MICROALGAE AS A SUSTAINABLE ALTERNATIVE FOR WASTEWATER TREATMENT

SaltGae

algae to treat saline wastewater

FINAL EVENT

Ljbliana (Slovenia),
September 25th, 2019

Project coordinator:
Jose Ignacio Lozano

FUNDITEC

This project has received funding from the European Union's Horizon 2020 Innovation Action programme WATER under grant agreement no 689785

Saltgae Project Overview

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A Horizon 2020 project:

"Demonstration project to prove the techno-economic feasibility of using algae to treat saline wastewater from the food industry."

• Action programme	Water 1b-2015 IA
• **Started**	01-Jun-2016
• **Ends**	30-September-2019
• Estimated Project Cost	€9 800 000
• Requested **EU Contribution**	**€8 300 000**
• Project Coordinator	José Ignacio Lozano (Funditec)
• Project Officer	Erik Pentimalli (EASME/B/02)
• Number of partners	21

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Project Motivation

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- For any industry generating large amounts of wastewater, **management of their residues to comply with the EU directives involves costs**, which can be very high.
- This issue is specially critical for many industrial sectors that **generate saline wastewater**, such as *food processing*, *leather* industries, land-based *aquaculture*.
- This kind of waste, with **high concentrations of biodegradable organic matter**, suspended solids, nutrients (nitrogen and phosphorus) **and salt** (concentrations up to 15%) **is *extremely difficult and expensive to treat by conventional means*** (e.g. anaerobic digestion treatment is inhibited).
- This limitation **can make the cost unaffordable** for SMEs, who can decide not to comply with EU directives and discharge without adequate treatment, causing severe damage to the environment.

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Project Description

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- Saltgae Project is an innovative **modular technology** for the **efficient treatment of saline wastewaters** with organic load, which:
  - ✓ *Complies with* European Directives
  - ✓ *Recycles water for non-potable applications and valorising the contaminants as a valuable resource.*
  - ✓ *Ease of operation*
  - ✓ Significant *cost reductions*

500 m^2 Algae pond

AD pilot reactor

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Project Objectives

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1)Technical

- To develop a ***techno-economically viable solution for the treatment of saline wastewaters*** from the F&B industry, and ***its demonstration at large scale***, with:
  - **Efficiency**: BOD, N and P *removal* (> 90%) and algae biomass growth (> 15 g/m^2/day);
  - **Robustness:** Able to deal with *different salinity levels* (2 g/L to 50 g/L), wastewater *compositions* and *cultivation* conditions;
  - **Cost reduction**: > 40% respect to current alternatives for saline wastewater with COD
  - **Profitability**: Able to valorize the algae biomass, transforming a waste into revenue, with an increment > 15% profit margin earned per tonne of algae biomass produced.

2) Social-environmental

- To develop an innovative platform
  - for the *mobilization and networking of stakeholders* from all the different ww sectors
  - for the *dissemination of results* with the aim of promoting paradigm shift in perception from ‘wastewater treatment’ to ‘resource valorisation’.

