ASSOCIAZIONE ITALIANA PER LA RICERCA INDUSTRIALE

GIORNATA AIRI PER L'INNOVAZIONE INDUSTRIALE 2018

Tecnologie innovative per il recupero e riciclo di prodotti e materiali nell'ambito dell'Economia Circolare

La bioconversione di rifiuti organici in bioplastiche

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THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION HORIZON 2020

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

Call: WATER-1b-2015 - Demonstration/pilot activities (IA)

GA 690323, 4 years, started June 1° 2016, 29 partners, 10 countries

EU Grant: 7 536 300 €

Coordinator: Francesco Fatone, Technical University of Marche, Italy

No Agro-Waste - Innovative approaches to turn agricultural waste into ecological and economic assets (NoAW)

Call: WASTE-7-2015 - Ensuring sustainable use of agricultural waste, co-products and by-products (RIA)

GA 688338, 4 years, started October 1° 2016, 32 partners, 15 countries

EU Grant: 6 887 570 €

Coordinator: Nathalie Gontard, INRA-Montpellier, France

REsources from URban BIo-waSte (RES URBIS)

Call CIRC-05-2016: **Unlocking the potential of urban organic waste (RIA)**

GA 730349, 3 years, started January 1° 2017, 21 partners, 8 countries.

EU Grant: 2 996 688 €

Coordinator: Mauro Majone, Sapienza University of Rome, Italy

3 projects with some common features

Focusing on **"waste" streams** as a renewable and largely available resource (no land, no water, no energy is needed to produce it)

Mild biotechnologies basen on **open microbial cultures** (no axenic cultures, no OGMs)

→

The organic fraction of municipal solid waste
Municipal wastewater
Park/garden waste
Agricultural and food-industry wastewater and waste

A large portfolio of bioproducts with market value under investigation (e.g. cellulose, biofuels, biofertilizers, biosolvents, biomethane and biohythane) and one in common: **polyhydroxyalkanoate (PHA) and derived bioplastics and biocomposites**

Also taking care of

✓ **the whole technology chain**

Different industrial sectors to be linked each other, each one having its own business targets, needs and specifications.

✓ **territorial conditions**

Affordable economic strategies to be tailored with respect to territorial **clusters**, i.e by taking into account present collection and management systems and where available "feedstock " is large enough

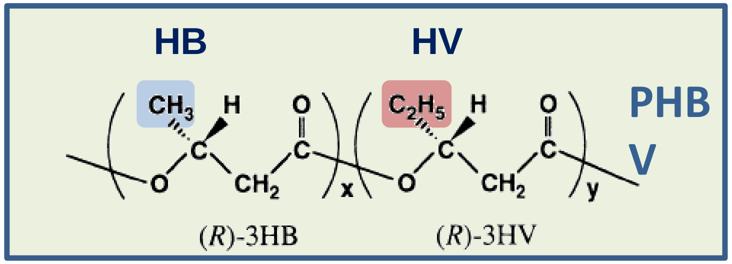
✓ **technical and non technical constraints**

Regulatory (e.g. **"end of waste"**), environmental, and social constraints, as function of local, regional and national conditions

Why focusing on PHA?

Product related Pro's

PHA is not a single polymer but a family of copolymers with tunable composition and properties,
so that, PHA can be the main constituent of several bioplastics, with a wide portfolio of applications.



- **Biodegradable commodity film**
- **Advanced packaging interlayer film**
- **Specialty durables (such as electronics)**
- **Biocomposites with fibers for construction sector**
- **Controlled C-release materials for environmental remediation**

Production process Pro's

- A novel PHA production process (**open microbial cultures instead of pure strains**), which can better cope with **large heterogeneity of the waste feedstock**,
- An upstream step, the **acidogenic fermentation**, which is both robust and tunable
- Overall, PHA production process is mostly **biological, under mild conditions and reliable**.
- Thus, an **easier integration with existing biological plants for waste and wastewater treatment**.
- Combining no-cost feedstock and novel processes, the **cost of PHA can significantly decrease**

Appealing: PHA is 3 times "Bio"

- Produced from renewable feestock (but no food)
- Produced through biological process (**but no OGM**)
- Easily and "truly" **biodegradable**

