



SCALBUR

LEADING A REVOLUTION  
IN BIOWASTE RECYCLING

# From wastewater treatment plants to biofactories

Yeray Asensio - Aqualia

Final Conference 19<sup>th</sup> of October 2022



# ➤ AQUALIA. Who we are?



**29,662,500**  
Population served  
(GWI\*)



**548,273**  
Customers receiving  
electronic invoices



**17**  
Countries  
present



**10,525**  
Employees



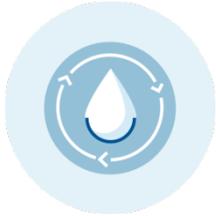
**827**  
WWTP's



**81,156** km  
of managed  
networks



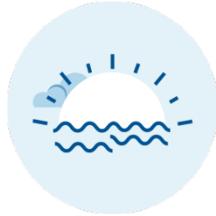
**15.7** M  
Invoices  
issued / year



**238**  
WPP's



**643** hm<sup>3</sup>/year  
Drinking water  
produced



**26**  
Desalination  
Plants



**2,855**  
Drinking water  
repositories

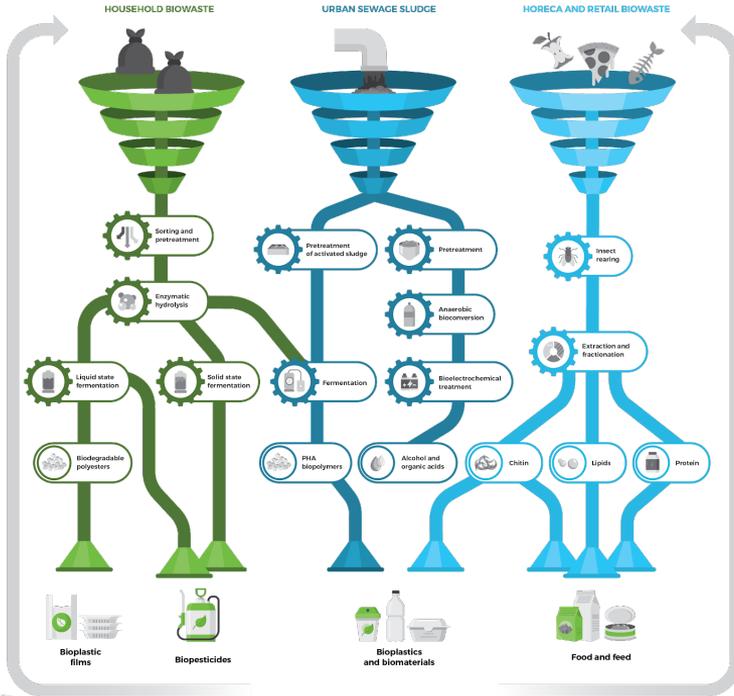


**5**  
Laboratories  
certified according to  
ISO-17025



**22**  
Sports  
centres

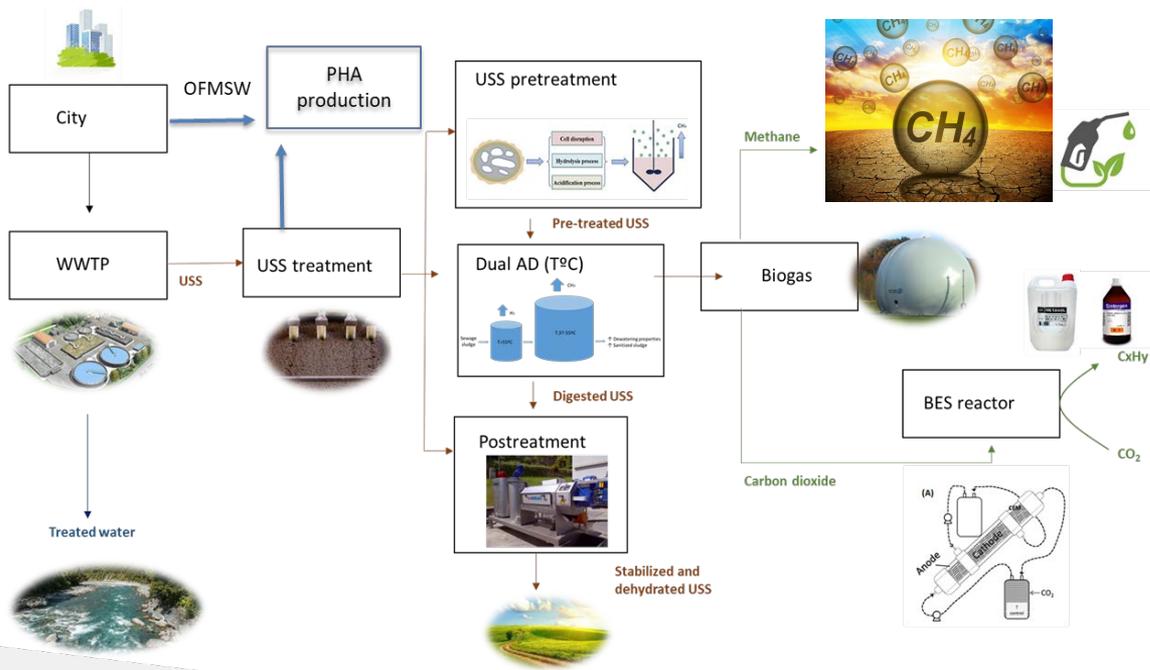