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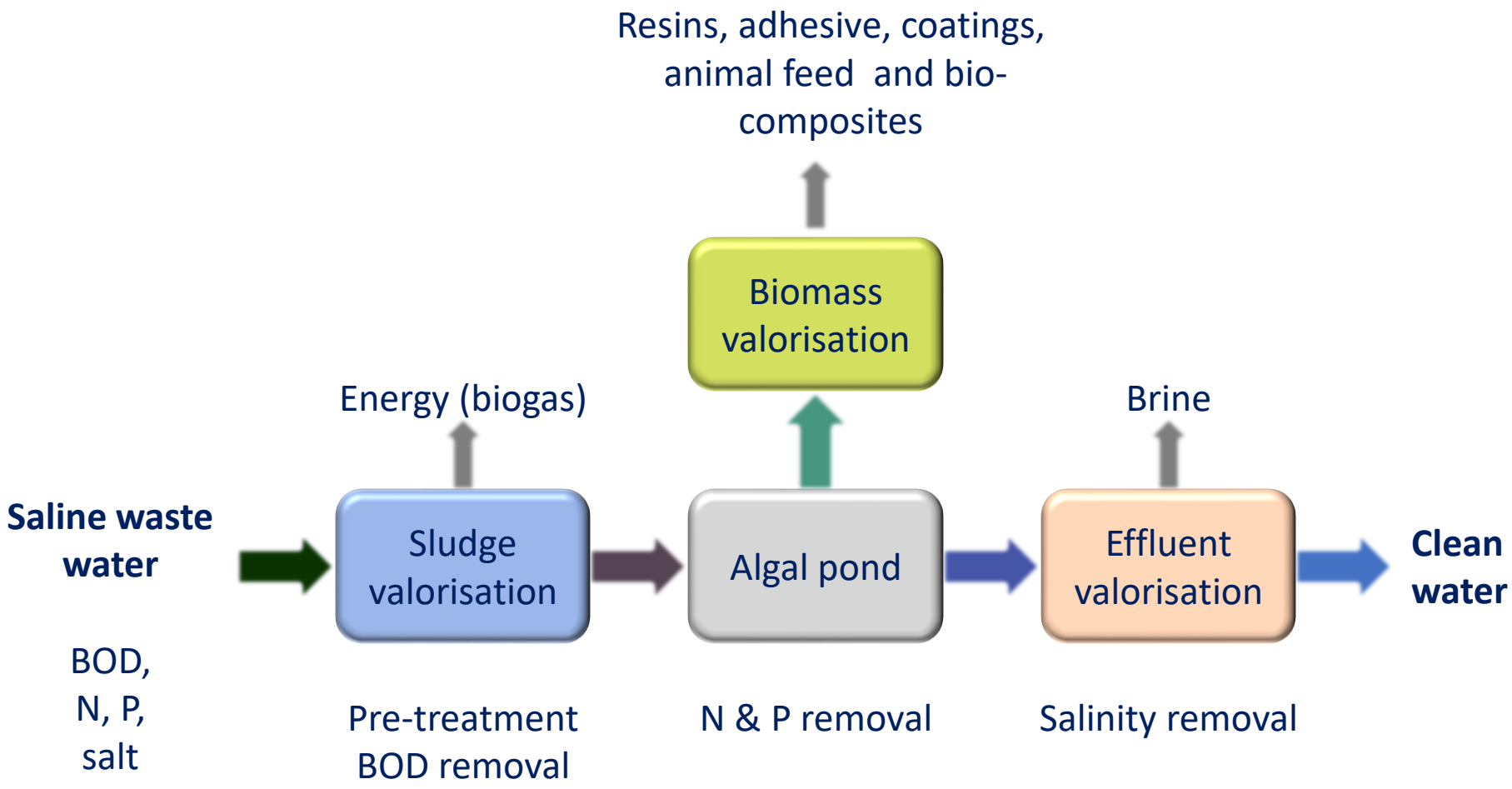
Saltgae Conceptual Diagram



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Consortium

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FUNDITEC

RISE

algen algal technology centre

Central & Northern Arava-Tamar R&D

Archimede Ricerche Srl

Bibo Aqua

NOVA id FCT

FOOD+i CLUSTER

DCU Ollscoil Chathair Bhaile Átha Cliath Dublin City University

European Desalination Society

enco engineering & consulting

EUBIA

OXIDINE Water Technology

EXTRACTIS

PTP SCIENCE PARK

iBET Instituto de Biologia Experimental e Tecnológico

INSTM

KOTO

PRODUMIX Basemixes for piglets Núcleos para lechones

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Consortium

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- Belgium
- France
- Ireland
- Italy
- Spain
- Slovenia
- Sweden
- Portugal
- Israel

