

***Demonstration of an integrated innovative
biorefinery for the transformation of
Municipal Solid Waste (MSW) into new
BioBased products***

Raul Muñoz Torre (mutora@iq.uva.es)
Universidad de Valladolid



Universidad de Valladolid

The **URBIOFIN** *consortium*

Research Project Budget: 15 M€
Duration: 4 years project (6/2017 – 5/2021)



www.imecal.com/perseo
 (Coordinator)



Universidad de Valladolid

www.uva.es



www.wur.nl/en.htm



clamber.castillalamancha.es



centro tecnológico

www.ainia.es



Engineering that inspires

www.exergy.uk.com



www.ciemat.es



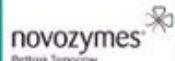
BioEconomy Cluster

www.bioeconomy.de



urbaser

www.urbaser.es



Belgium Tomorrow

www.novozymes.com



Research & Innovation

www.seeingnewdata.com



THE NEW PACKAGING

www.ses-packaging.com



Biomasa Peninsular

www.bpeninsular.com



NaturePlast Bioplastics Expert

www.natureplast.eu



www.natrue.org

The **URBIOFIN** *objective*

NEW MODEL OF OFMSW TREATMENT

Biorefinery
Multiple bioproducts
Higher value

Landfill
Composting
Anaerobic Digestion

OFMSW

URBIOFIN - BIOREFINERY

BIO-BLOCKS

BIO-POLYMERS

ADDITIVES

- Bioethanol
- Volatile fatty acids
- Biogas

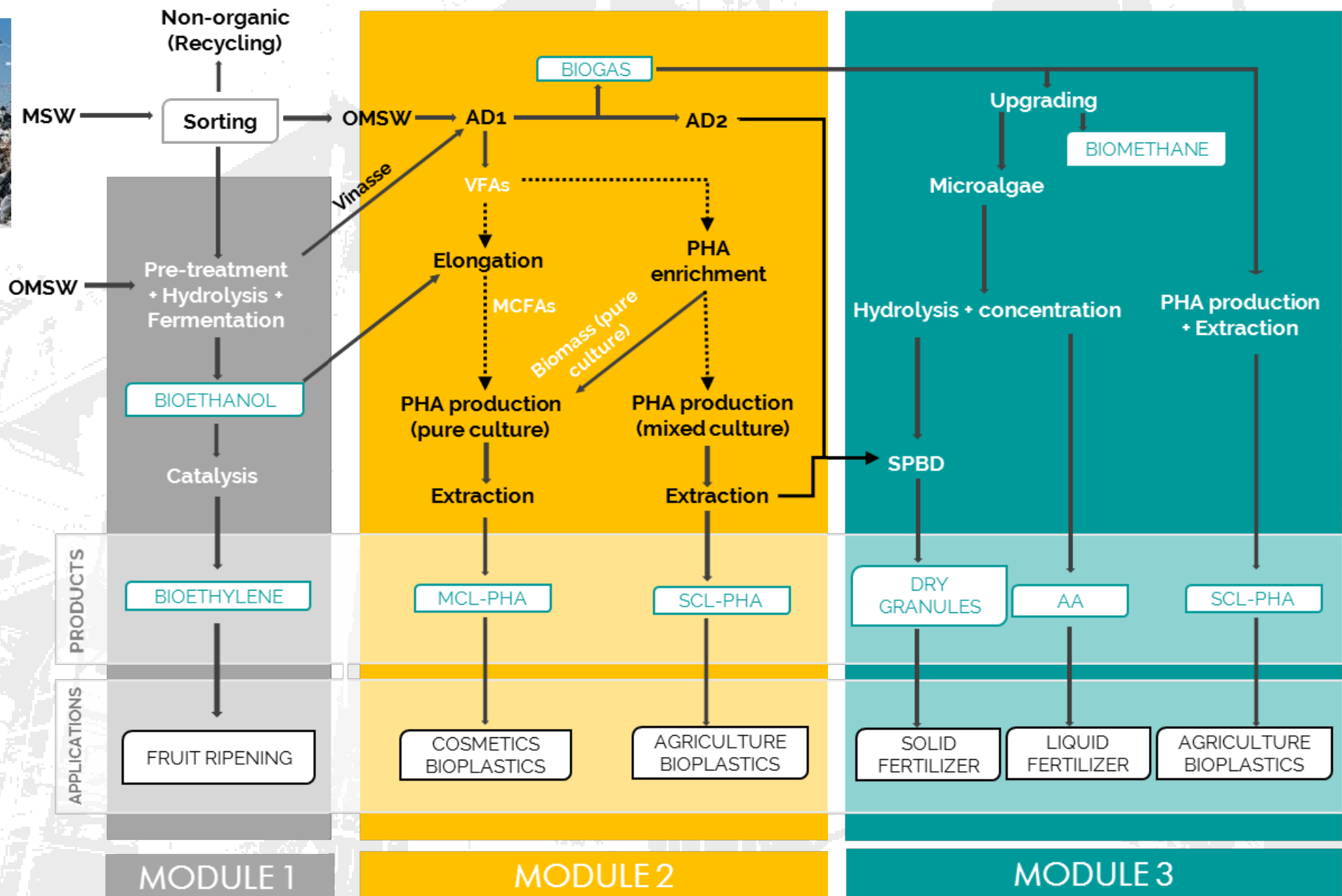
- Polyhydroxyalkanoates
- Combined PHA's

- Bioethylen
- Biochemical products

VALUE

Project Challenges

- ✓ **To tackle the issues inherent to MSW treatment**, such as variability in composition (seasonality and geographic location) and presence of inhibitors to downstream biotechnological processes.
- ✓ **To validate the whole value chain at demonstration scale** (TRL 5-7).
- ✓ **To demonstrate at Demo-scale the economic and environmental benefits of the Urbiofin** treatment and conversion technologies of the OFMSW into final or intermediate products.
- ✓ **To validate safety, quality and purity of the products** in order to meet commercial and/or regulatory requirements.
- ✓ **To assess the environmental and socio-economic performance** of the whole value chain using a Life Cycle Assessment (LCA)

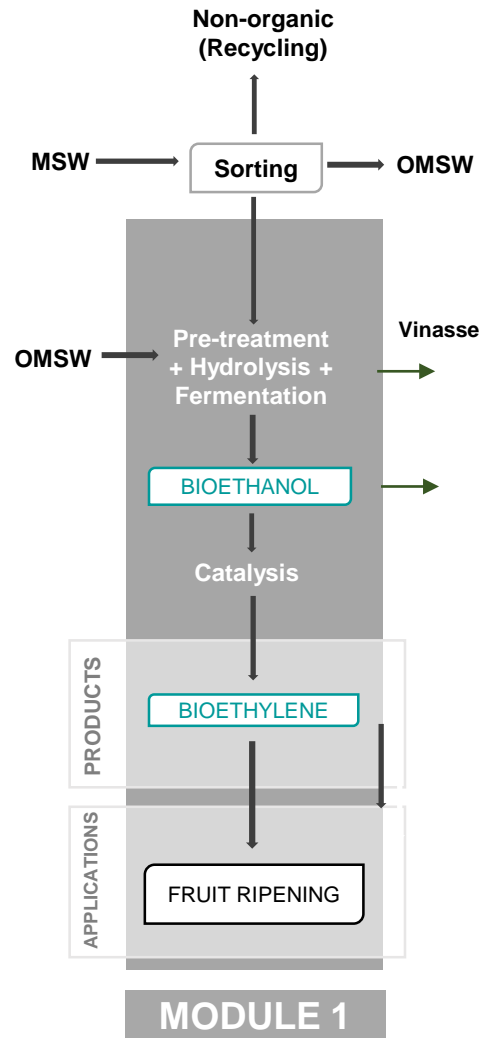


Module I.

