ECOMONDO
XX Conferenza sul compostaggio e Digestione Anaerobica – Sessione Tecnica
7 Novembre 2018
Rimini

ENVIRONMENT PARK Parco Scientifico Tecnologico per l'Ambiente

Valorizzazione della frazione organica dei rifiuti per la produzione di VFA

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*** Acea Pinerolese Industriale SpA**

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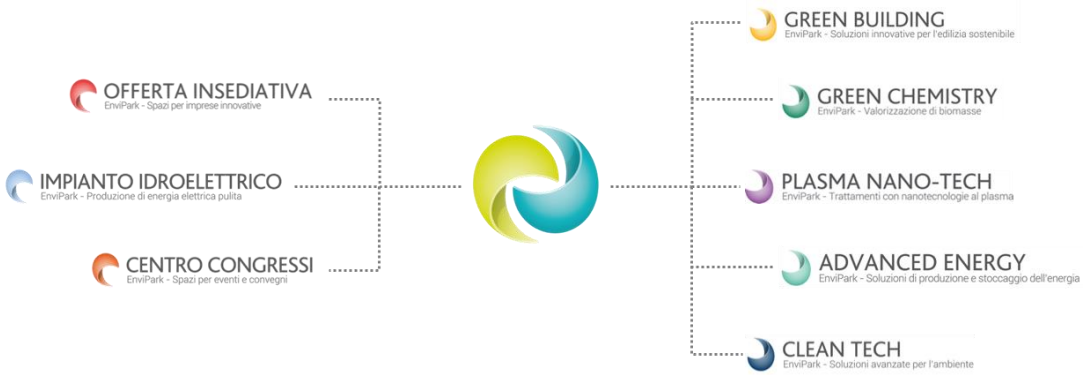
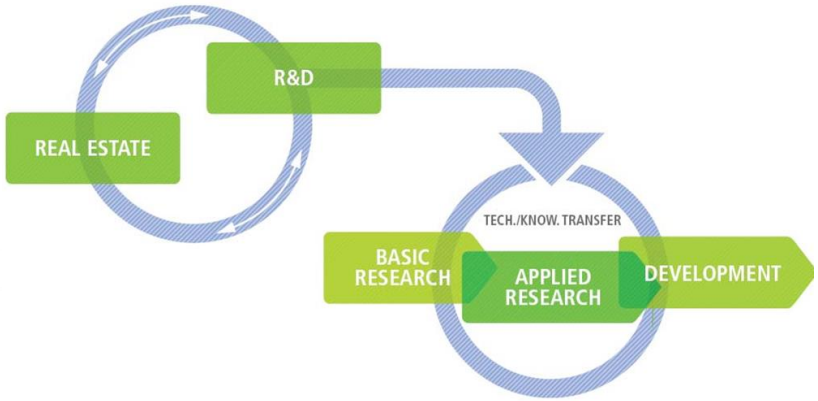
The company

Environment Park SpA

- ✓ Scientific and technological Park in Turin - Italy
- ✓ Private large company with public shareholders (established in 1996)
- ✓ Eco and Demo site (30 ha for companies real estate, and own facilities and laboratories installation)

Business model and units





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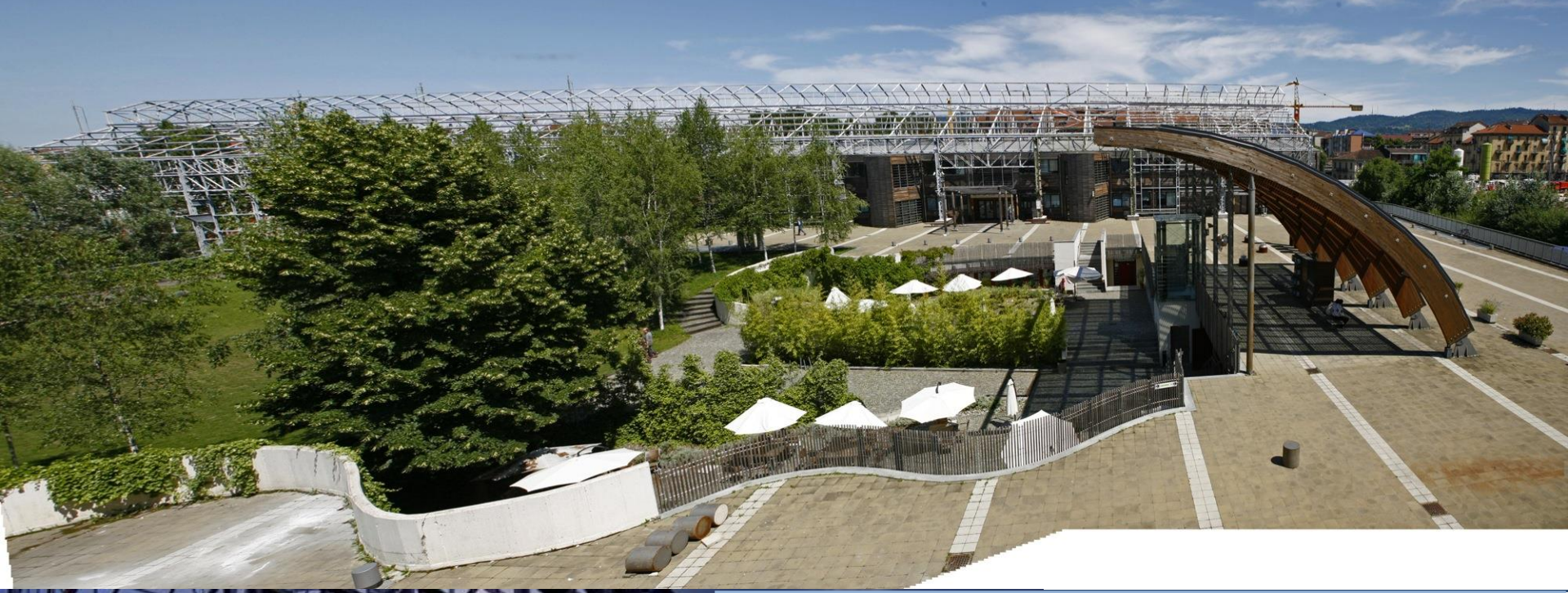
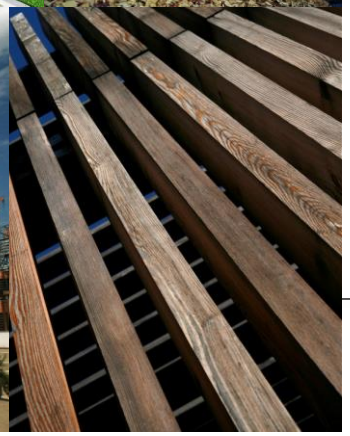