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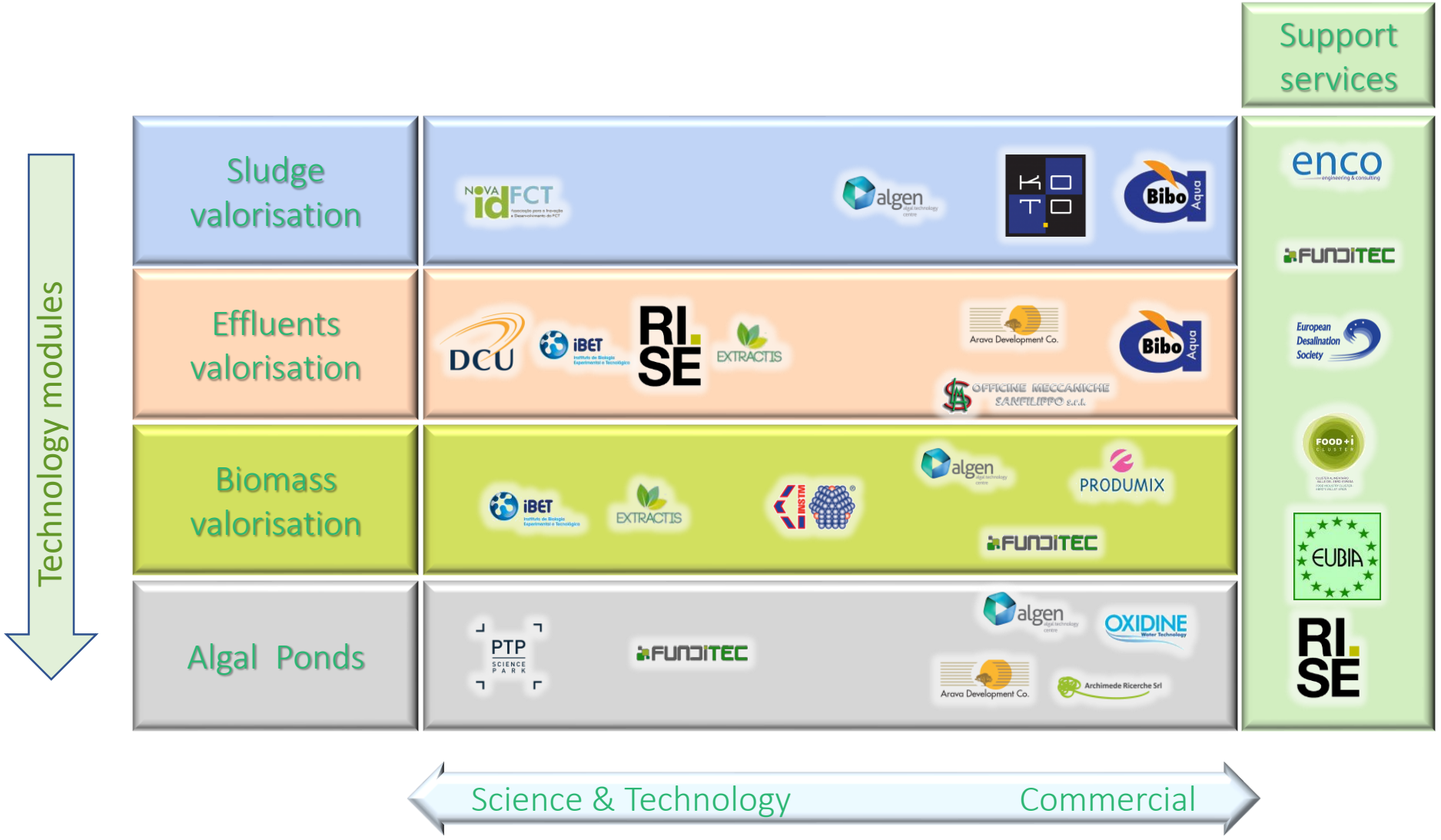
Project structure vs Partners



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INNOVATION RESULT:
Efficient Sludge valorisation

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Pre-treatment

Remove of 90% suspended solids,
removal of 30% of incoming COD

Sieving/DAF

Air
Micro bubbles

Two-phase AD in saline WW

Technology challenge

CH_4, CO_2

hydrolysis
acidogenesis
acetogenesis

50 g Na / L
127 g NaCl / L

VFAs
Etanol

Dilution with
desalinated water

methanogenesis

20 g Na / L
50 g NaCl / L

Anaerobic granules

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INNOVATION RESULT: Effluent valorisation

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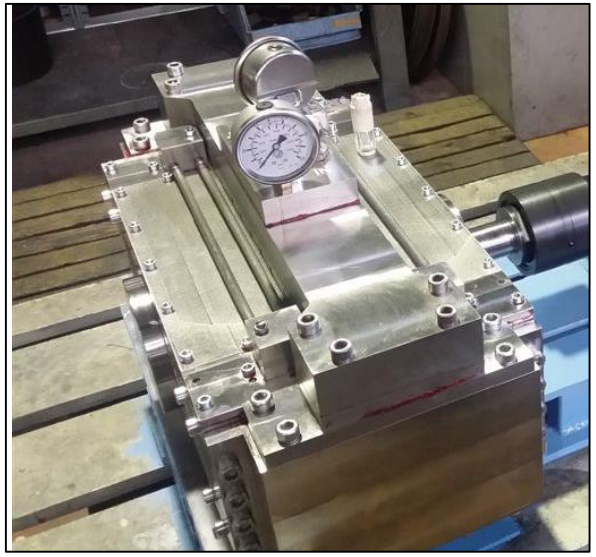
- Ultrafiltration:

- Best pretreatment for 99% removal of mass foulants
- Good method for biomass harvesting Up to 250g/l

- Electrodialysis vs RO:

- ED: achieve low conductivities (1-2 mS/cm) with sufficient yields to consider a viable industrial installation (>50%).
- RO: good performance without severe fouling!