Conversion of OFMSW to bioethanol and bioethylene

Key Figures

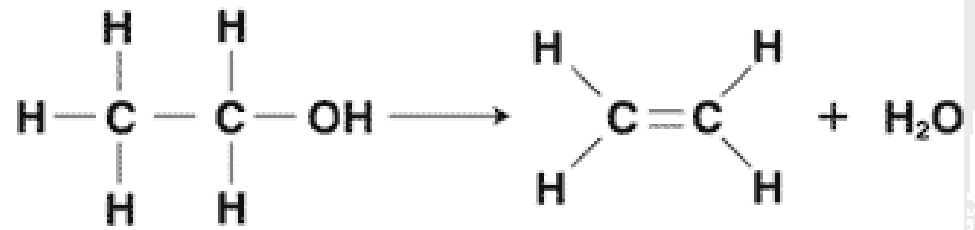
0.19 m³ Bioethanol/tn OFMSW



Module I.

Conversion of OFMSW to bioethanol and bioethylene

➤ Bioethylene:



Ethanol

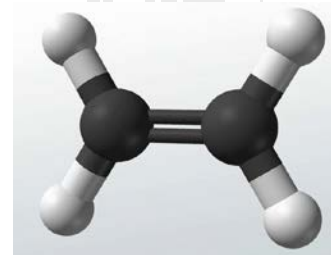
Ethylene

Key Figures

91 kg Bioethylene/tn OFMSW



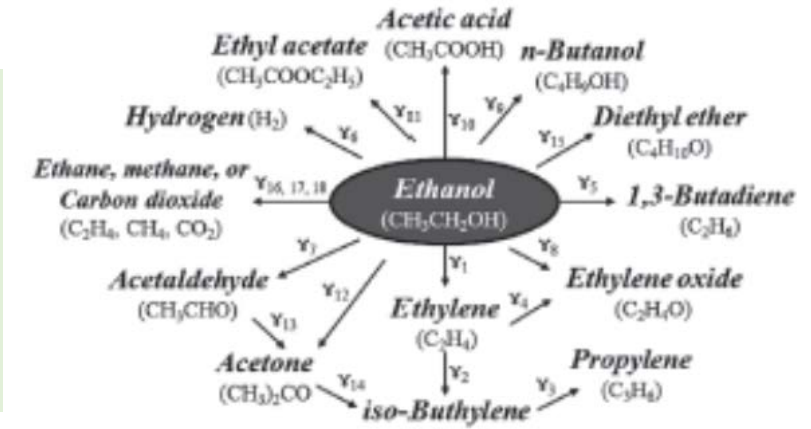
Bioproducts:



Market of bioproducts

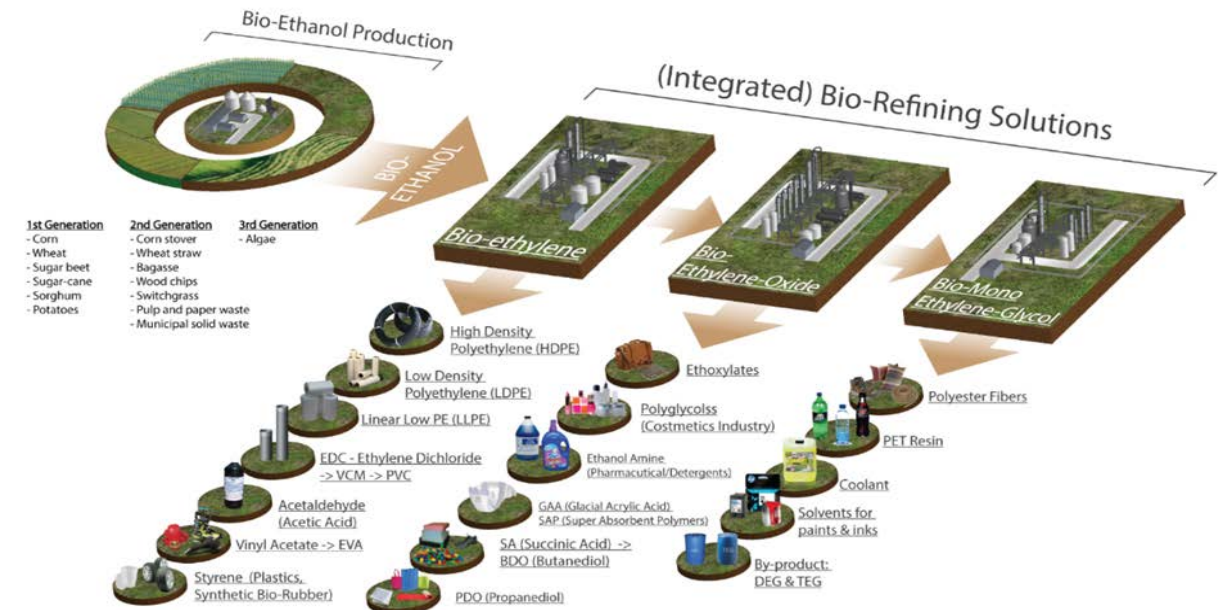
➤ Bioethanol:

- ✓ **Biofuel: 90% of total biofuels. Market Forecast in Europe: 13 billion € in 2030**
- ✓ **Chemical Building block:** Bioethanol is considered as one of the “**top 10**” potential biobased raw materials for the chemical industry. (US Energy Department)



➤ Bioethylene:

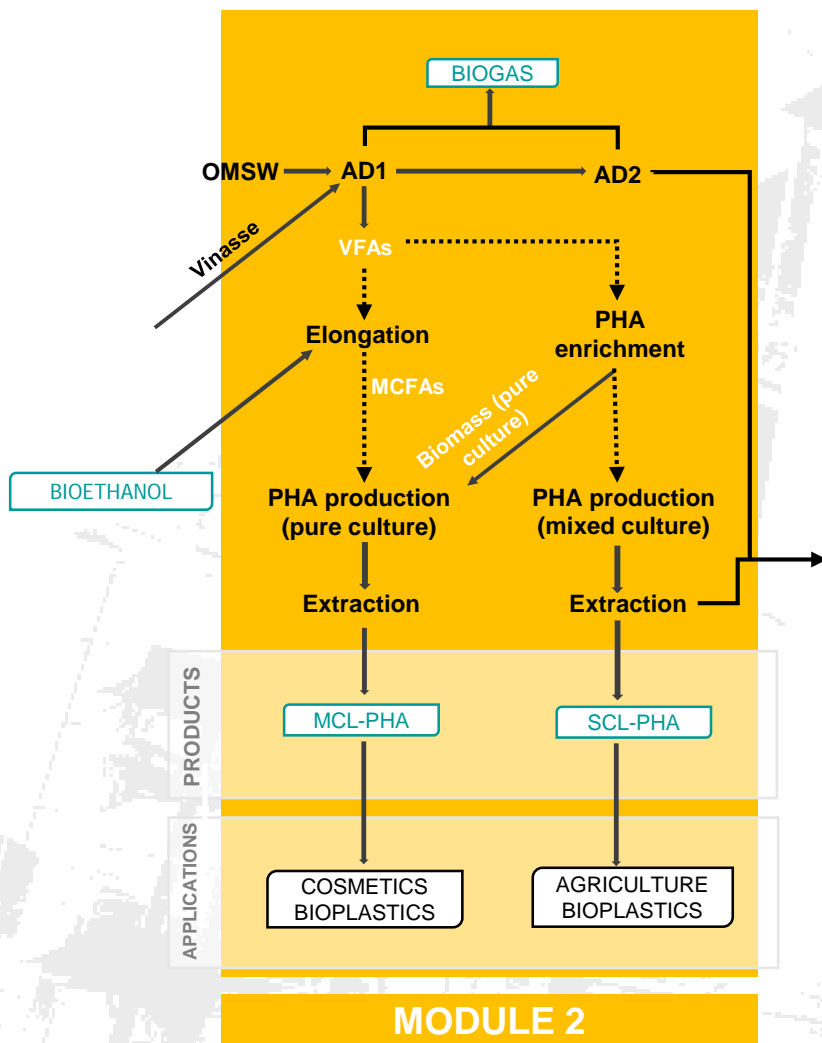
- ✓ Global bioethylene market size was over USD 160 billion in 2015 and is foreseen to exceed USD 235 billion valuation by 2024



Module II. Conversion of OFMSW to VFAs for production of PHA.

Key Figures

11 kg VFA/tn OFMSW



Key Figures

1.1 kg SCL PHA/tn OFMSW
0.7 kg MCL PHA/tn OFMSW

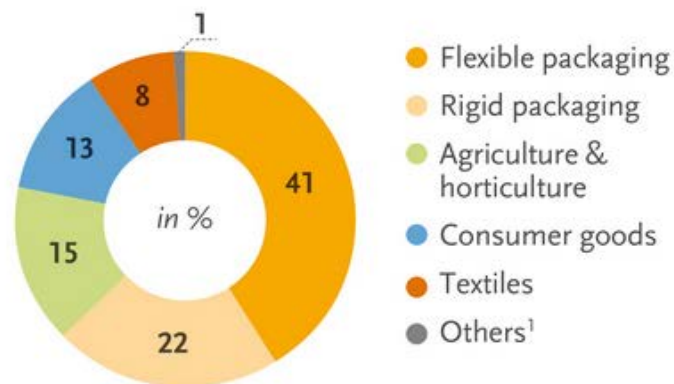
AD 1 = 100 m³

Market of bioproducts

➤ Bioplastics:

- ✓ Biodegradable bioplastics market is expected to double between 2014 and 2019.
- ✓ In the case of PHA market it is expected a growth from 32 to 104 Mton, mainly related to flexible or rigid packaging and agriculture purposes.

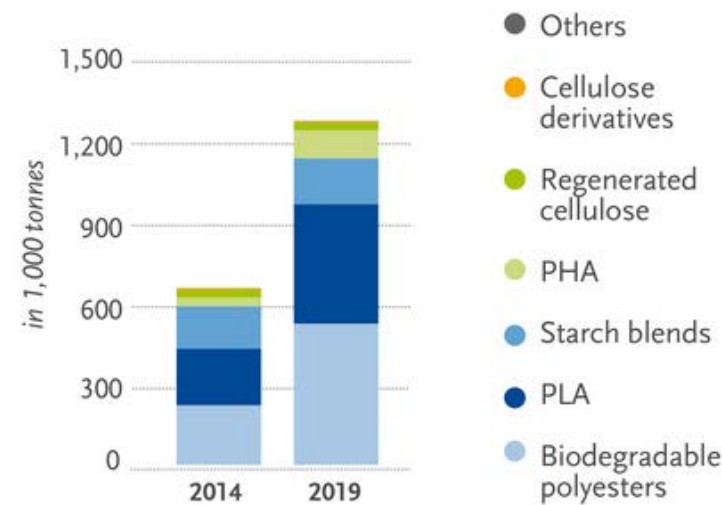
Biodegradable bioplastics markets 2014



¹ Including electrics & electronics

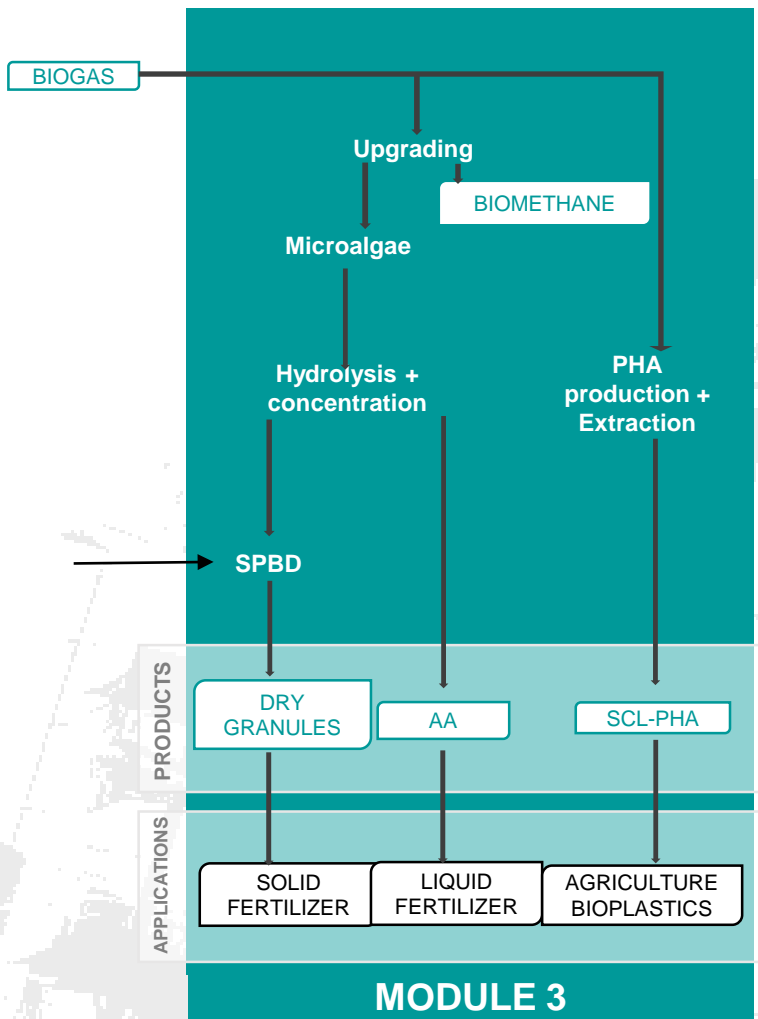
Source: European Bioplastics, Institute for Bioplastics and Biocomposites, nova-Institute (2015).
More information: www.bio-based.eu/markets and www.downloads.ifbb-hannover.de