# SCALIBUR – Our mission



- **Main objective:** “Start to end” valorisation process to obtain ready-to-use products from sewage sludge (biogas, biofertilizers, carboxylates and alcohols and PHAs)
- **Specific objectives:**
  - Design, operation and integration of prototypes (OFMSW and USS – DS1 and DS7).
  - Optimization and validation of the technologies in the DS. (DS1, DS6, and DS7)

# SCALIBUR – Our mission

- ✓ To work towards circular economy, converting wastewater treatment plants into biofactories.



# ➤ Advanced AD

Advanced Anaerobic Digestion



## Decentralised Anaerobic digestion

Almost 30% of the total sludge is produced in small WWTPs.

Decentralized anaerobic digestion reduces the amount of sludge produced, chemicals, CO<sub>2</sub> emissions (due to transport) without losing low-cost horizon



## DUAL Anaerobic digestion

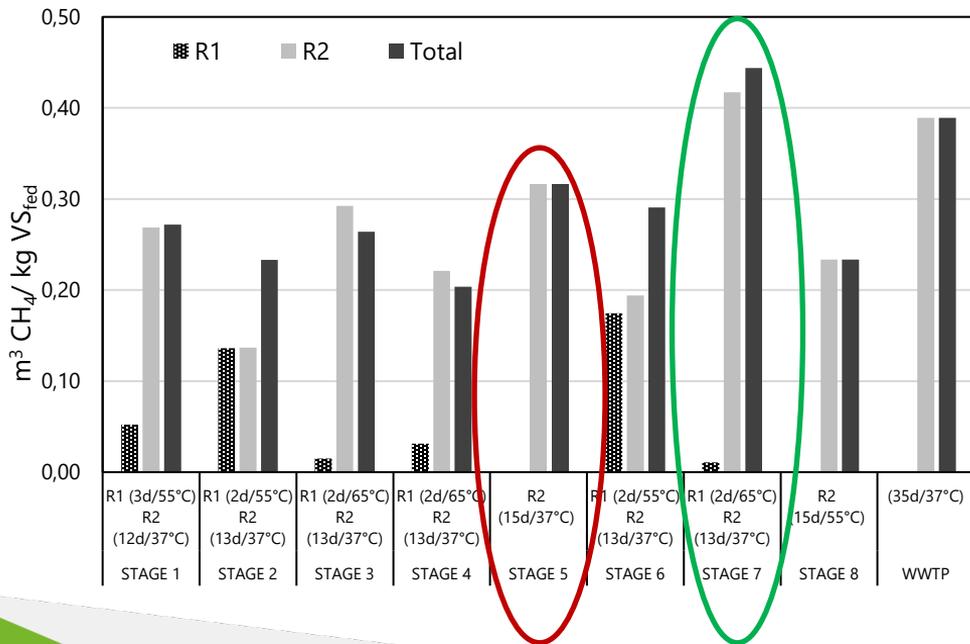
Thermophilic reactor (55-65°C)  
+  
Mesophilic reactor (35-37 °C)

Dual Anaerobic digestion:

1. Sludge reduction
2. Sanitation (**WARNING!**)
3. Bioenergy production.
4. Chemical Usage Reduction

# Advanced AD. Main results DUAL AD.

## DUAL AD



## What about sanitation?

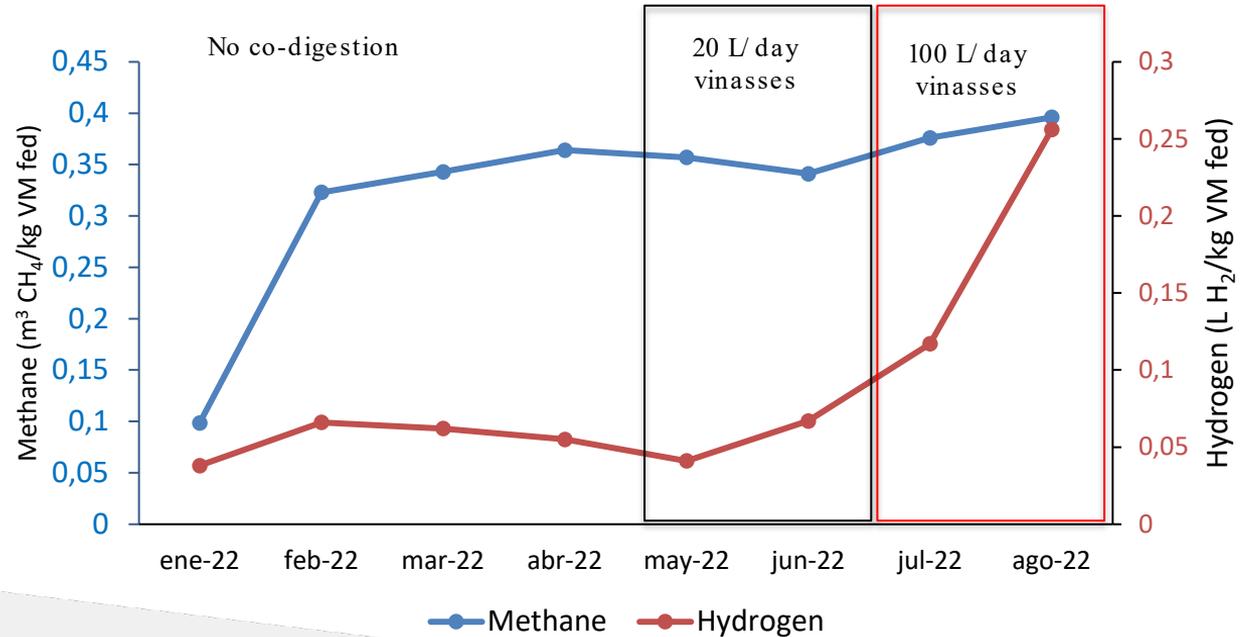
Stage	Sample	Faecal coliforms (CFU/g)	Salmonella spp. (/50g)	Nematodes (eggs/25g)	E. Coli (CFU/g)	E. Coli (CFU/g dw)	E. Coli reduction	Clostridium perfringens spores (CFU/g dw)
<i>Sewage Sludge Directive 86/278/EEC*</i>		absence in a sample of 50g (ww)			<500 CFU/g (ww)			
<i>3rd Draft Sewage Sludge Management<sup>b</sup></i>					< 1x10 <sup>6</sup> CFU/g (dw)		99.99% (4 Log) reduction	< 3x10 <sup>5</sup> CFU/g (dw)
1	Feed	5.00E+03	Detected*	36	2.80E+03	1.58E+05		5.63E+05
	R2 digestate	<10	Not Detected*	18	<10	3.10E+02	99.80%	1.86E+07
	Dewatered Sludge	2.40E+07	Not Detected	<1	2.30E+07	5.20E+08		4.52E+07
3	Feed	1.80E+03	Not Detected	<1	1.50E+03	6.48E+04	99.99%	6.05E+06
	R2 digestate	7.60E+05	Detected	<1	5.00E+06	2.21E+08		1.01E+07
	Dewatered Sludge	1.10E+04	Detected	<1	3.50E+03	1.82E+05	99.92%	1.98E+07
5	Feed	1.60E+03	Not Detected	<1	1.10E+03	6.00E+03	100.00%	6.00E+05
	R2 digestate	4.50E+05	Detected	<1	1.20E+05	4.28E+06		2.03E+07
	Dewatered Sludge	<10	Not Detected	<1	5.00E+00	3.35E+02	99.99%	9.90E+06
6	Feed	4.70E+04	Not Detected	<1	4.00E+04	1.41E+05	96.70%	3.33E+06
	R2 digestate	8.00E+03	Detected	<1	5.20E+03	2.31E+05		1.51E+07
	Dewatered Sludge	<10	Not Detected	<1	1.00E+00	9.93E+01	99.99%	4.07E+06
7	Feed	8.00E+03	Not Detected	<1	2.70E+03	1.58E+04	93.17%	3.75E+06
	R2 digestate	1.70E+05	Detected	<1	1.20E+05	3.72E+05		1.76E+05
	Dewatered Sludge	3.20E+02	Not Detected	<1	2.60E+02	8.15E+03	97.81%	5.01E+05
8	Feed	4.70E+02	Not Detected	<1	4.40E+02	1.14E+04	96.92%	5.97E+06
	R2 digestate	9.30E+02	Detected	<1	8.30E+02	1.22E+05	22.85%	6.59E+07
	Dewatered Sludge	3.74E+05	Not Detected	<1	3.49E+05	1.55E+06	72.83%	1.80E+07

# Advanced AD. Main results DUAL AD.

ANNEX: Co-digestion trials at pilot scale using optimized stage [co-substrates].