- High pressure RO pump and energy recovery device

- Self-priming pump design that avoiding the need for a booster pump to pressurize the feed flow.
- Efficiency around 90%

Technology challenge

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INNOVATION RESULT: Algal Ponds

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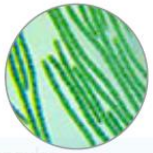
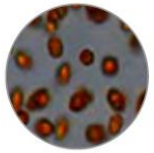
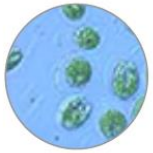
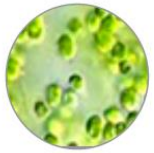
SALTGAE solution (algal-bacterial ecosystem)

When we add algae to bacterial system:


Spirulin


Dunaliella salina


Tetraselmis


Nannochloropsis

- ✓ they can consume the CO_2 produced by bacteria and convert it into own biomass using solar light (photosynthesis). A side product of this process is oxygen, which can be used by bacteria to reduce BOD: replaces the need for aeration.
- ✓ Partially embodies the energy contained in the wastewater into the biomass which can then be used for other purposes or to recover energy into biogas.
- ✓ As result, the treatment is much cheaper due to the reduced costs of aeration, CO_2 is recycled rather than contributing to the climate change, and biomass can be further utilized (and sold).

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INNOVATION RESULT:
Algal Ponds

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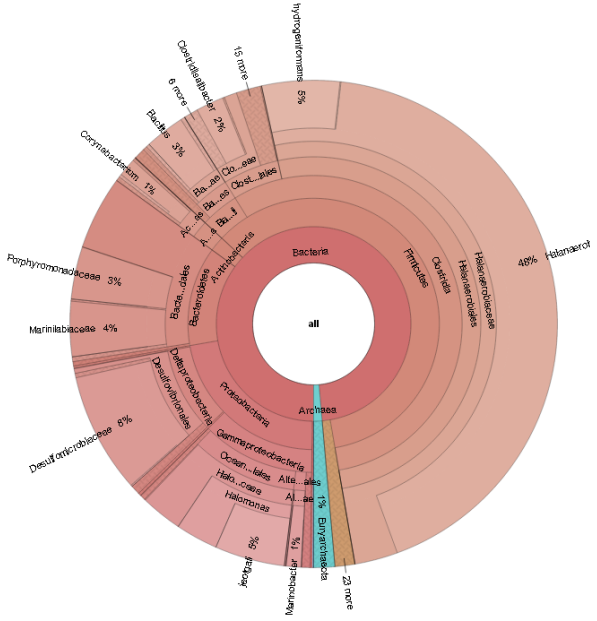
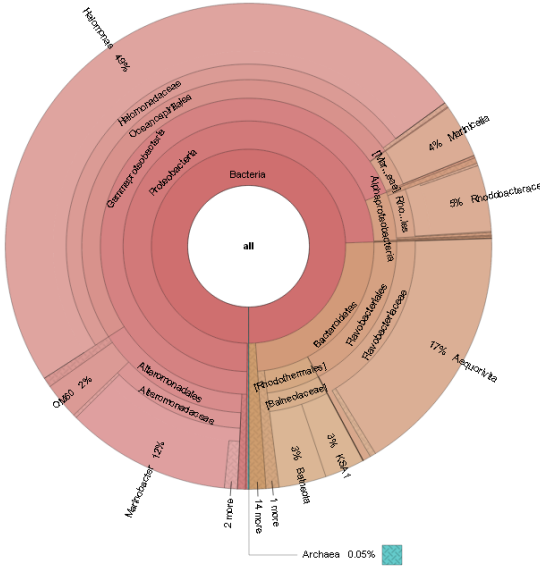
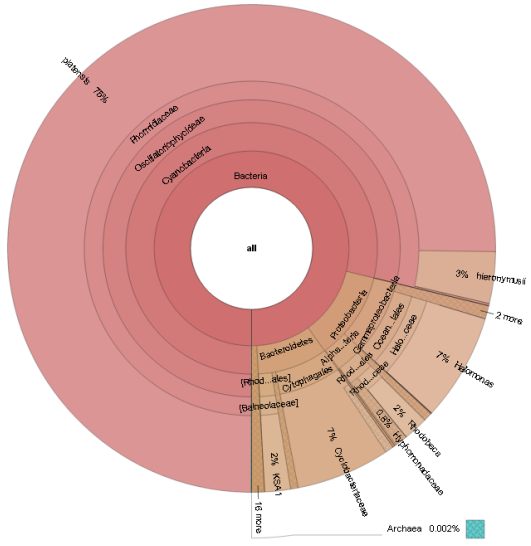
A. Microbiome of tannery WW