Biodegradable bioplastics 2014 vs. 2019



Source: European Bioplastics, Institute for Bioplastics and Biocomposites, nova-Institute (2015).
More information: www.bio-based.eu/markets and www.downloads.ifbb-hannover.de

Module III. Biogas bioconversion to biomethane and added value products



AD 2 = 40 m³

Key Figures

450 Nm³ Biogas/tn OFMSW_{hydrolysed}

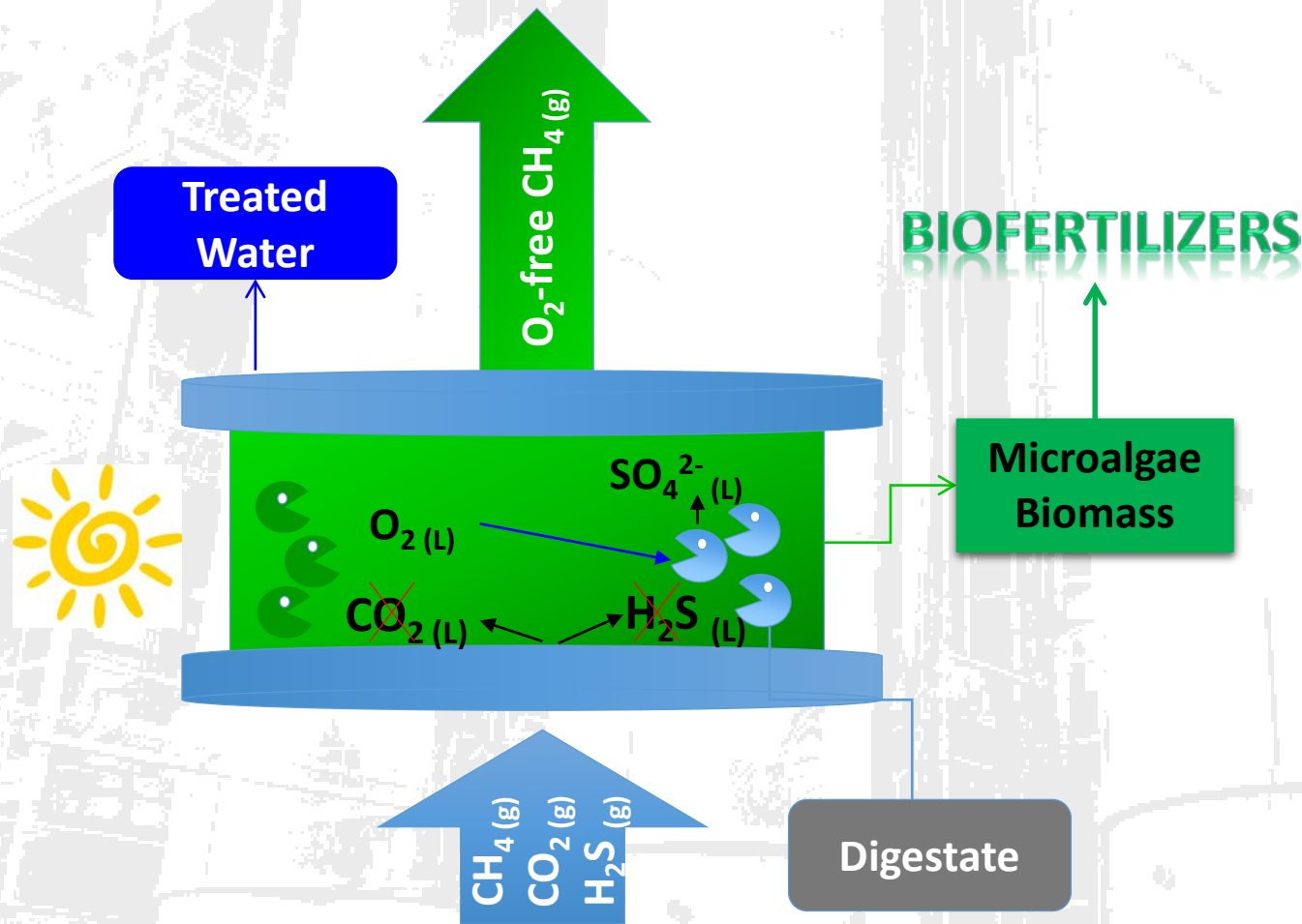


Bioproducts:



Module III. Biogas bioconversion to biomethane and added value products

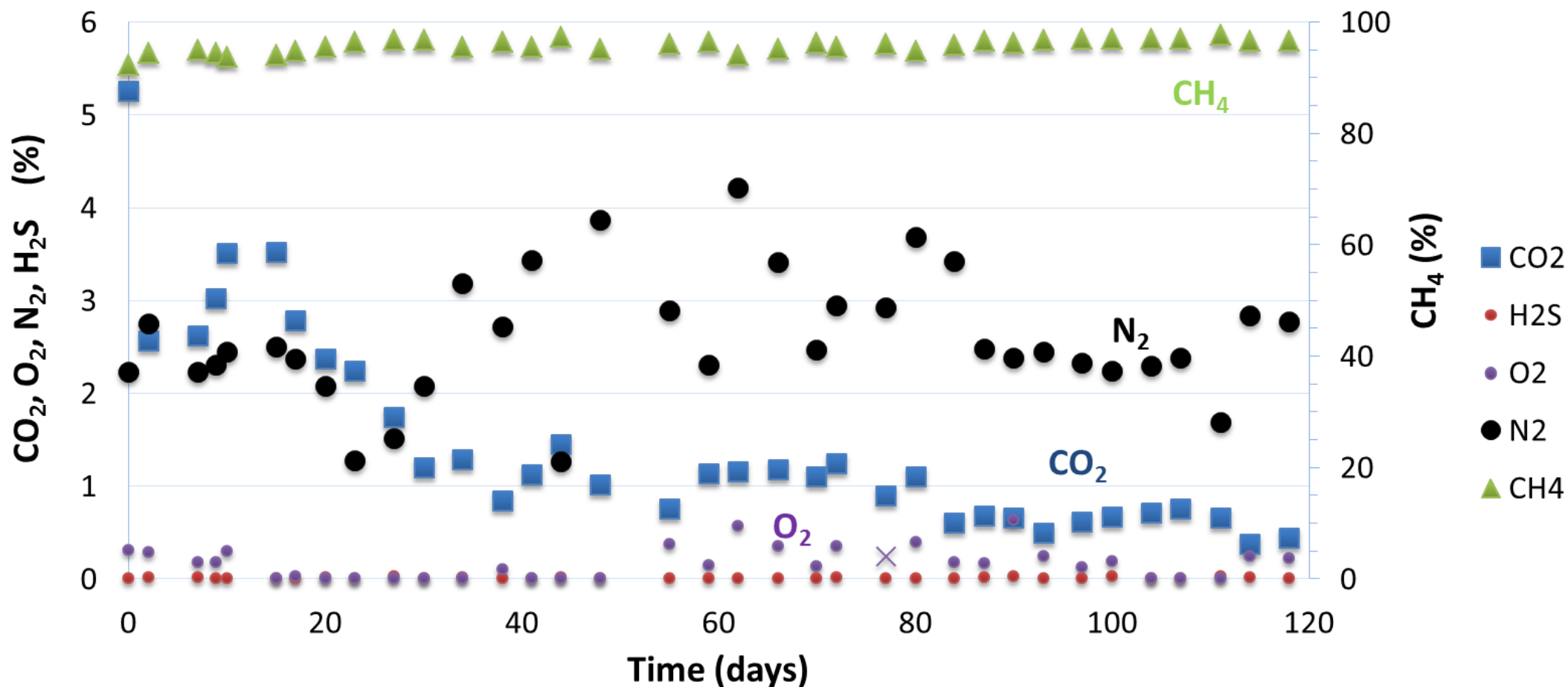
Simultaneous **Photosynthetic** Biogas Upgrading and **Microalgae-**based Digestate Treatment