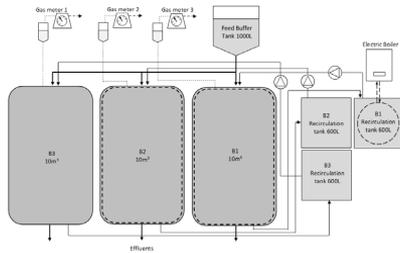
## DUAL AD tests.



# Advanced AD. Main results DAHLIA®.



M01 Decentralized AD



M48 Decentralized AD: DAHLIA®

Some relevant results:

- **Cost-effective solution for US\$ treatment in small WWTPs.**
- **↓ US\$ management costs.**
- **↓ CO2 emissions.**
- **Adapted to different climate scenarios**



Adapted to different climate scenarios: Cost-effective solution



Greenhouse



insulating outer layer



Fed by gravity

DAHLIA  
(Working volumes)

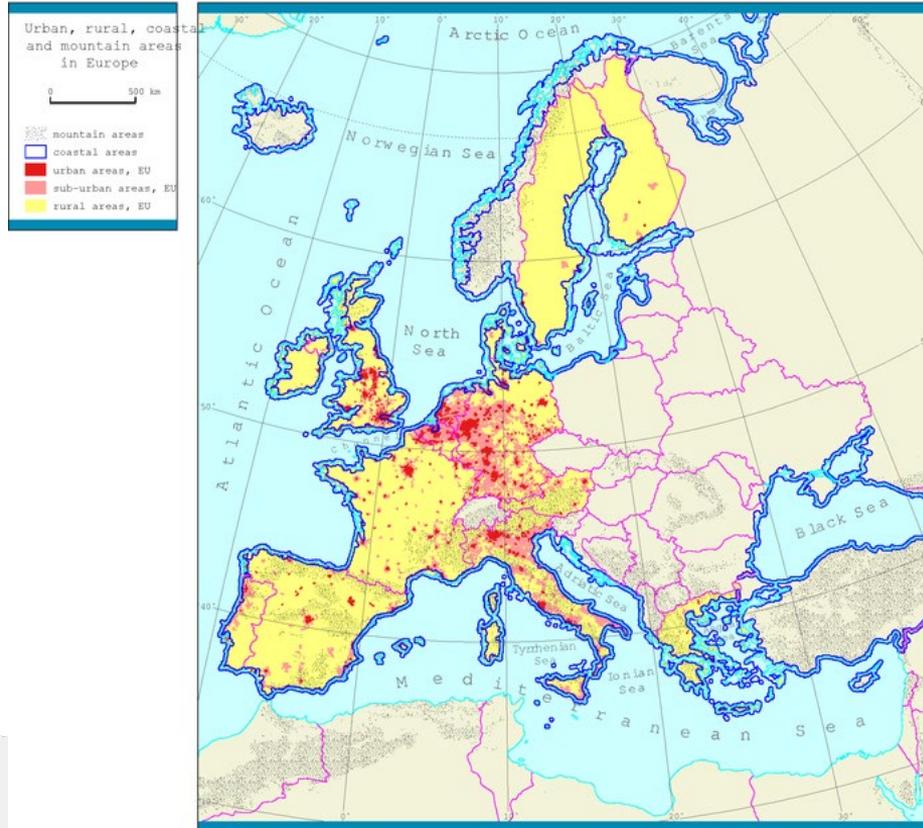
10 m<sup>3</sup>

20 m<sup>3</sup>

50 m<sup>3</sup>

100 m<sup>3</sup>

## ➤ Advanced AD. Main results DAHLIA®.



# ➤ Microbial Electrochemical Technologies. Starting point!

The ability of microorganisms to derive electricity from their vital activities was initially described by English botanist [Potter \(1911\)](#). In this work, he measured the electric potential of *Saccharomyces cerevisiae* and *Escherichia coli*, using a galvanic cell with platinum electrodes, attributing his

microbial biotechnology

Applied  
Microbiology  
International  
Open Access

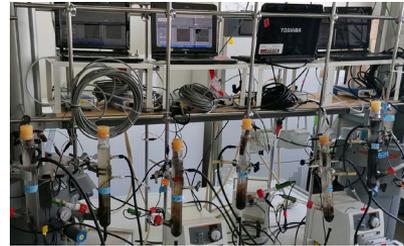
Editorial | [Open Access](#) 