The eco-site

- Green roofs
- Rain water recovery systems
- Wood chips for heating and cooling
- Thermal solar and heat recovery systems
- PV generator
- Eco-efficient building technologies
- Hydropower plant



Comparison with a traditional building:

- ✓ Energy saving: ~ 32 %
- ✓ Water saving: ~ 40 %
- ✓ Energy produced from RES: 329,3 kWh/sqm instead of an average production of 27,8 kWh/sqm in traditional buildings

Green Chemistry sector

GREEN CHEMISTRY
EnviPark - Valorizzazione di biomasse

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Green Chemistry sector operates in development and optimization of technologies in the field of exploitation of organic materials

Areas of activities: biochemicals, biofuels, biomass exploitation for energy production, algae

Biomass pre-treatment: Pilot plant testing

- Steam Explosion (35L)
- Chemical Hydrolysis (115 L)
- Enzymatic Hydrolysis (115 L)

Fermentation pilot plants

Production of biochemicals, exploitation of by-products, production of bio-H_2, bio-CH_4, aerobic and anaerobic fermentation (5,35,150 L)

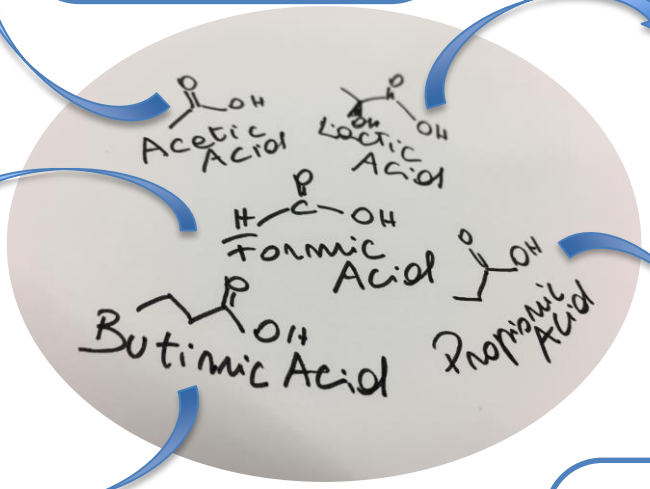
Algae processes

Tubular helical photo-bioreactor pilot plant (200L): outdoor with no artificial light for the cultivation of different algae strains (oxygen degaser, CO_2 insufflation)

WHY TO FOCUS ON VFAs

- ✓ Vinyl acetatae monomers
- ✓ Solvents
- ✓ Ester production
- ✓ Food beverage addittives

- ✓ Moisturizers
- ✓ Monomers for biodegradable polymers
- ✓ Buffering agents
- ✓ Food beverage addittives



- ✓ Antibacterial agents
- ✓ Rubber processing
- ✓ Tanning
- ✓ Pesticides
- ✓ Pharmaceutical additives

- ✓ Esters used in food as aroma
- ✓ Food flavouring
- ✓ Animal feed supplement
- ✓ Pharmaceuticals addittives

- ✓ Animal and uman food additive
- ✓ Chemical intermediates
- ✓ Solvents
- ✓ Flavouring agents