Module III. Biogas bioconversion to biomethane and added value products

Key Figures

$\text{CH}_4 > 95 \%$, $\text{CO}_2 < 1 \%$, $\text{N}_2 < 3\%$, $\text{O}_2 < 0.5 \%$

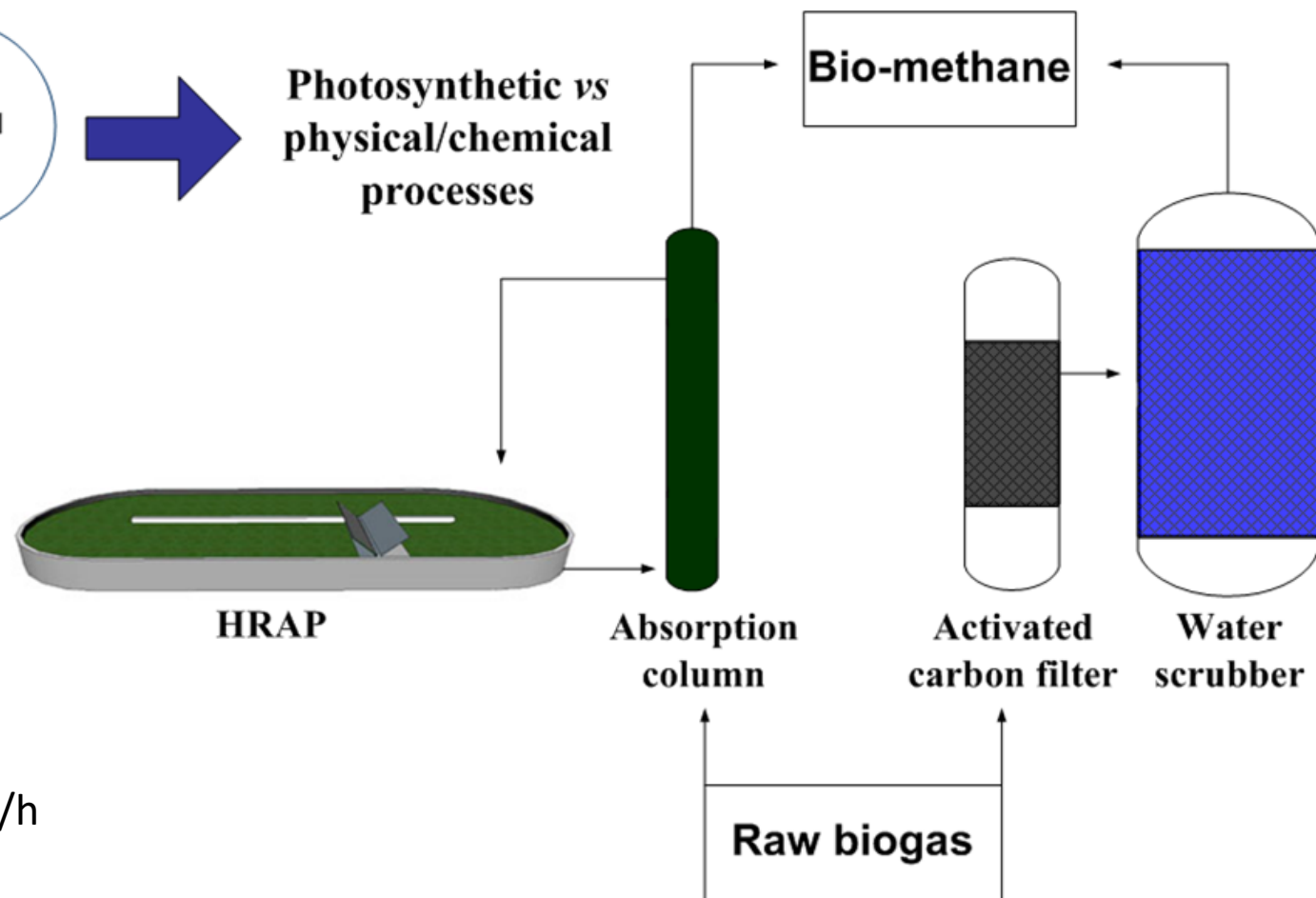


Module III. Biogas bioconversion to biomethane and added value products

IChemE Sustainability Metrics



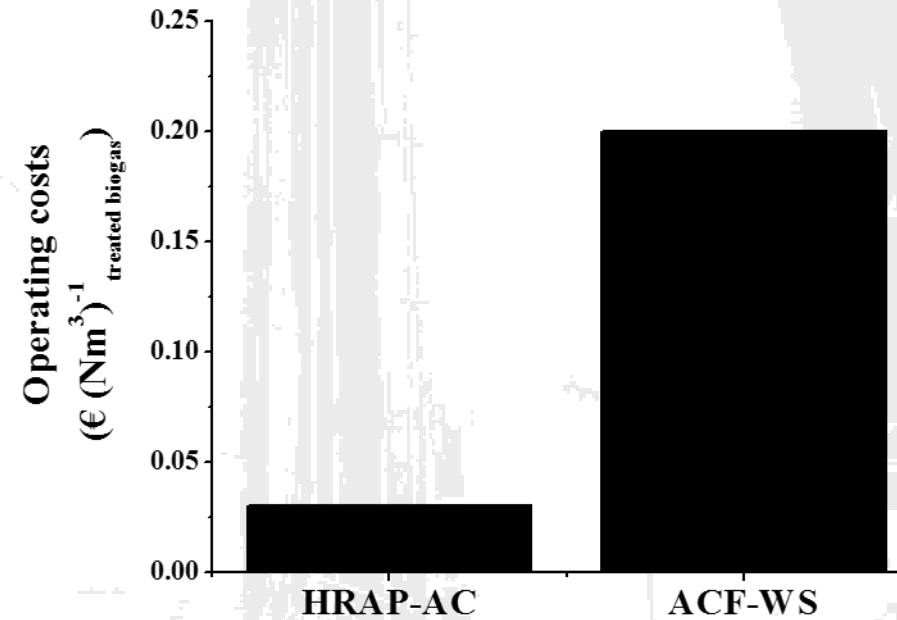
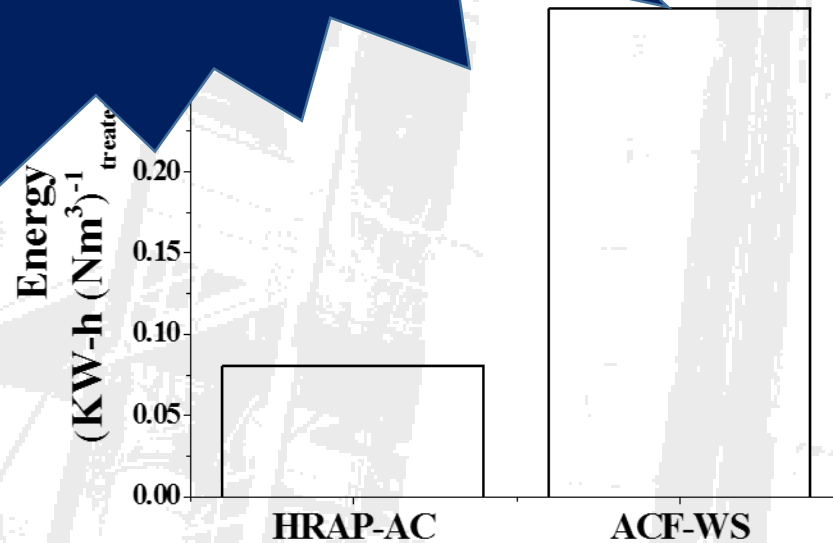
Photosynthetic vs
physical/chemical
processes



