



Accelerating circular bio-based solutions  
integration in European rural areas

# Microalgae as part of the circular economy

## An introduction to the ALG-AD project

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# The ALG-AD project combines AD with microalgal cultivation to generate value

## AIMS



Develop new market opportunities for digestate without risk of eutrophication



Recycle liquid digestate into biomass

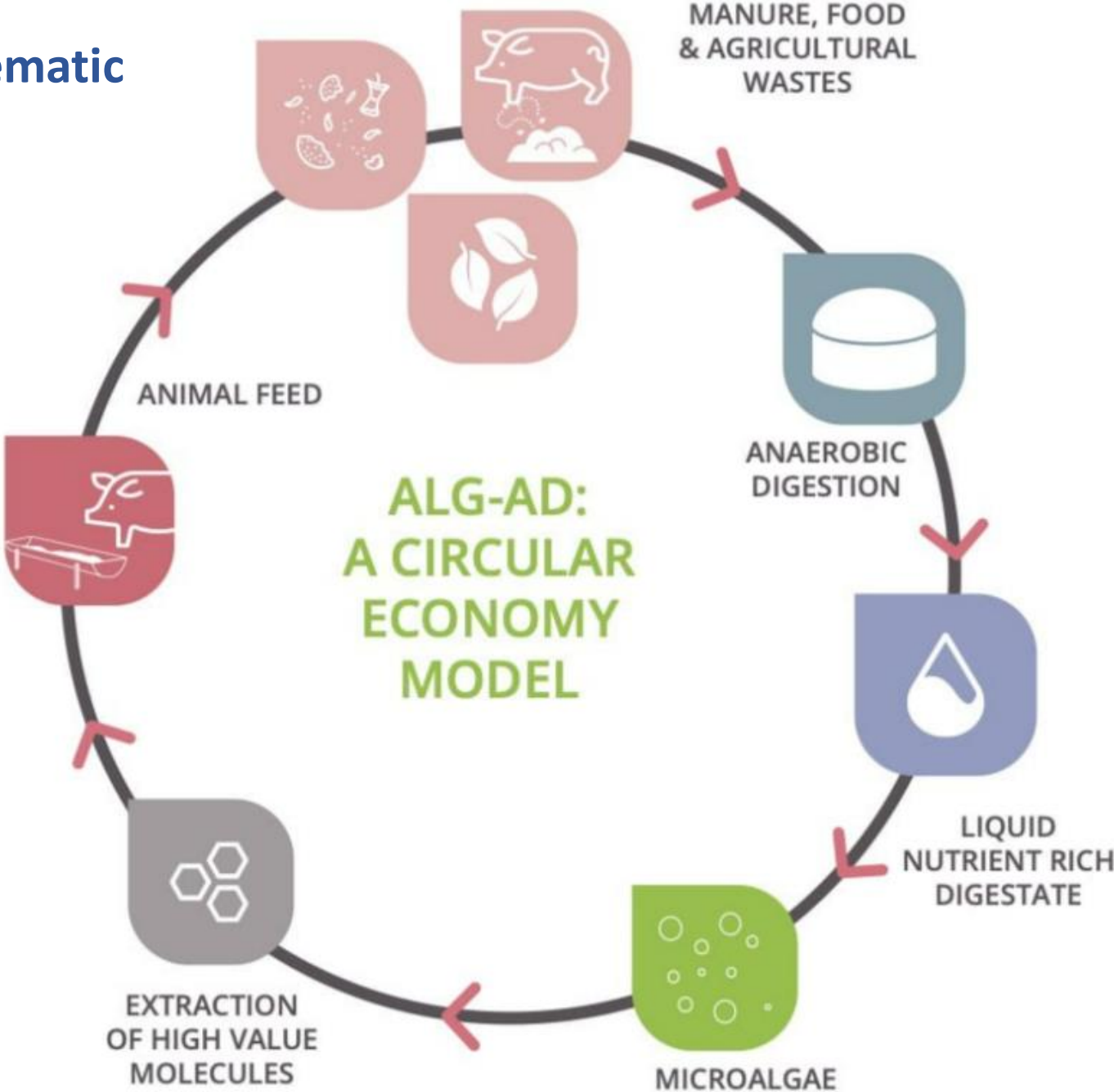


Produce sustainable animal feed



Provide an alternative to imported proteins for animal and fish feed

# ALG-AD simplified schematic



# ALG-AD work-packages

Work-package 2:

Charactering biomass

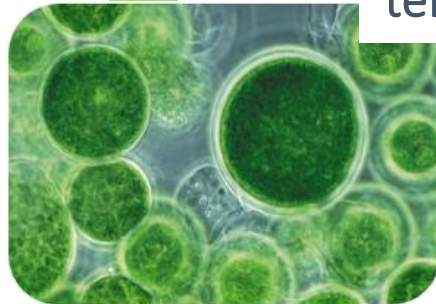
Developing algal biomass  
into commercial products

Piglet feed trials



Work-package 3: Scenario  
& Decision Tools

Work-package 4: Long  
term roll out of technology



Capitalisation WP:  
Fish feed trials



Work-package 1:  
Three pilot facilities

Operation of investments using waste  
nutrients from AD to produce algal biomass

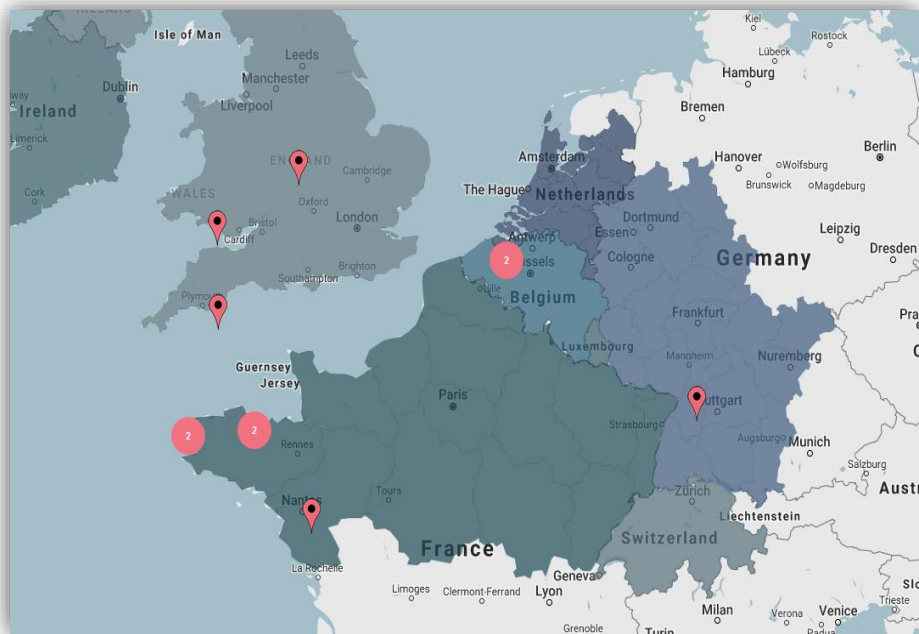


# ALG-AD: Creating value from waste nutrients - Integrating Algal & AD technology

2017-2021: € 6.2 M

11 key partners

UK, France, Belgium, Germany



