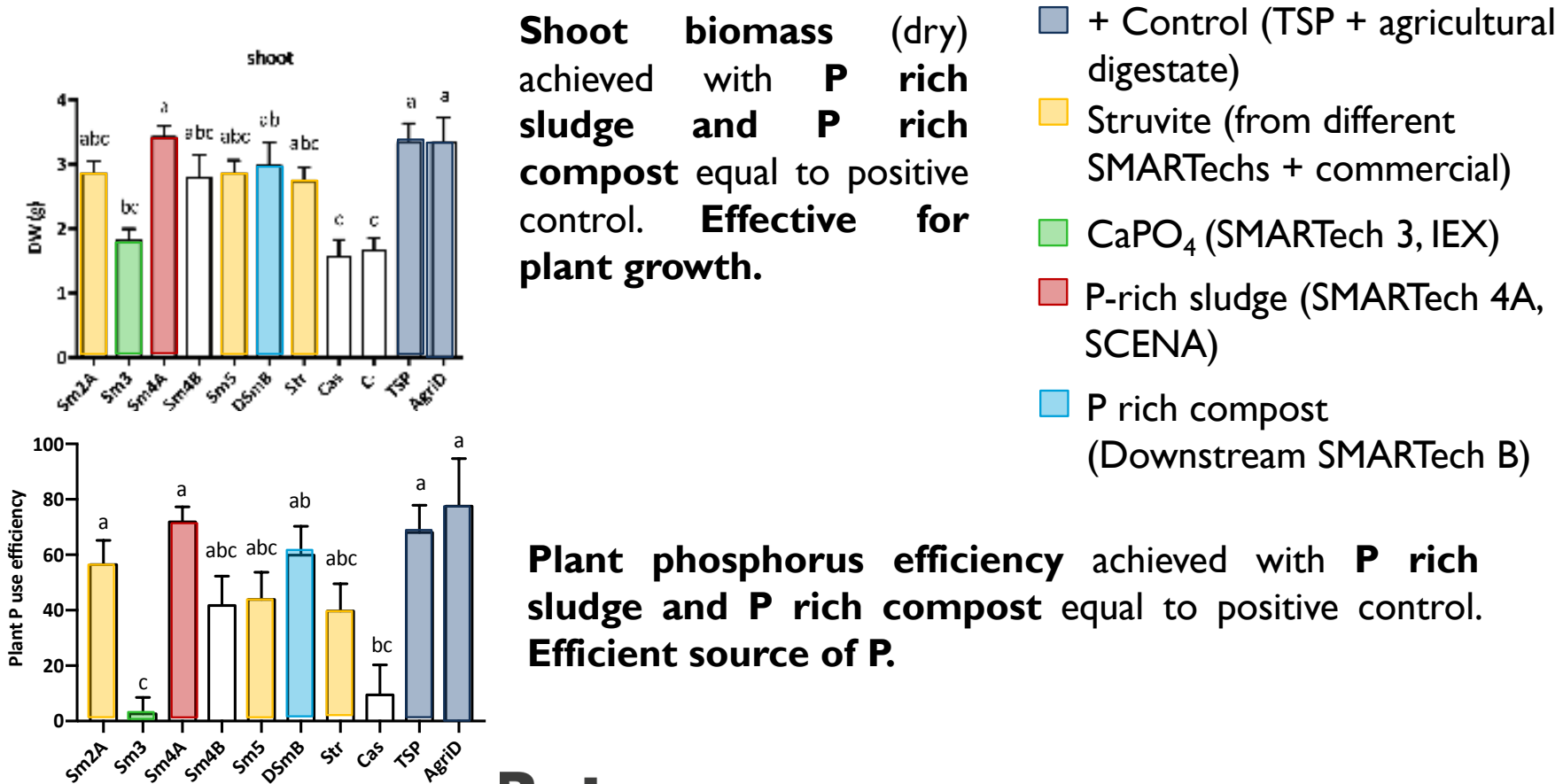


Quality of SMART BBF/fertilising products

- In terms of:
 - **Agronomic value:** agronomic test in pot and open field
- Safety of products:
 - Heavy metals
 - Polycyclic aromatic hydrocarbons (**PAH**)
 - **Cloroalkanes**
 - **Pesticides** (108 polluting molecules)
 - **PPCP** (including antibiotics, pesticides, and estrogens) (15 substances included in 2018 EU watch-list).