Capacidad de Upgrading: 300 Nm³/h

Module III. Biogas bioconversion to biomethane and added value products

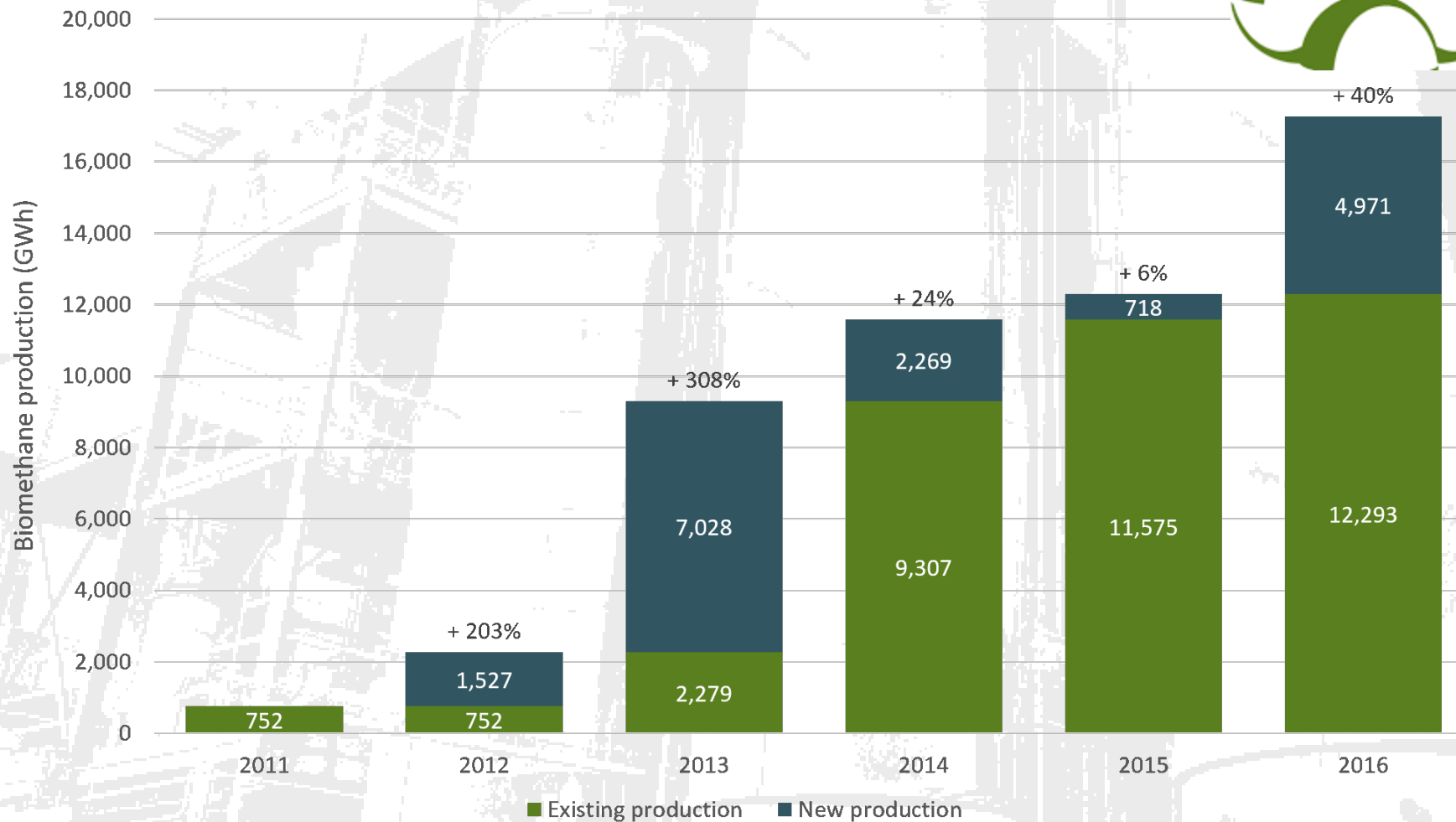
**4 times lower
energy
consumption!!**



Module III. Biogas bioconversion to biomethane and added value products



EBA
European Biogas Association

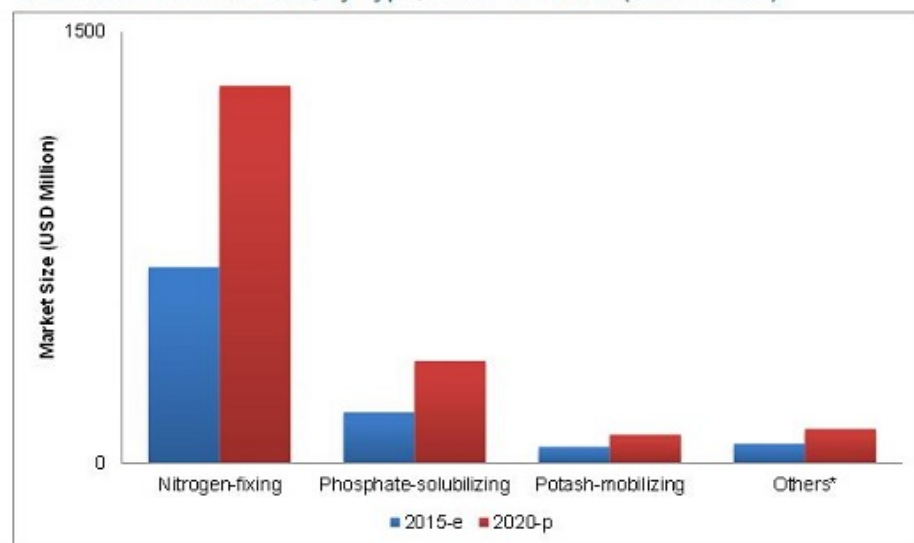


Market of bioproducts

➤ Biofertilizers

- ✓ Global bio-based fertilizers market is expected to reach USD 1.9 Billion by 2020 at a CAGR of 14.0% from 2015 to 2020

Biofertilizers Market Size, by Type, 2015 Vs. 2020 (USD Million)