B. Microbiome of *D. salina* in tannery WW



C. Microbiome of *Spirulina* in tannery WW



Algal-bacterial ecosystem

Krona pie-charts of microbiome associated with:

A. Tannery WW without algae
B. D. *salina* grown in tannery 10% v/v
C. *Spirulina* grown in tannery 10% v/v

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INNOVATION RESULT:
Algal Ponds

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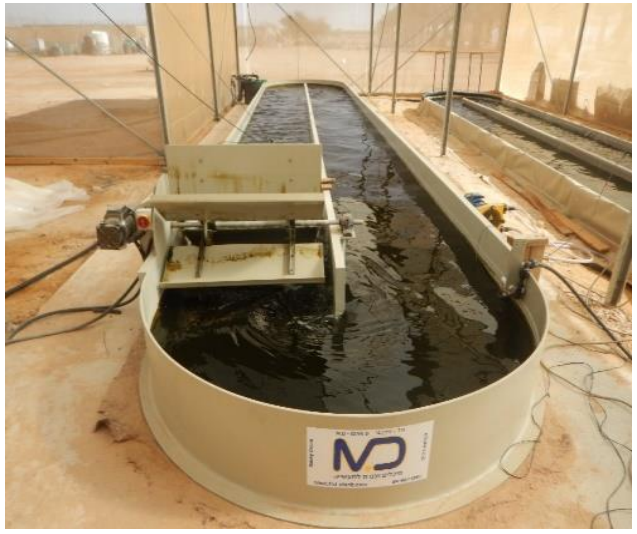
Smart Desing and Operation

- *Efficiency:* Different agitation degrees and pond shapes
- *Saving energy:* Different agitation devices (paddle Wheel)
- *Economy:* Different materials and construction approach to <u>reduce cost</u>



Technology challenge

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INNOVATION RESULT: Biomass Valorisation

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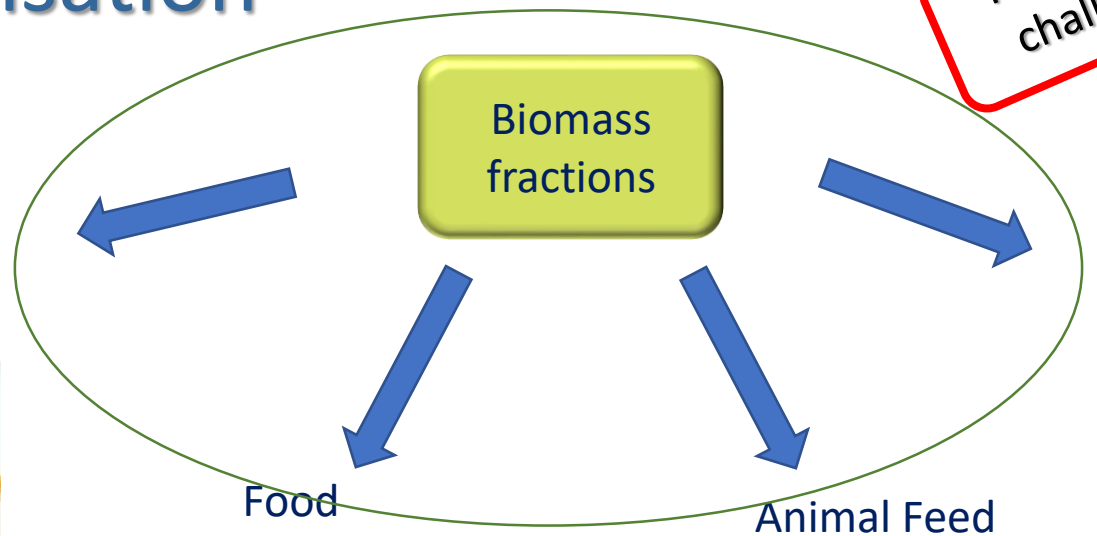
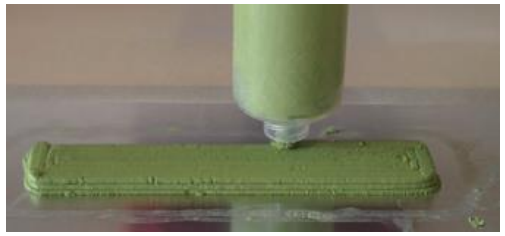
Technology challenge