and it's not recycled: it's virgin material

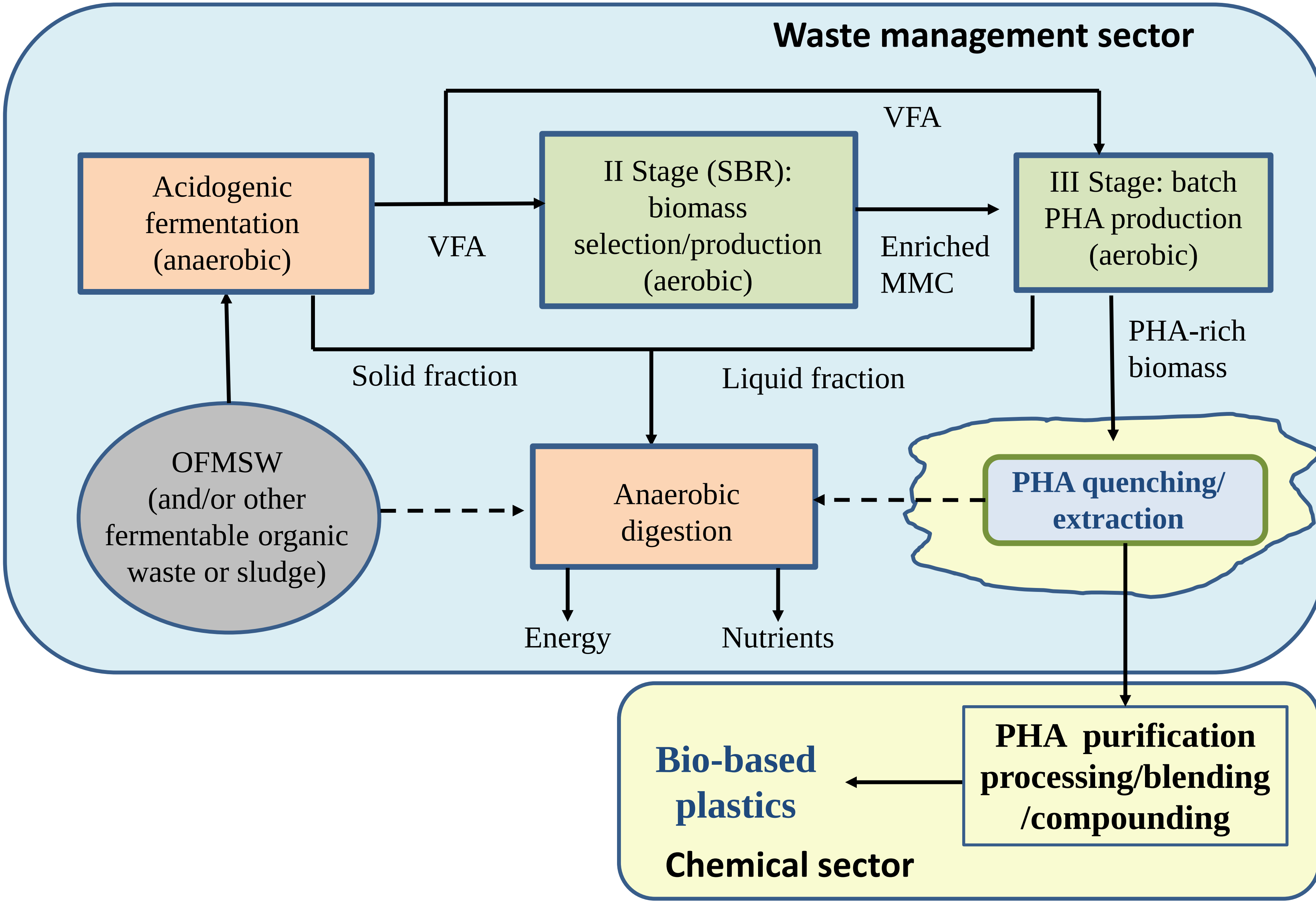
Applications and economics

High market potential

As higher as more PHA cost decreases; but still higher value than biogas and compost

Already under investigation at TRL 6

Typical process for PHA production from MMC and organic waste



Pilot scale optimisation of PHA production process from biowaste

Although the main steps of MMC process are largely validated at lab-scale,
pilot scale experimentation is essential for several reasons