Microbial electrochemical technologies: maturing but not mature

Federico Aulenta, Sebastià Puig, Falk Harnisch

First published: 26 December 2017 | <https://doi.org/10.1111/1751-7915.13045> | Citations: 10

**BIOELECTROCHEMICAL REACTOR FOR TREATING REAL BREWERY WASTEWATER  
(Hydrogen production!!!)**



**Lab-Scale 0.2 mL (working volumen)**

**DEMO Scale (200 L wastewater/h)**

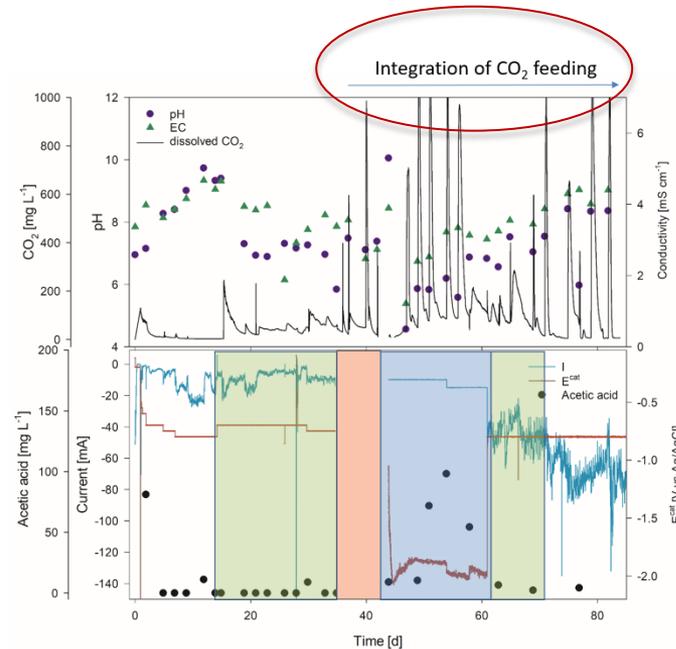
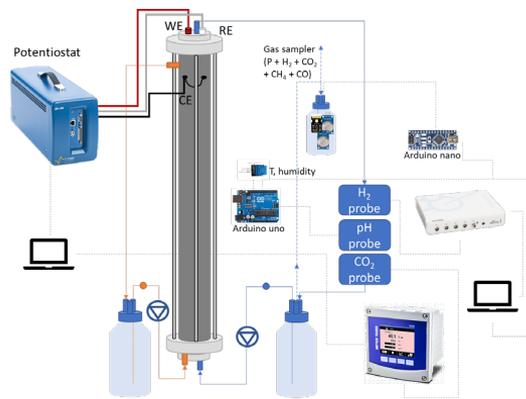


**7-YEAR DEVELOPMENT**

**INDUSTRIAL SCALE 20 m<sup>3</sup>/h UNDER CONSTRUCTION!!!!**

# CO<sub>2</sub> recycling. Main results.

- ✓ Maximum HAc concentration: 1.52 g L<sup>-1</sup>
- ✓ Max HAc production rate: 0.312 g m<sup>-2</sup> d<sup>-1</sup>.
- ✓ CO<sub>2</sub> conversion rate: 1.89 tCO<sub>2</sub> tHAc<sup>-1</sup>.
- ✓ Energy consumption: 2.82 kWh kgHAc<sup>-1</sup>



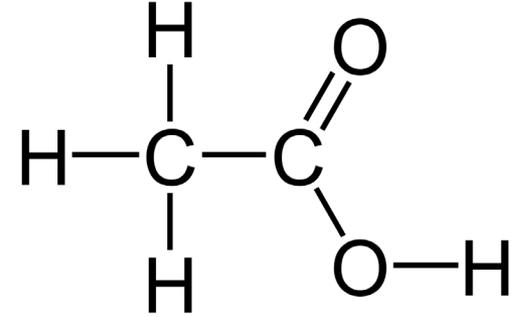
# ➤ Biobased products! READY TO USE!



Bio-fertilizers



Bio-energy



Organic acids!

## ➤ Summary

- We have optimised a great solution to treat USS for high-populated cities (DUAL AD). High-quality bio-fertilizer!
- We have developed and registered DAHLIA<sup>®</sup> that is ready for isolated areas (no matter the climate scenario)!. Energy recovery in isolated areas!
- We have learnt about pilot bioelectrochemical reactors. More research is needed to optimise the technology, but we are on the right track!!! But we are able to produce organics!



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 SCALIBUR project

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