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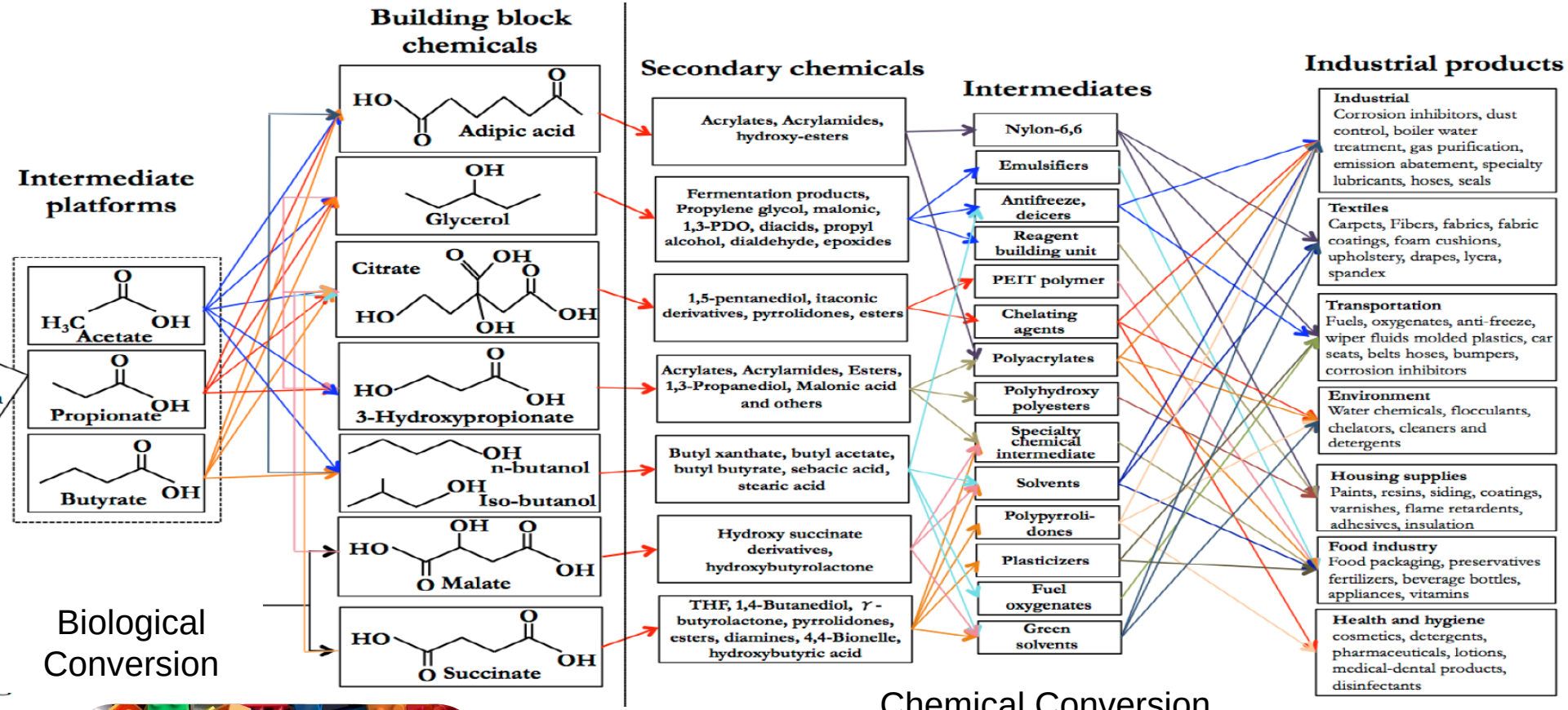
Fonte: Biorefineries based on volatile fatty acids platform – Kartik Chandran – Columbia University. FSM4, Chennai



OFMSW and digestate samples characterisation

Sample type	Date of sampling	VFA (mg/Kg)	Acetic acid (mg/Kg)	Propionic acid (mg/Kg)	Butyric acid (mg/Kg)	Valeric acid (mg/Kg)
OFMSW	07/12/2017	1601,0	1523,0	77,7	< 10	< 10
OFMSW	19/12/2017	2740,0	2375,0	229,0	136,0	< 10
OFMSW	20/12/2017	2147,0	1905,0	176,0	66,2	< 10
OFMSW	22/12/2017	257,0	175,0	81,9	< 10	< 10
OFMSW	08/01/2018	2452,0	1847,0	172,0	338,0	95,3
OFMSW	10/01/2018	1897,0	1711,0	63,0	92,6	< 10
OFMSW	12/01/2018	2658,0	2486,0	69,0	103,0	< 10
Digestate	07/12/2017	562,0	385,0	116,0	60,9	< 10
Digestate	19/12/2017	648,0	407,0	174,0	66,5	< 10
Digestate	20/12/2017	484,0	297,0	133,0	53,5	< 10
Digestate	22/12/2017	257,0	175,0	81,9	< 10	< 10
Digestate	08/01/2018	506,0	384,0	69,5	52,5	< 10
Digestate	10/01/2018	341,0	341,0	< 10	< 10	< 10
Digestate	12/01/2018	915,0	686,0	142,0	87,2	< 10

- **Quantity** and **composition** of VFA are **very variable** in OFMSW and digestate
- **Acetic acid is the most abundant** VFA in OFMSW and digestate

proteine

carboidrati

lipidi

BATTERI IDROLITICI

Aminoacidi

Zuccheri

Acidi grassi a lunga catena

BATTERI ACIDOGENICI

VFA

Piruvato

H_2 e CO_2

ACETOGENICI eterotrofi sintrofici

OMOACETOGENICI autotrofi

Sintrofia

ACIDO ACETICO

Sintrofia

IDROGENOCLASTICI metanogeni

OMOACETOGENICI autotrofi

CO_2

CH_4

Le attività sulla conversione della FORSU

Presentati in fase di valutazione:

- PERCIVAL: conversione di FORSU e di sottoprodotti agroindustriali in Biochemicals anche utilizzando VFA con building blocks
- SATURNO: conversione della FORSU e della CO_2 in biocarburanti biochemicals e biostiamolanti anche utilizzando VFA con building blocks

Approvati in fase di svolgimento

Borsa Lagrange: durata un anno dedicata alla conversione della FORSU in VFAs

BIFOUR: progetto regionale su polo di innovazione, metanazione chimica e biochimica della FORSU

BRISK2: progetto Europeo INFRAIA su infrastrutture ad accesso aperto per la produzione di biocombustibili

BioRobur^{plus}: progetto Europeo su piattaforma JTI dedicato all'ottmizzazione su scala demo della produzione di idrogeno da FORSU