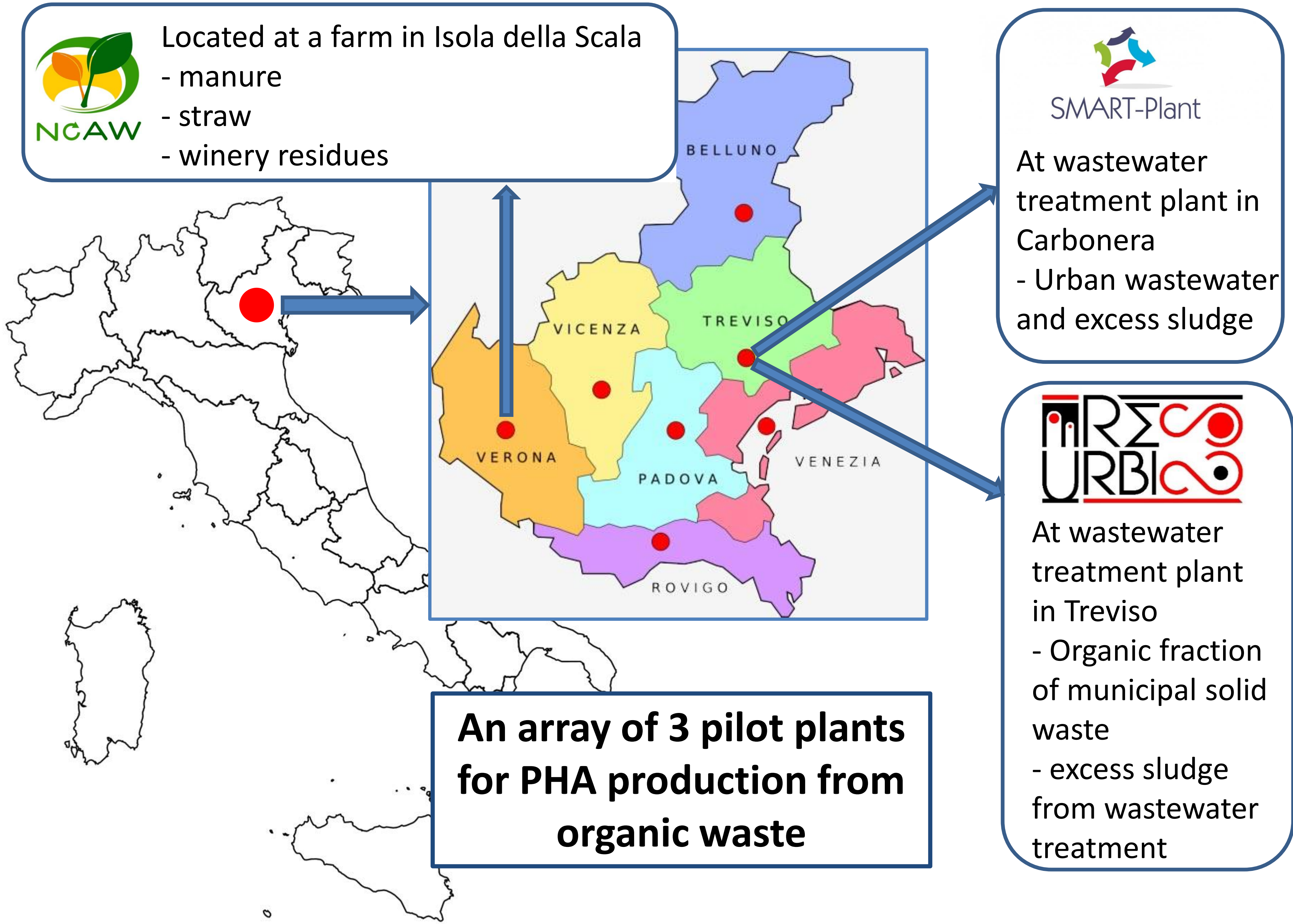
Process-related challenges

- Given the process has many steps, pilot-scale is essential to supply **robust technical-economic data**, especially because cost decrease remains a key target
- Long term experimentation with "true" waste feedstock is needed to address effects of **feedstock heterogeneity**
- An integrated process is required for **optimal management of water/solid overflows** and related energy recovery. This is also essential for making appropriate LCA
- The **extraction step** still requires optimization (as milder conditions as possible)

Product-related challenges

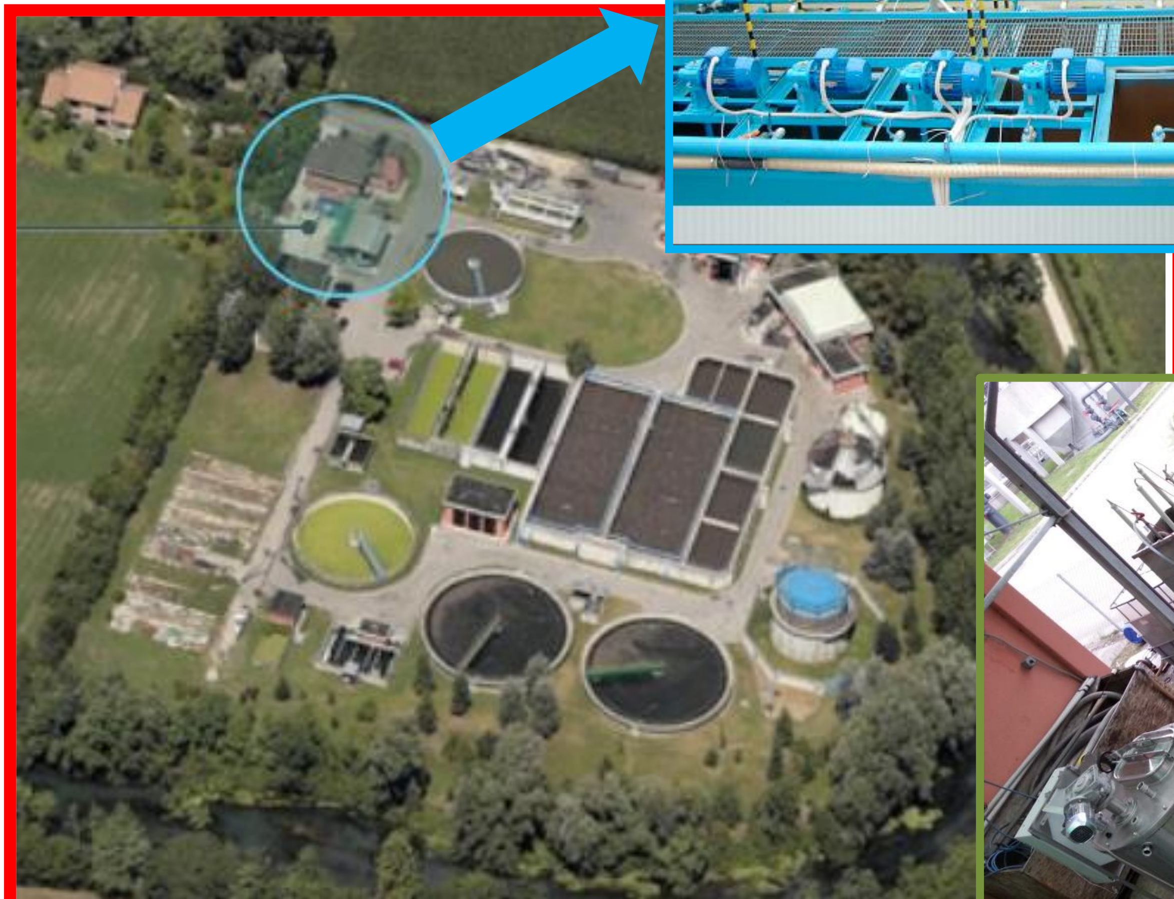
- PHA batches have to be steadily produced and delivered to investigate **downstream processing**, especially by using conventional industrial equipments (i.e in the range 1-10 Kg/batch).
- **Contaminant migration** and abatement and possible transfer into the products has to be investigated under close-to reality conditions.