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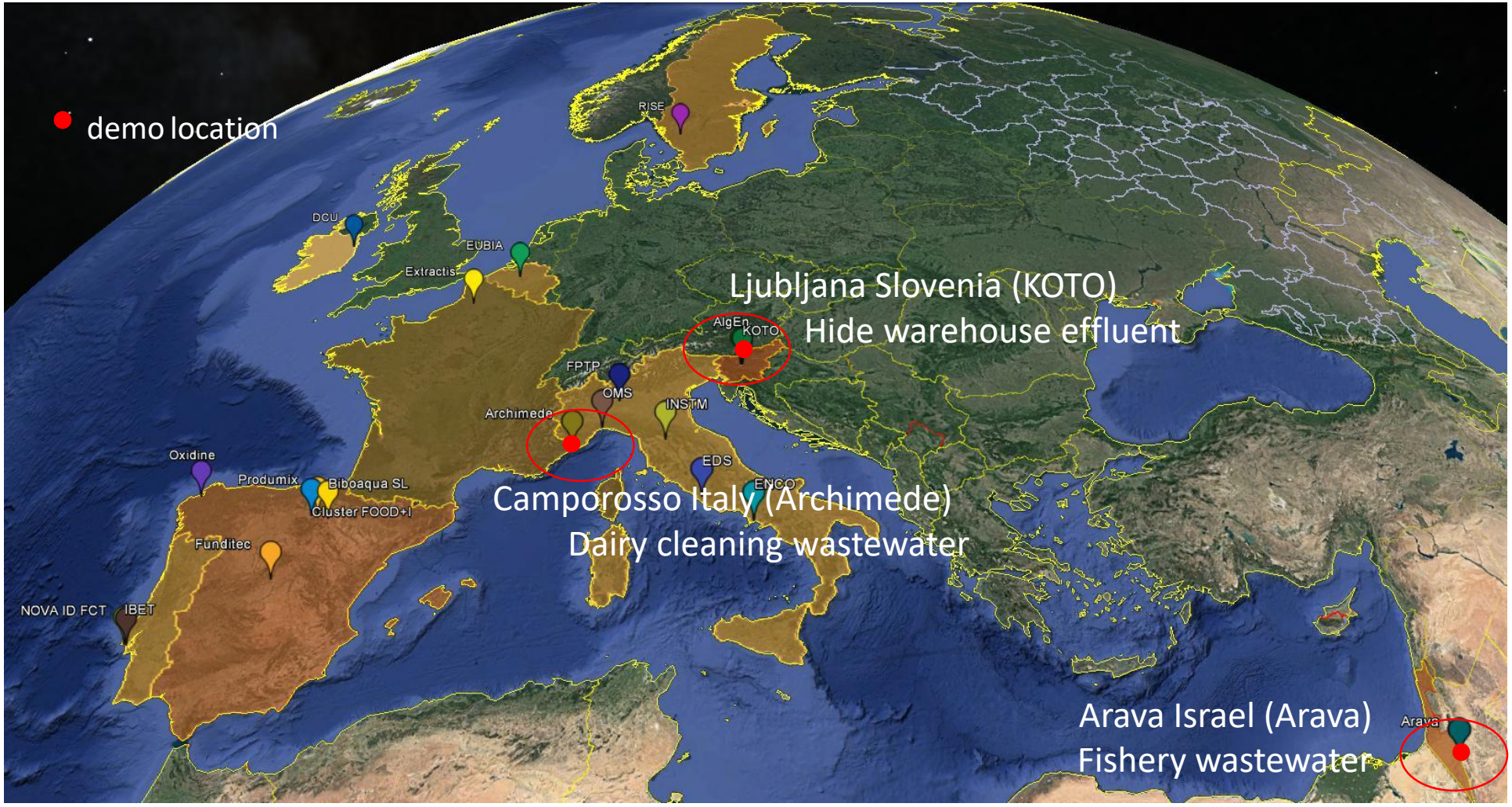
Demo Sites