Agronomic value: agronomic test in pot












Safety of fertilising products: emerging pollutants

- Sum of 16 PAH:
 - **None** of the products **exceeds** the most stringent value established in different EU regulations (3 mg PAH/ kgTS)
- Pesticides:
 - **6 pesticides detected** out of 108, only in CaPO₄ and struvite
 - Values slightly higher than the most restrictive values of the maximum residue level tolerated in food (Reg. EC 396/2005)
- PPCP:
 - **5 PPCPs quantified** out of 15: Clarithromycin, Azythromycin, Ciprofloxacin, Imidacloprid, Estrone.
 - **Lower PPCP concentrations** in **mineral** fertilisers compared to organic fertilisers
 - **Dynamic composting** is able to **reduce PPCP** concentration in sludge

Safety of fertilising products: Heavy metals Regulation 2019/1009

**86 / 278 / CEE

Use of sludge in agriculture

SMART Product	SMARTech	Fertilising product	Category
Struvite 	SMARTech 2b (SCEPPHAR) & SMARTech 5	Solid mineral, P as sole primary macronutrient	PFC 1 (C) 
Ammonia solution 	SMARTech 3 (IEX)	Liquid mineral, N as sole primary macronutrient	
Calcium phosphate 	SMARTech 3 (IEX)	Solid mineral, P as sole primary macronutrient	PFC 1 (C) 
P rich sludge 	SMARTech 4A (SCENA)	Solid organic, NP as primary macronutrients	**
P rich compost 	Downstream SMARTechB	Solid organic, NP as primary macronutrients	PFC 1 or PFC 3 

Regulatory barriers for SMART recovered nutrients

- Sewage sludge is **not included as input material** for compost in **fertilising products European regulation** (2019/1009 and previous 2003/2003)
- Although, its **inclusion** was **proposed** in the **end-of-waste criteria** for biodegradable waste subjected to biological treatment

CMC 3: COMPOST

1. An EU fertilising product may contain compost obtained through aerobic composting of exclusively one or more of the following input materials:
 - (a) bio-waste within the meaning of Directive 2008/98/EC resulting from separate bio-waste collection at source;
 - (b) derived products referred to in Article 32 of Regulation (EC) No 1069/2009 for which the end point in the manufacturing chain has been determined in accordance with the third subparagraph of Article 5(2) of that Regulation;
 - (c) living or dead organisms or parts thereof, which are unprocessed or processed only by manual, mechanical or gravitational means, by dissolution in water, by flotation, by extraction with water, by steam distillation or by heating solely to remove water, or which are extracted from air by any means, except:
 - the organic fraction of mixed municipal household waste separated through mechanical, physicochemical, biological and/or manual treatment,
 - **sewage sludge, industrial sludge or dredging sludge, and**
 - animal by-products or derived products falling within the scope of Regulation (EC) No 1069/2009 for which no end point in the manufacturing chain has been determined in accordance with the third subparagraph of Article 5(2) of that Regulation;
 - (d) composting additives which are necessary to improve the process performance or the environmental performance of the composting process provided that:
 - (i) the additive is registered pursuant to Regulation (EC) No 1907/2006 (?), with a dossier containing:
 - the information provided for by Annexes VI, VII and VIII to Regulation (EC) No 1907/2006, and

European fertilising products regulation 2019/1009

Barriers for SMART recovered BBF

- **Market competition:**
 - Fossil fertilising products
 - Cost of current mineral fertilisers
 - Manure based fertilising products



Opportunities for SMART recovered BBF

- **Opportunity for decentralised production (near of the end-users)**
- **WWTP turning into biorefineries → added value production/crossing value chains**
- **Renewable and sustainable**
- **Job opportunities**
- **Upgrading to tailor made fertilisers (reducing heterogeneity, improving delivery, etc)**

Comparative economic study

Supported by the Framework Programme
Horizon2020 under the grant agreement n°690323



SMART biofertilizer






Compost from
conventional sludge



Compost from MSW



Manure compost

	SMART biofertilizer	Compost from conventional sludge	Compost from MSW	Manure compost
NPK 	>5%N >5% P >1%K	1.4-2.7%N 0.4-0.9% P	1.5- 2.1%N 0.6-0.9%P	2- 2.5%N 2-2.5%P 2-2.5%K
consumption 	100- 160 kwh/t _{sludge}		160-250 kwh/t _{OFMSW}	
price 	30-40€/tn	11-23 €/tn	20-35 €/tn	19-28 €/tn



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ANY QUESTIONS?



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