Exploring micropollutant migration and/or abatement in novel waste-to-product technologies is a "hot spot" for full exploitation of circular economy principles.

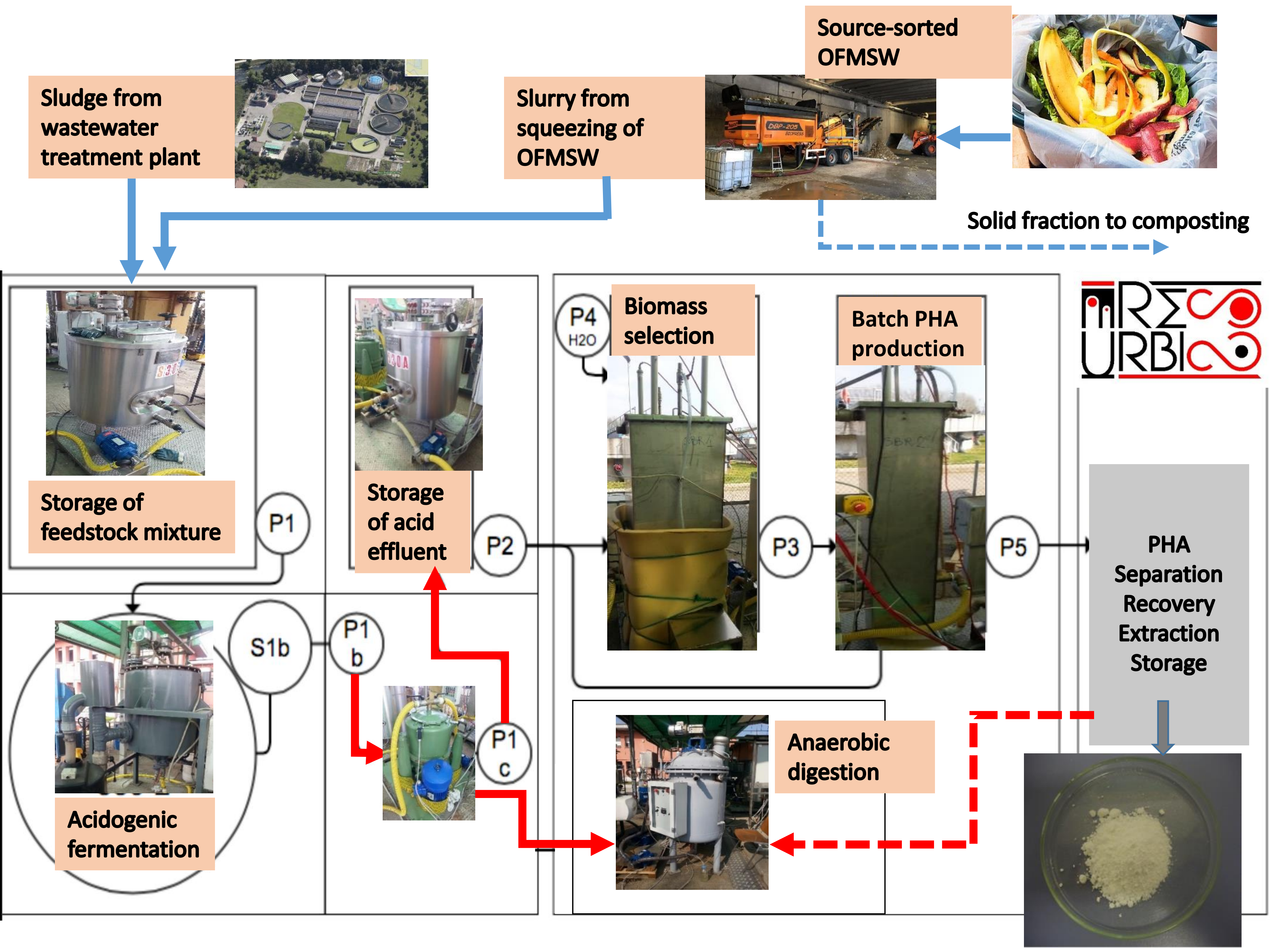


Located at a farm in Isola della Scala
- manure
- straw
- winery residues
NCAW
BELLUNO
VICENZA
TREVISO
VERONA
PADOVA
VENEZIA
ROVIGO
SMART-Plant
At wastewater treatment plant in Carbonera
- Urban wastewater and excess sludge
RES URBIS
At wastewater treatment plant in Treviso
- Organic fraction of municipal solid waste
- excess sludge from wastewater treatment
An array of 3 pilot plants for PHA production from organic waste