*Others include zinc, boron, and sulfur-solubilizing biofertilizers

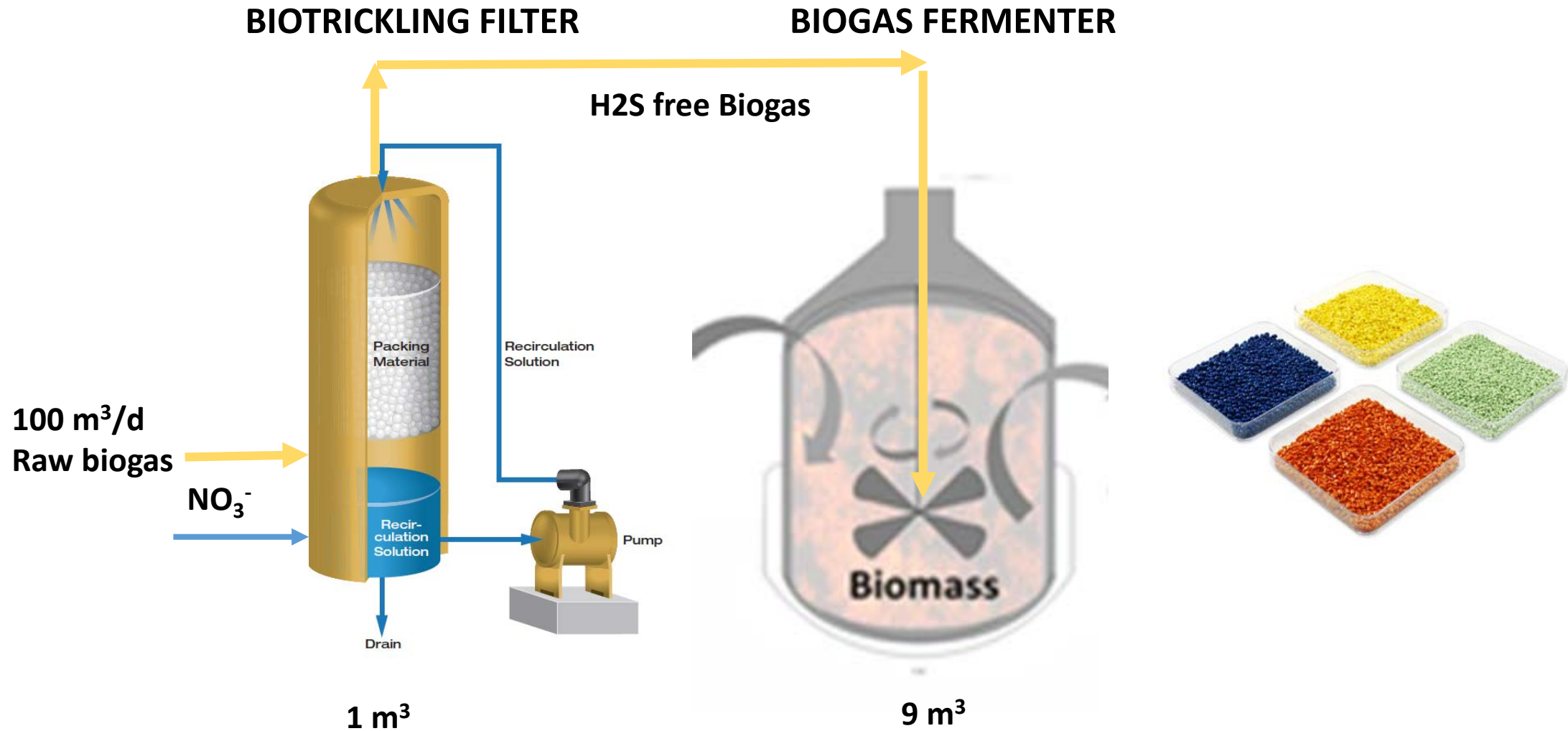
E – Estimated; P – Projected

Source: Expert Interviews and MarketsandMarkets Analysis

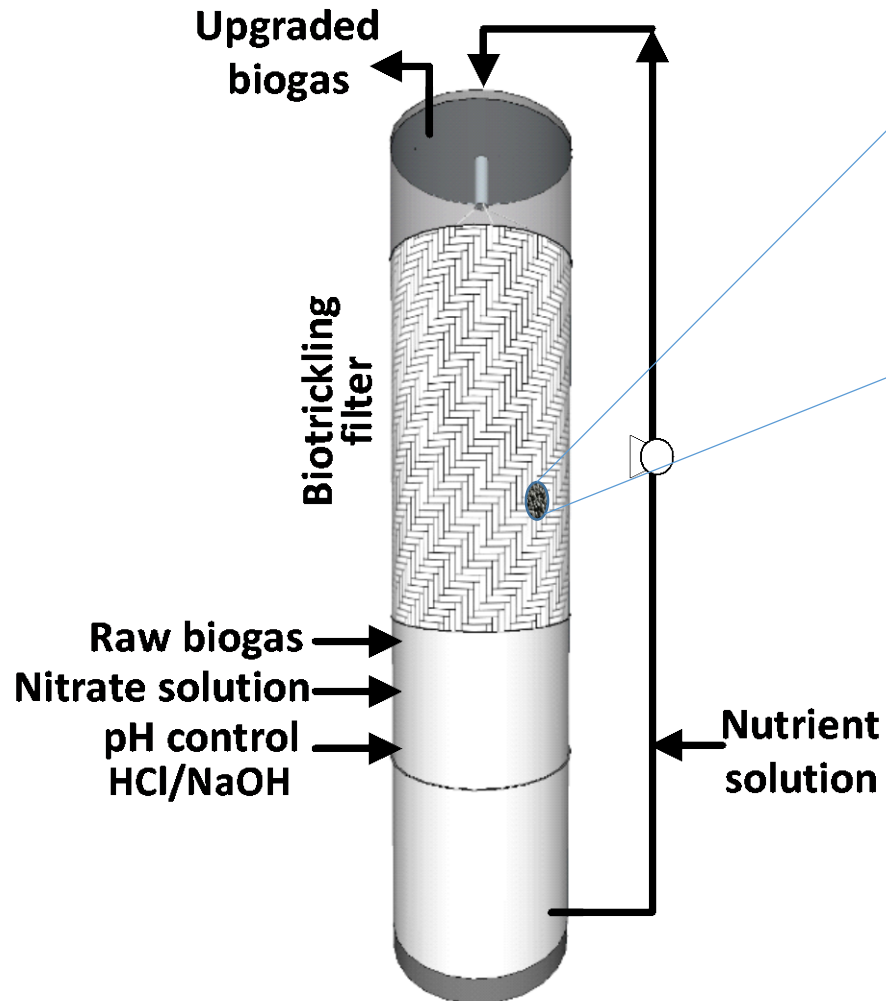
Advantages of bio based fertilisers vs conventional (mineral) fertilisers

- ✓ It is a recovered / renewable origin bioproduct
- ✓ It improves soil quality/health and not only crop productivity
- ✓ It contains higher components and nutrients concentration
- ✓ It offers easy manipulation and application in field
- ✓ Slow release of nutrients and improved crop yield
- ✓ It reduces the environmental footprint of crop production

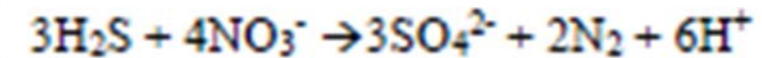
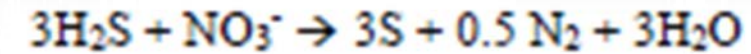
Module III. Biogas bioconversion to biomethane and added value products



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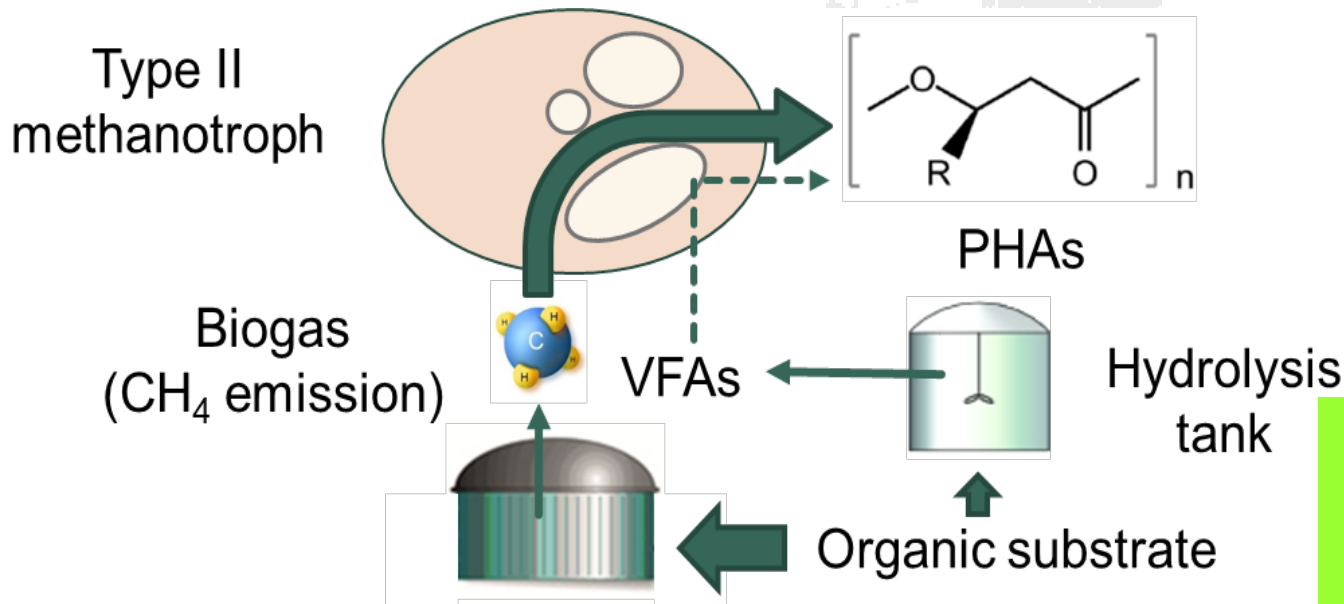
Anoxic