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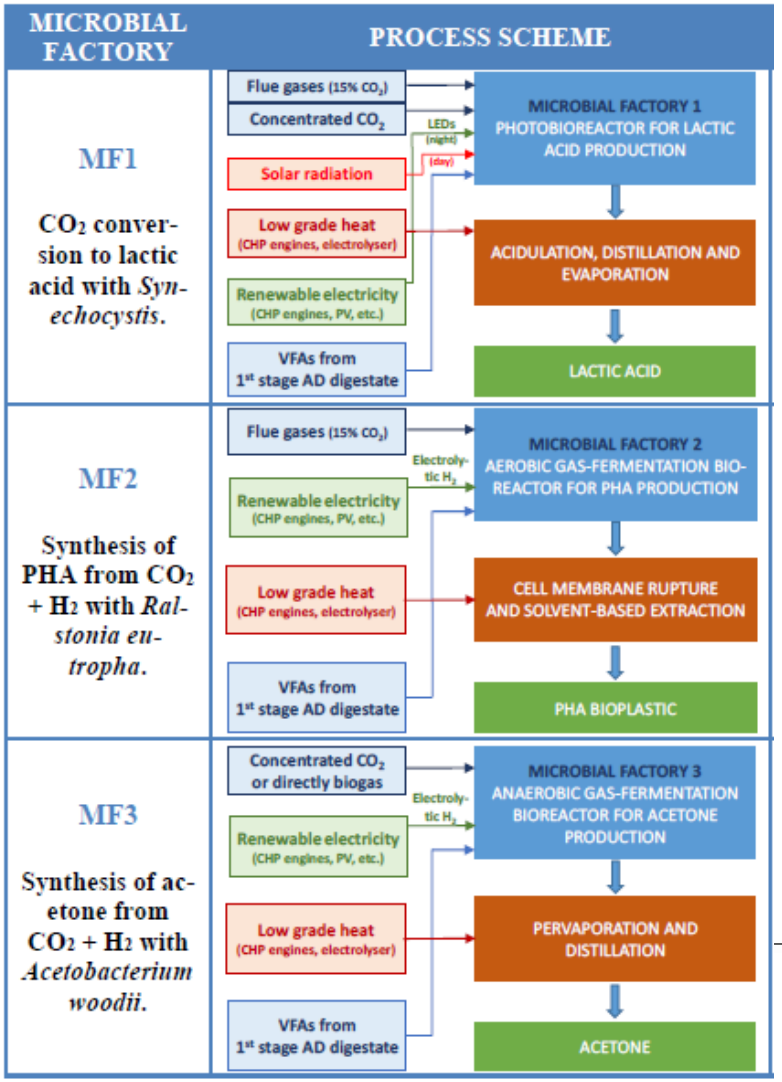
engicoin

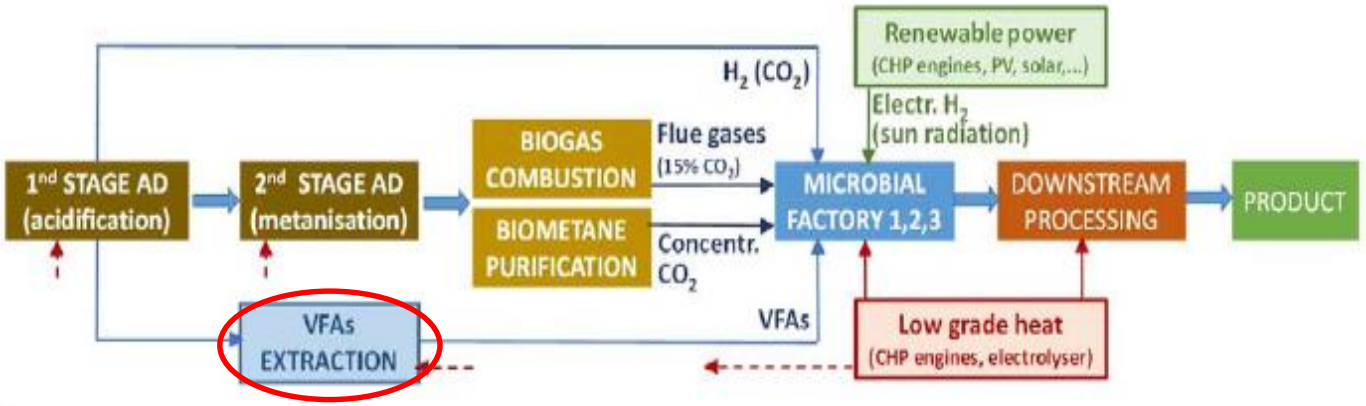
"**Engi**neered microbial factories for **CO_2** exploitation in an **in**tegrated waste treatment platform"



Call: BIOTECH-05-2017 "Microbial platforms for CO_2-reuse processes in the low-carbon economy"

In ENGICOIN, Envipark come terza parte di ACEA è incaricata di ottimizzare la produzione di VFA e $BioH_2$ come substrati in alimentazione alle MF_s per la produzione di acetone e PHA

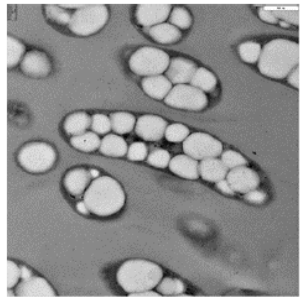
Task 2.3: Complementary carbon substrates extraction and purification from the AD digestate