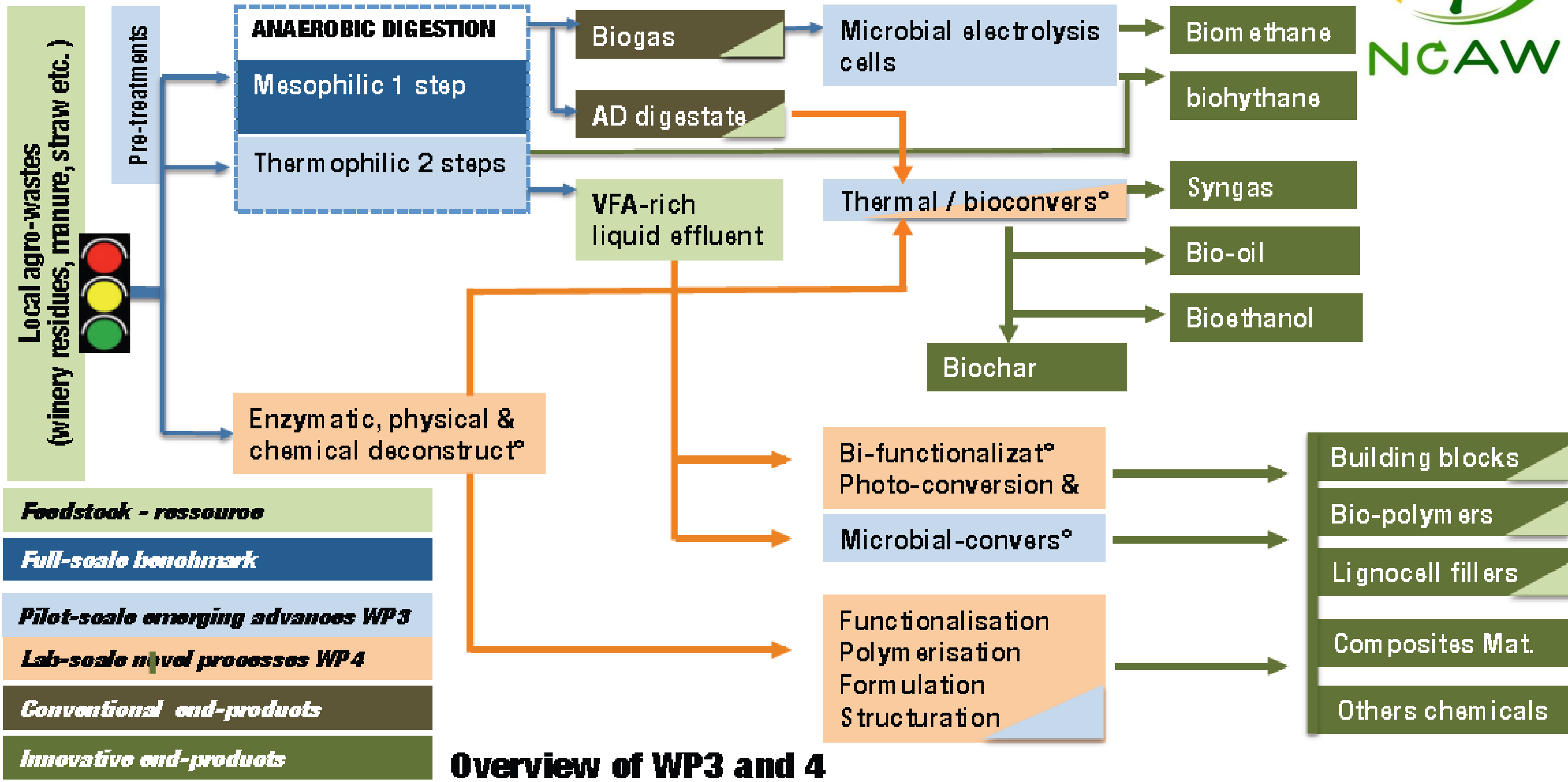
Pilot scale platform of Universities of Venice and Verona at the wastewater treatment plant of Treviso (held by Alto Trevigiano Servizi, ATS)



Joint PHA production pilot plant, by Universities of Venice and Rome «Sapienza»