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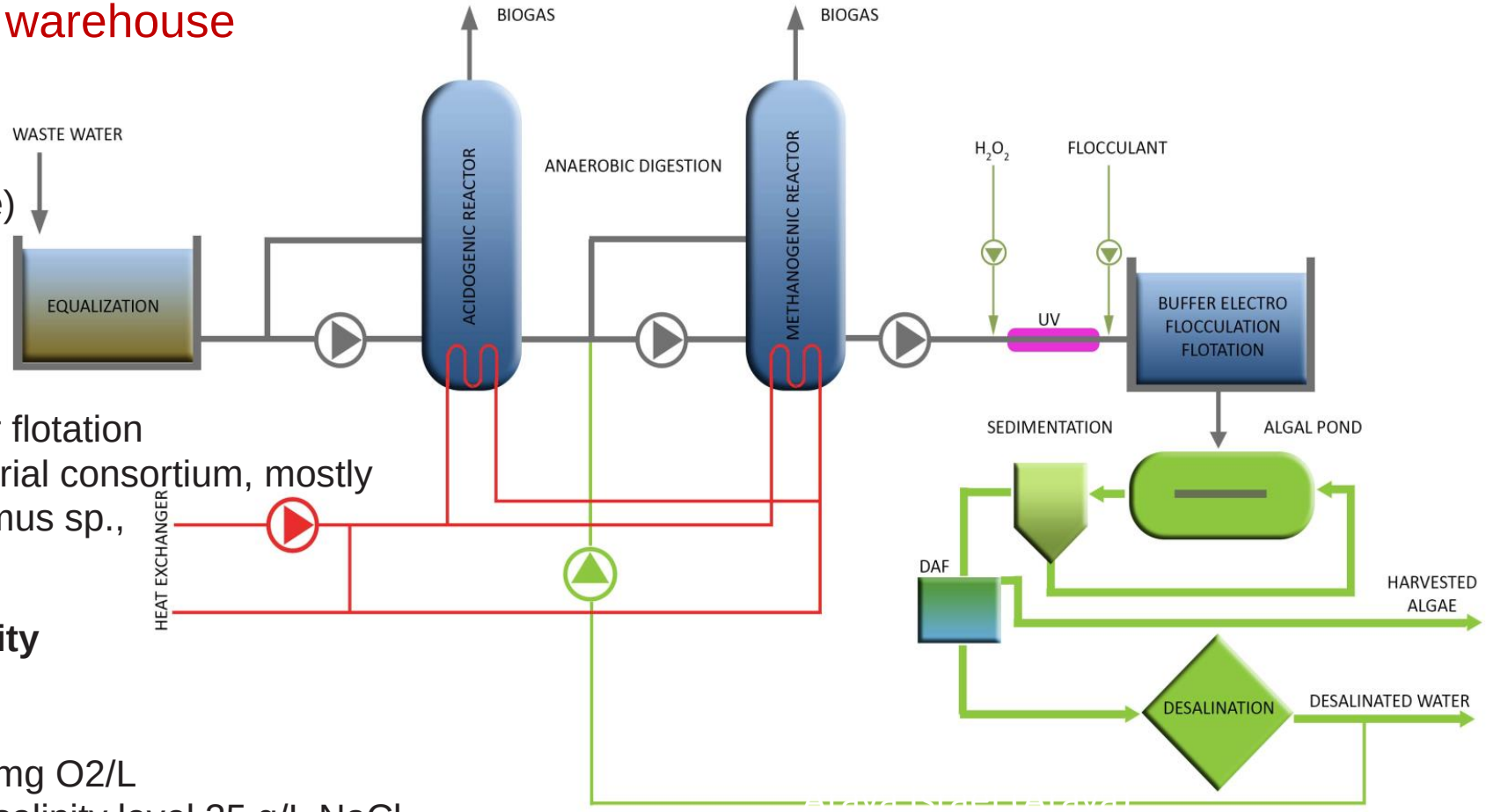
Ljubljana Demo

Water from the tannery warehouse

Technologies

- ✓ Sieving and pre-treatment
- ✓ Anaerobic digestion (Two stage)
- ✓ 100 m2 algal-bacterial pond
- ✓ Desalination pre-treatment
- ✓ Reverse osmosis
- ✓ Biomass harvesting by sedimentation and dissolved air flotation
- ✓ Naturally occurring algae-bacterial consortium, mostly Scenedesmus sp, Ankistrodesmus sp.,



Demonstrator treatment capacity

- ✓ Up to 1 m3/d
- ✓ Salinity levels: up to 50 g/L
- ✓ Organic matter: COD 12,000 mg O2/L
- ✓ 0.25 m3 methane/kg COD at salinity level 35 g/L NaCl

Contact: Robert Reinhardt robert@algen.si

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Arava Demo

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Arava uses water from aquaculture (fish farming) by algae

Technologies

- ✓ Smart metering and DAF system
- ✓ HRAP algal pond: 3 x 50 m3 HRAPs
- ✓ RO system
- ✓ Spirulina, Tetraselmis, Nannochloropsis

Demonstrator treatment capacity

- The fish system: three 10 m3 L tanks with about 700 kg of total fish biomass (barramundi fish).
- Salinity levels: 2.5 g/L
- Organic matter: COD 10,000 mg O2/L, 5 kg/d of biomass
- Wastewater contains around 200 ppt of nitrate and 10 ppt phosphate.