Controlled anaerobic digestion Acidogenic phase

CO_2 - H_2 VFA

MF 2 engineered *Ralstonia Eutrpha*



PHA

Task 2.3 : VFA production and extraction from the AD digestate

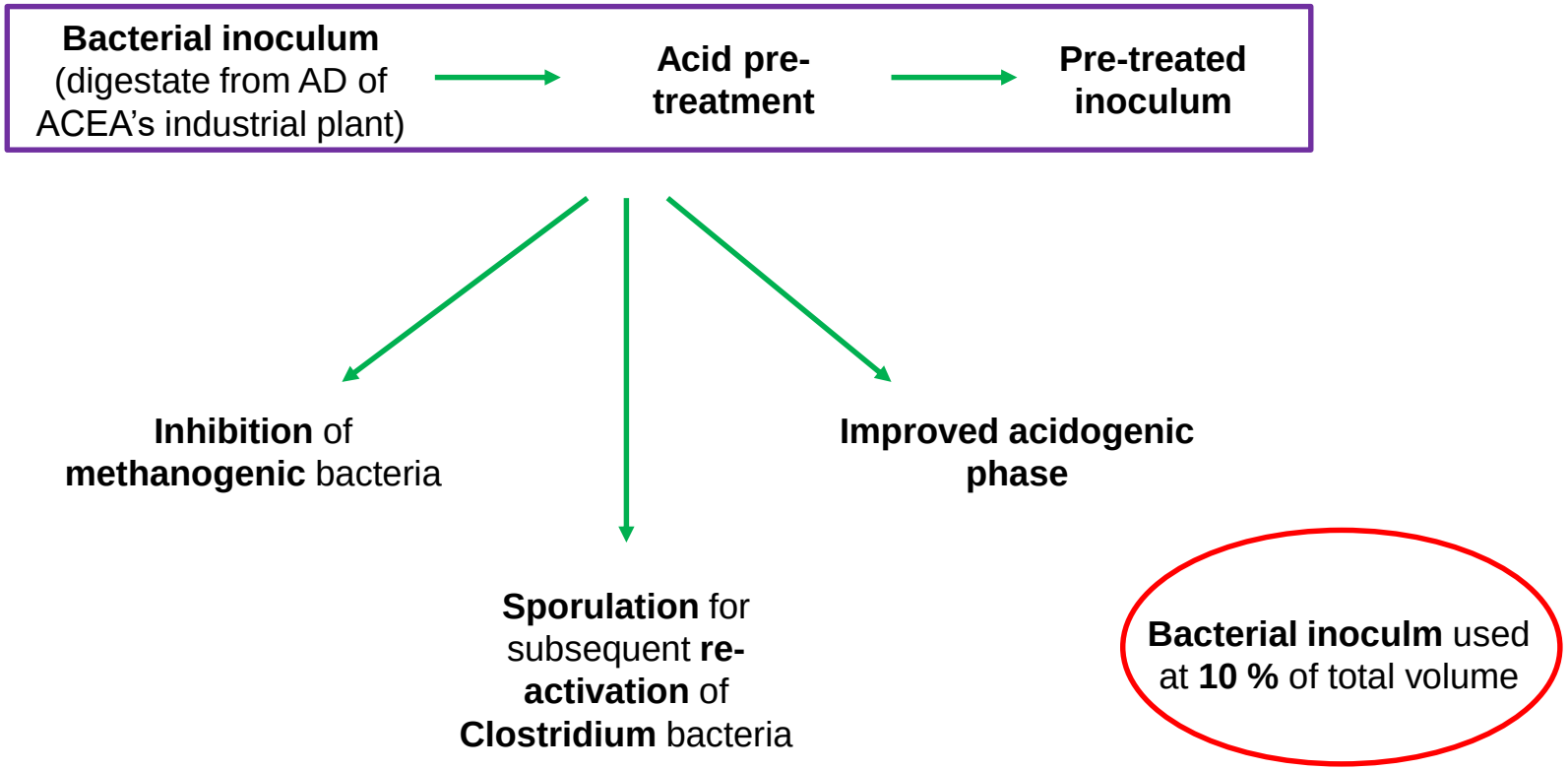
The tests at pilot scale are performed in **CSTR reactors** of different volumes and with different flow rates in order to fine tune **HRT, T, pH as key controlling parameters** for the amount and composition of the VFAs generated

- Selection of **bacteria consortia** responsible for this production during this experimental campaign.

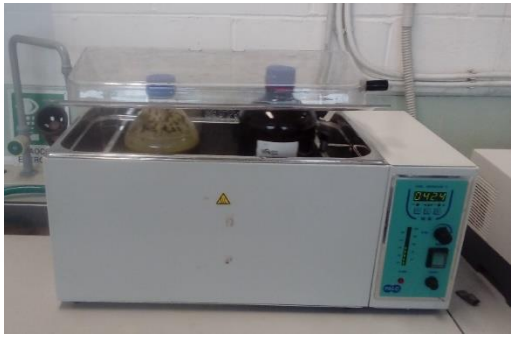
- **Outcomes coming from the partnership** on the improvement of the properties of final products **steer the effort in selection of** the right **operating conditions** for maximizing the production of such acids.

- **Complementary production of H2 and CO2** in the gaseous phase will be monitored and considered as possible by-products to be used as feeding for the following steps

Environment Park VFAs production method
Inoculum pre-treatment



Materials and methods



Thermostatic bath
- **Proper mixing (100 – 120 rpm)**
- **Constant temperature (mesophilic)**

Every 24 h → Withdrawn a sample (20ml) → Centrifuge 3500 rpm 10 min 4°C

Withdrawn a sample (20ml) → **pH**, **Temperature**

Centrifuge 3500 rpm 10 min 4°C → **Acetic acid** (mg/L) Enzymatic kit from Megazyme

Centrifuge 3500 rpm 10 min 4°C → **Total VFA** (mg/L) Chemical Kit from Merck

Process parameters identification

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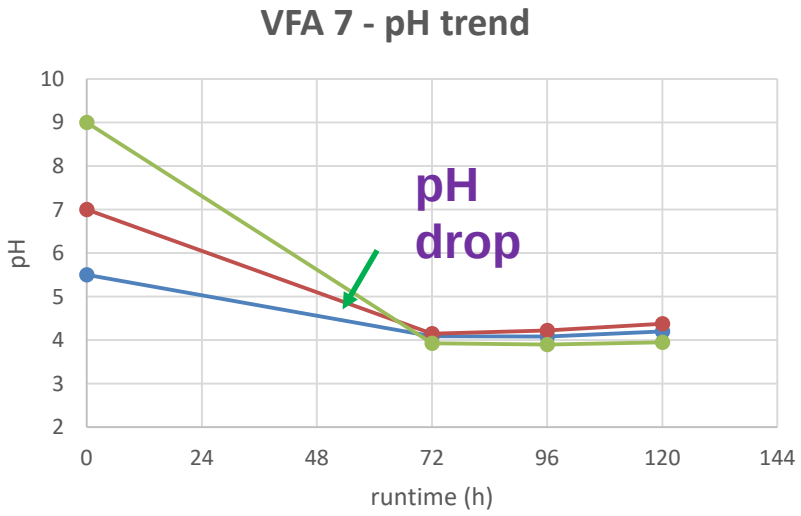