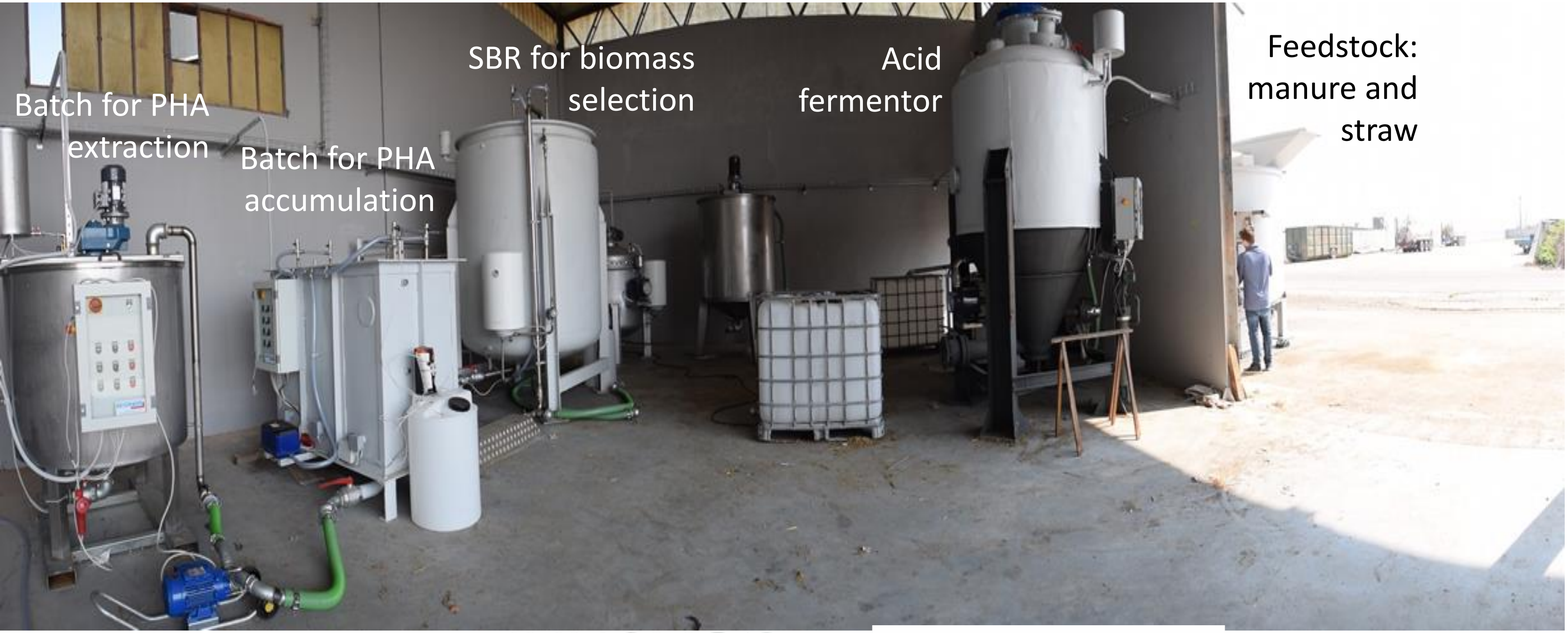

Source-sorted OFMSW
Sludge from wastewater treatment plant
Slurry from squeezing of OFMSW
Solid fraction to composting
P4
H2O
Biomass selection
Batch PHA production
Storage of feedstock mixture
P1
Storage of acid effluent
P2
P3
P5
PHA Separation Recovery Extraction Storage
S1b
P1 b
P1 c
Acidogenic fermentation
Anaerobic digestion

NoAW technical solutions to transform agro-waste biomass into a portfolio of useful bio-based products



- Several geographical case-studies: Germany, France, Italy, Denmark, Greece
- Each one having a full-, demo-, or at least pilot-scale plant,
- Having the anaerobic digestion as the benchmark, to be further improved/refined
- Dealing with different (mixed) feedstock, representative of the geographical area (including manure, straw and winery waste)

NCAW



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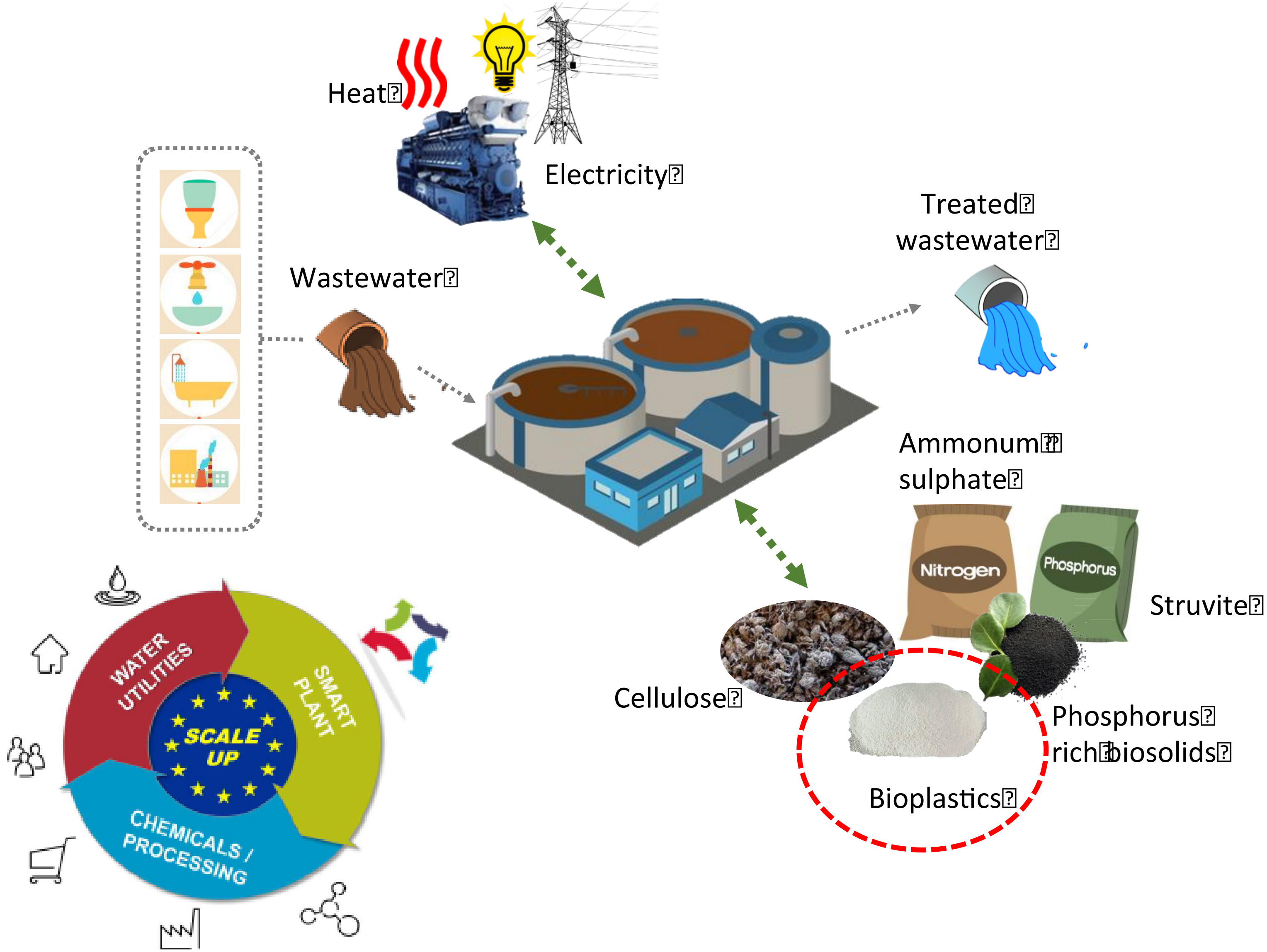
Smart-Plant rationale