Contact Dr. Yair Kohn yairk@arava.co.il en.agri.arava.co.il

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Camporroso Demo

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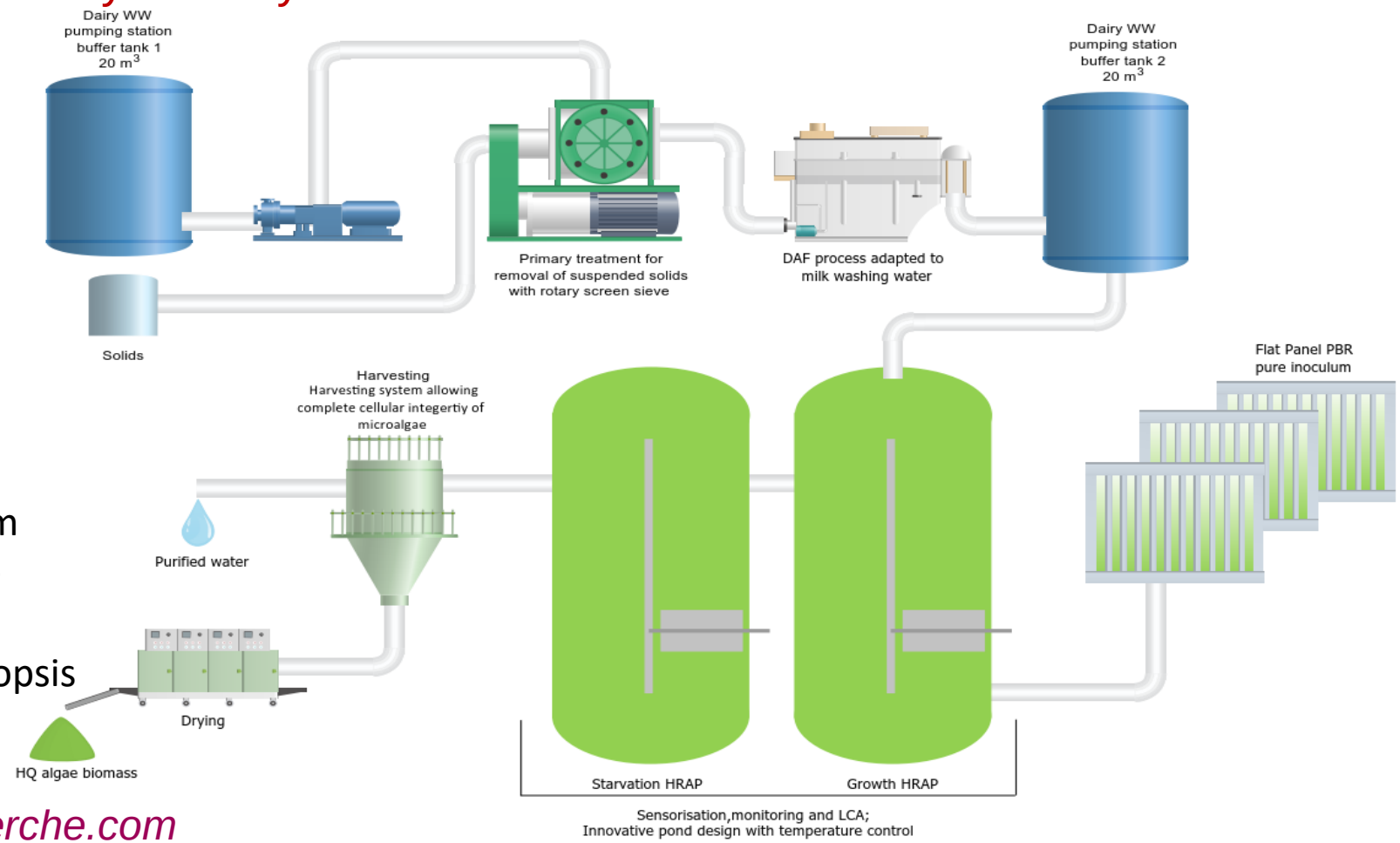
Archimede treat water from the dairy industry.

Demonstrator treatment capacity

- 20 m3/d
- Salinity levels: 10–30 g/L
- Organic matter: COD 5,000 mg O2/L,
- TKN 100 ppm
- 20 kg/d of biomass

Technologies

- ✓ Dairy wastewater pretreatment
- ✓ 3000 m2 algal phyto depuration system
- ✓ Biomass harvesting drying and storage
- ✓ Microfiltration and centrifugation
- ✓ Spirulina, Tetraselmis and Nannochloropsis



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Thanks for your Attention

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