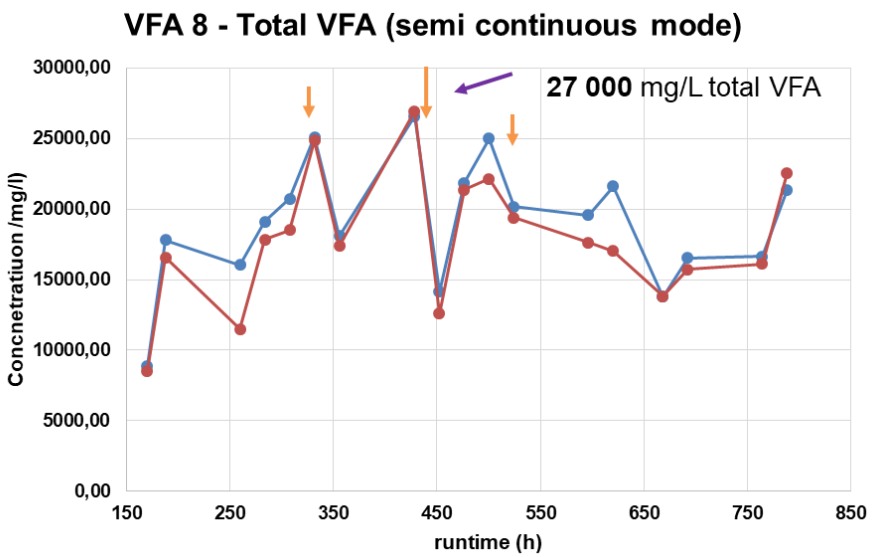

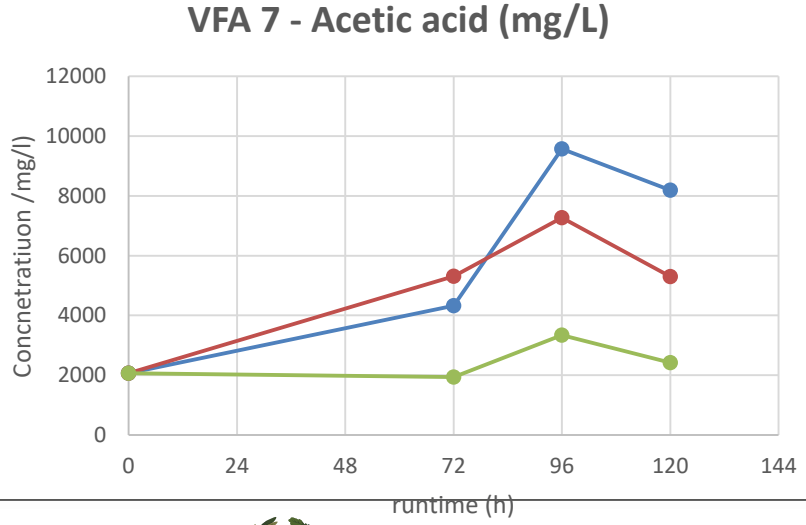

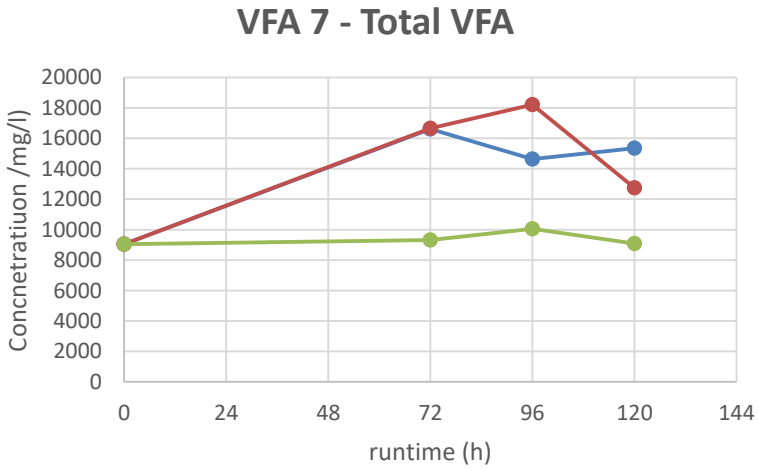

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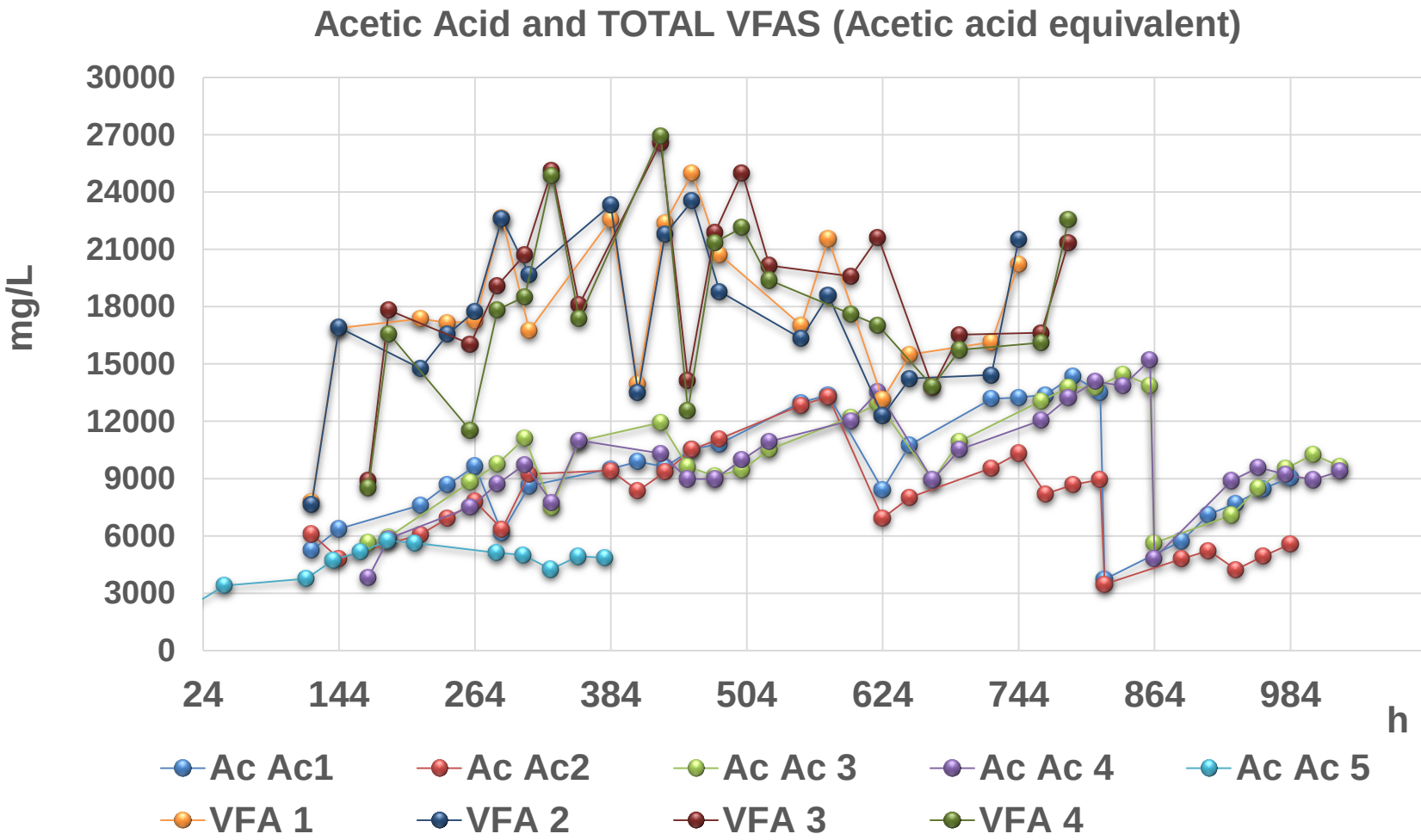