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www.smart-plant.eu

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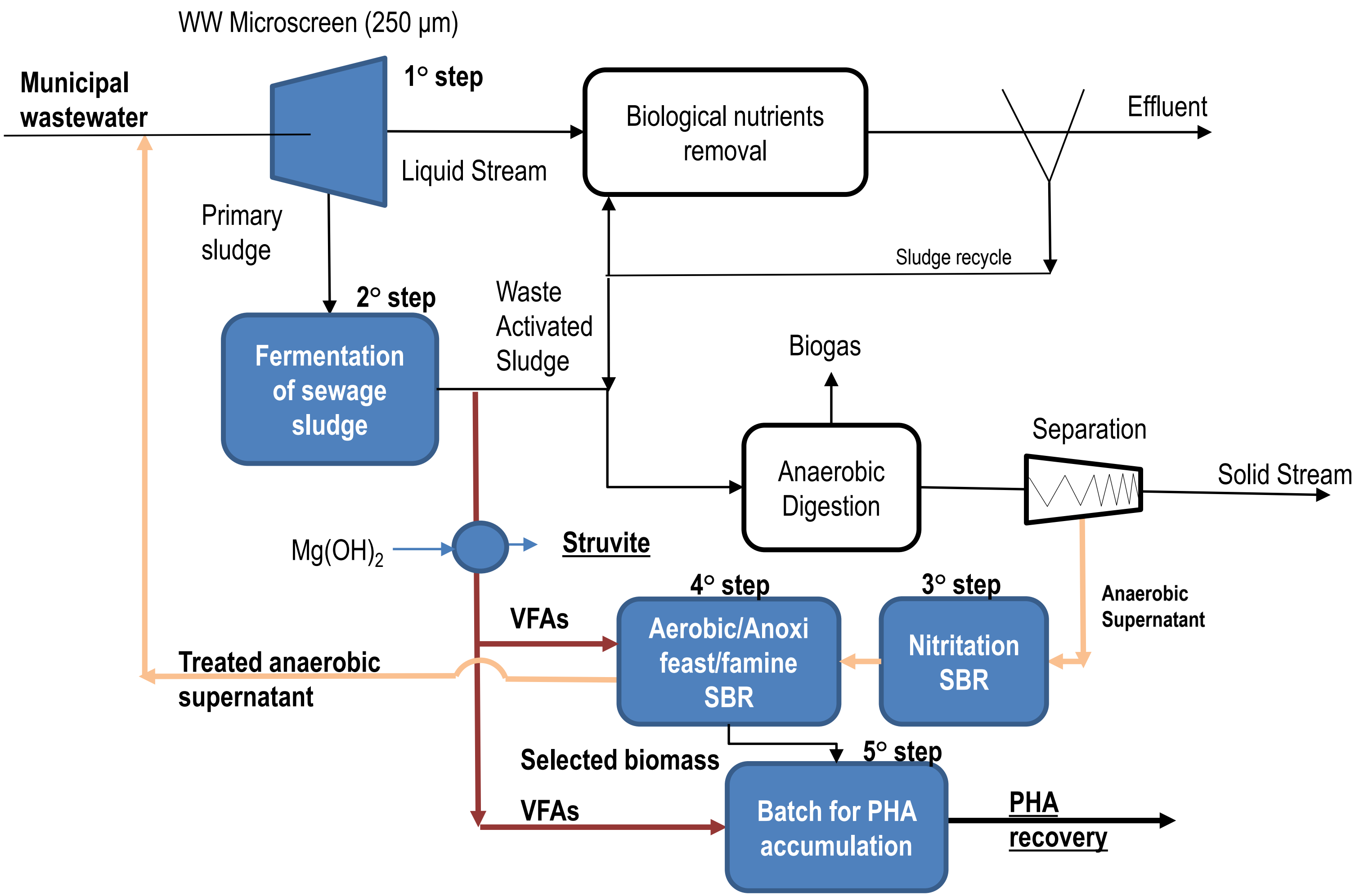
Sidestream S.C.E.P.P.H.A.R.: Short-Cut Enhanced Phosphorus and PHA recovery (Smartech 5)