- Based on the action of lithoautotrophs: H_2S as energy source & CO_2 carbon source
- e- acceptor: NO_3^-
- No significant CO_2 associated
- EBRT: 2-16 min (H_2S -RE: 99%)

Module III. Biogas bioconversion to biomethane and added value products

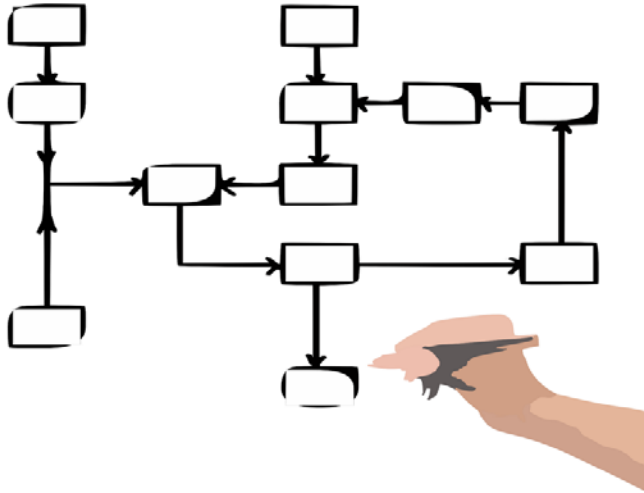
Explore the potential of biogas bioconversion into biopolymers



Culture condition	PHA		
	PHA content (wt %)	HB fraction (mol %)	HV fraction (mol %)
Biogas	43.1 ± 1.8	100	0
Biogas + Acetic acid	52.3 ± 0.7	100	0
Biogas + Propionic acid	47.9 ± 0.7	98	2
Biogas + Butyric acid	52.2 ± 2.1	100	0
Biogas + Valeric acid	53.8 ± 0.8	75	25

The achievements

Process definition and improvements



2017-2018

**Pilot plants start the
DEMO activity.**



2019-2020

✓ **Final products requirements**



2020-2021



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Bio-based Industries
Consortium



Horizon 2020
European Union Funding
for Research & Innovation