Preliminary VFA production tests in semi-continuous mode



Production method and process parameter settling

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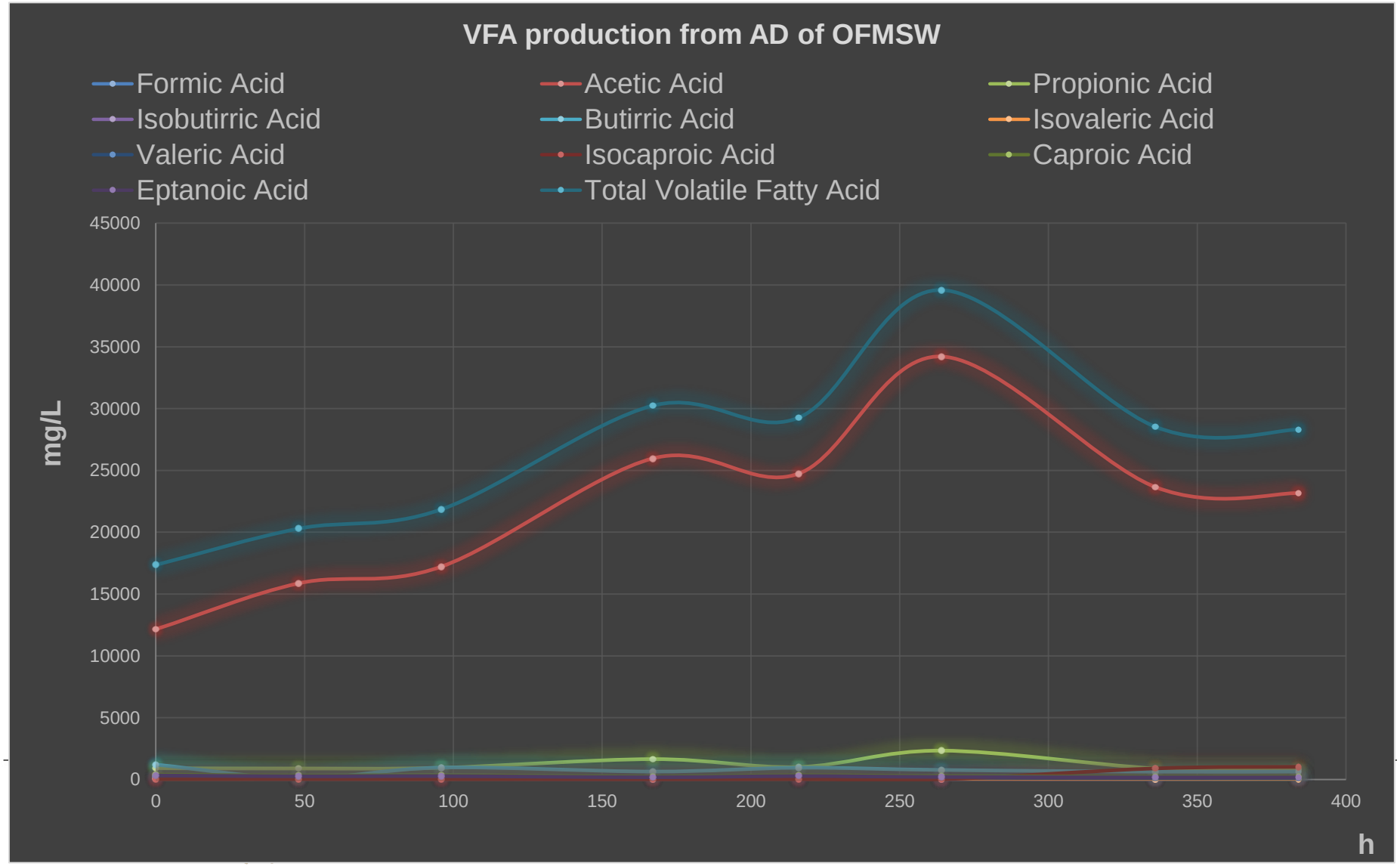
Focus on Acetic and Total VFAs results