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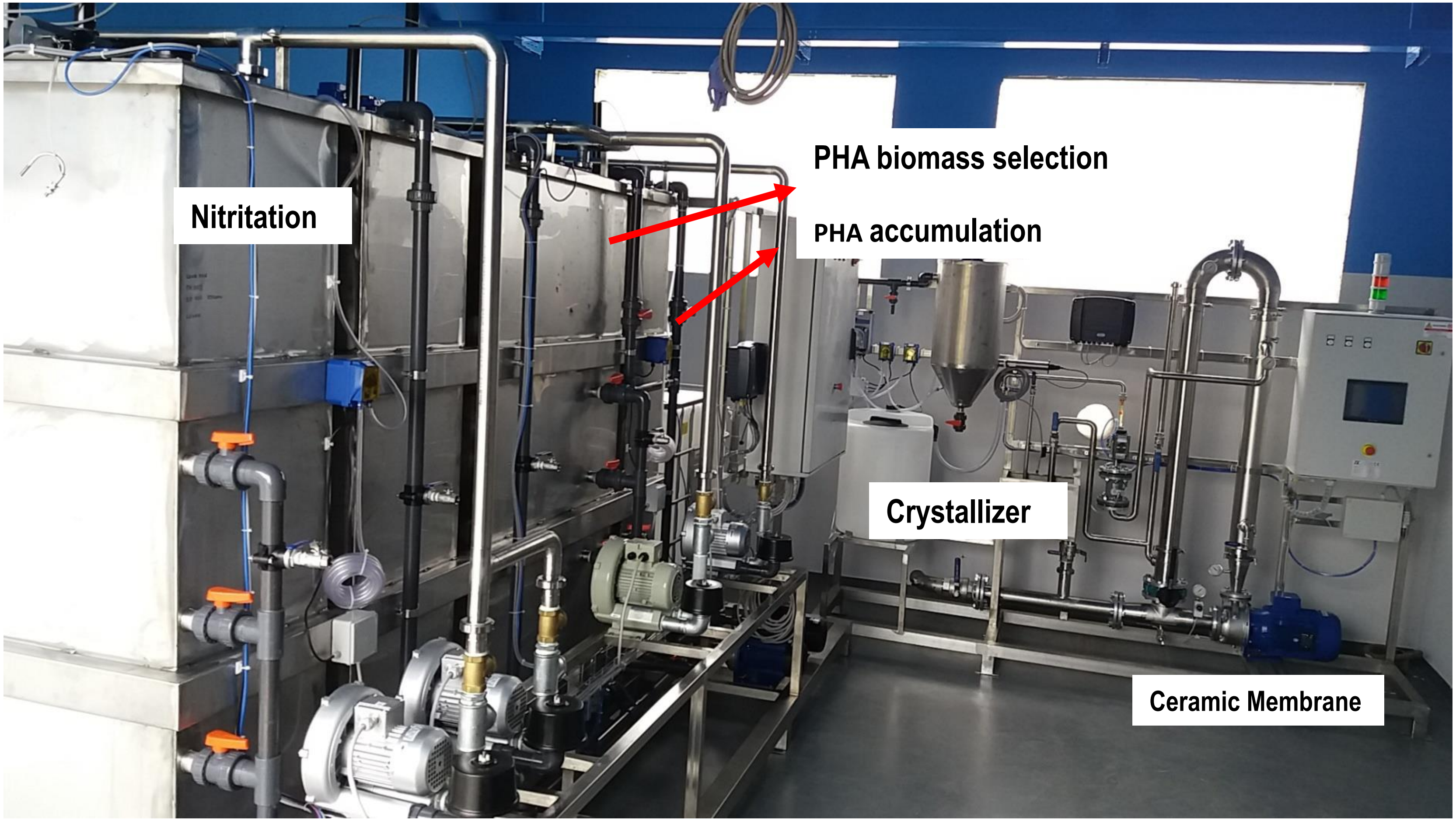
(2) SCEPPHAR pilot scale (Smartech 5): TRL 5



Start-up: 28/08/2017

Potential recoveries: 0.7-0.8 kgPHA/day; up to 300 gStruvite/day)

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Is it worthwhile to put all this effort together?

An estimate of potential impacts

Based on a preliminary mass balance of the new technology chain, an **OFMSW collection area of about 3,000,000 inhabitants** might guarantee the throughput of ~ **6-8 Kton PHA/year**.

Co-treatment with other urban biowaste (excess sludge, markets and park/garden waste) from the same area can increase the production capacity to ~ **18-20 kton PHA/year**.

This PHA production capacity would result into revenues of **~ 60-80 million EUR per year**, margins of **~ 30-40%** and the creation of **~** 100 new jobs for the cluster.

Under assumption of co-treatment, sustainable operative margins can be achieved even at smaller size, e.g from **500.000 inhabitants**. This is the smallest cluster being considered in the RES URBIS (Province of Trento).

According to population distribution in Europe (BBSR 2011), there are **115 Metropolitan Areas** which have more than **500.000 inhabitants** each and an average size of 3 million.

Thus, **~ 343 million people live in metropolitan areas** that have a suitable size to exploit the RES URBIS approach, which means a **potential** of producing up to **2,2 million ton PHA per year** (excluding food-processing waste), 8.8 billion € and **~** 10 000 new green jobs in Europe.

This PHA production is ~ 10 times more than present PHA production capacity worldwide but still less than 5% of present plastics demand in Europe.

Work is in progress
Thank you for your attention

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http://www.resurbis.eu/

http://noaw2020.eu/

http://smart-plant.eu/