Production method and process parameter settling

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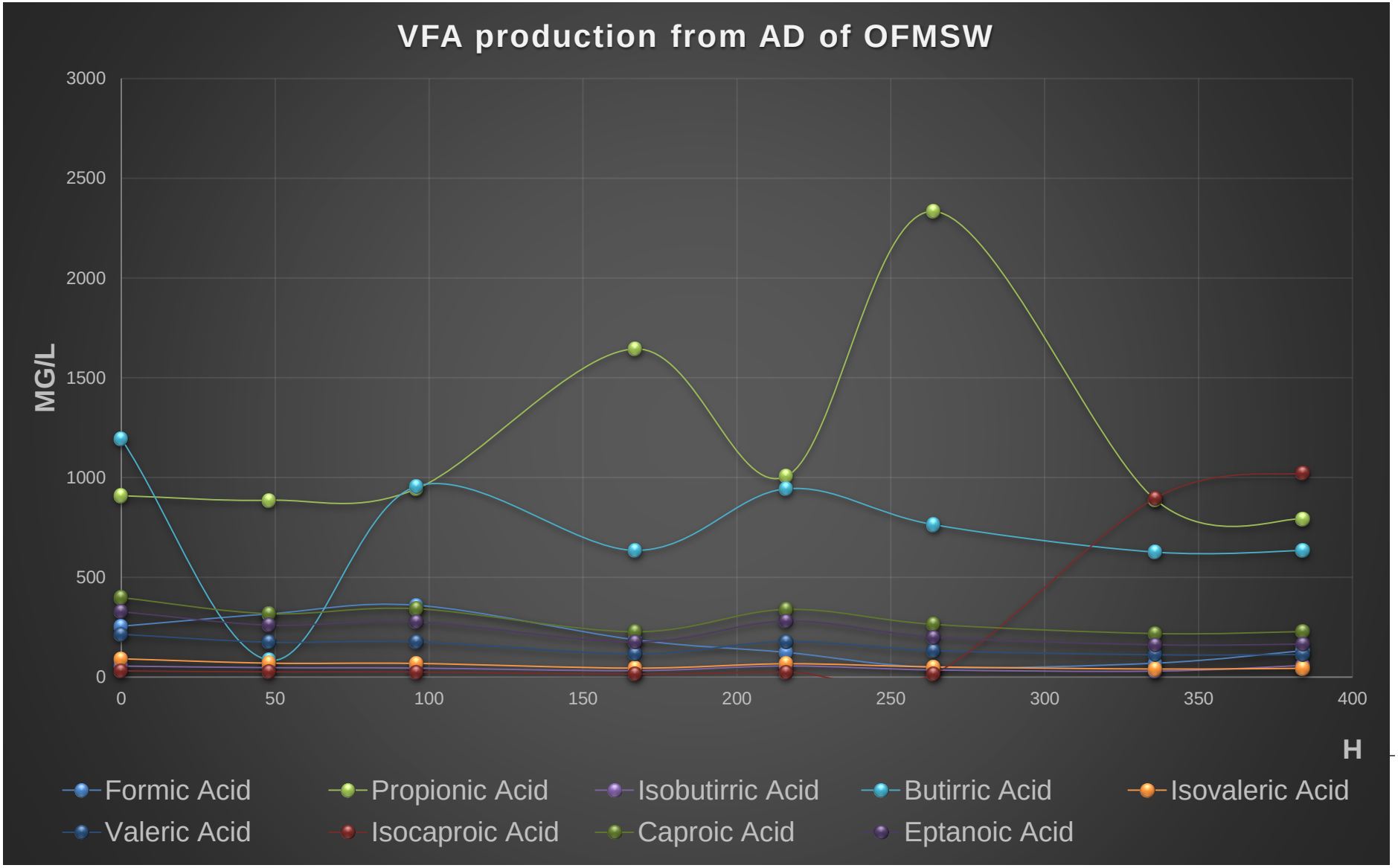
Focus on other low percentage and longer chain acids results



Identification of process parameters

- **OFMSW : inoculum** ratio of **10:1** has been confirmed to be **adequate for VFA production**
- **Inoculum pre-treatment** has been confirmed to **allow VFA** production and to **inhibit the methanogenic phase**
- A **screening** of 3 different **starting pH** has been done and suggest that an **acid starting pH** is **optimal** both to **decrease process cost** and to **increase VFA yields**
- A **working temperature in mesophilic range** has been confirmed to be **suitable**
- An **HRT of 11 days** has been tested and confirmed to be **optimal** for improve the total value of VFAs and the Acetic acid production
- **Longer HRT** could be tested in order to increase **C>5 Acids** values

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