# WP1: 3 pilot facilities testing different digestates & algae



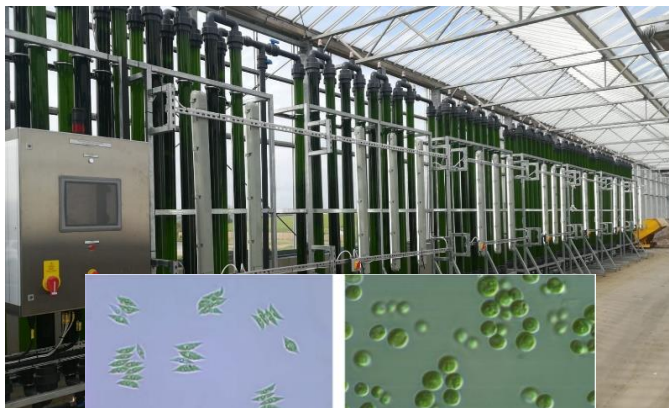
Langage AD,  
Plymouth



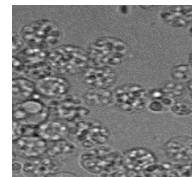
Cooperl,  
Lamballe



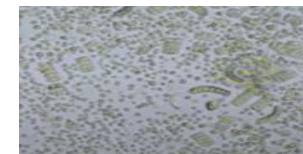
Innolab,  
Ghent



*Chlorella* and *Scenedesmus*  
Autotrophic and mixotrophic



*Aurantiochytrium magrovei*  
Heterotrophic



Mix *Chlorella* and *Desmodesmus*  
Autotrophic

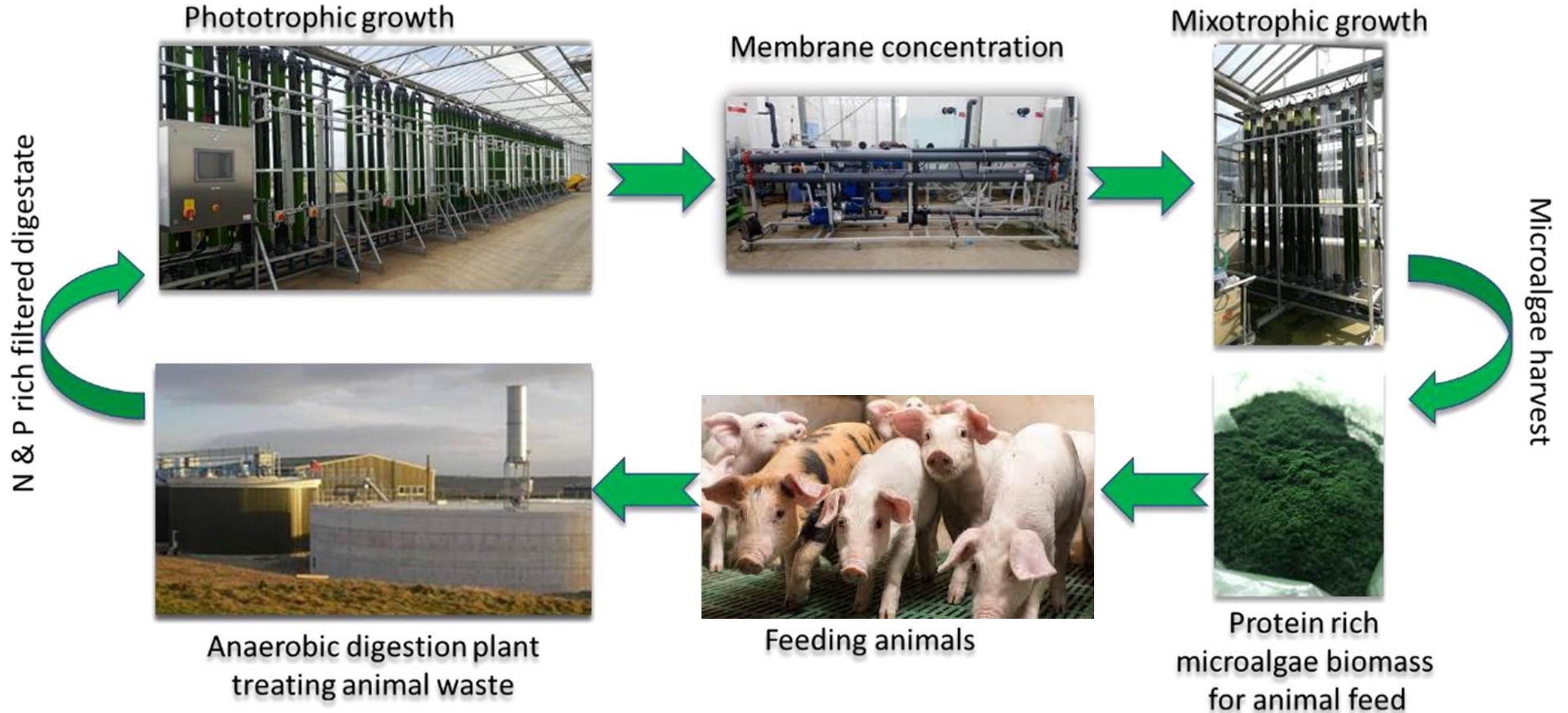
# ALG-AD: Using waste nutrients from AD to cultivate algae to create animal and fish feed: 2017-2022

Integrating algal & AD technology



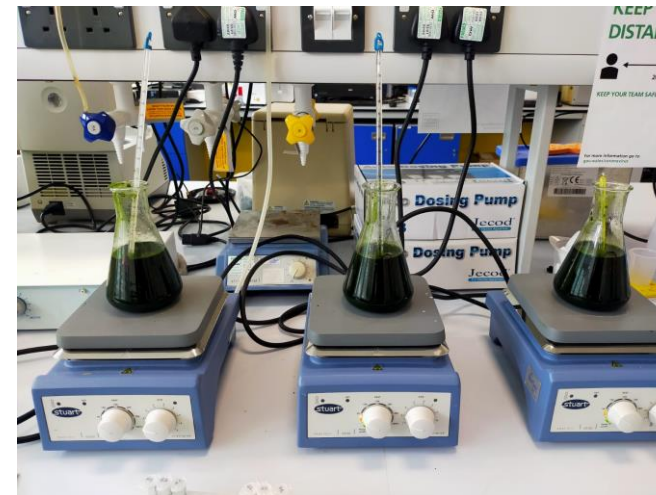
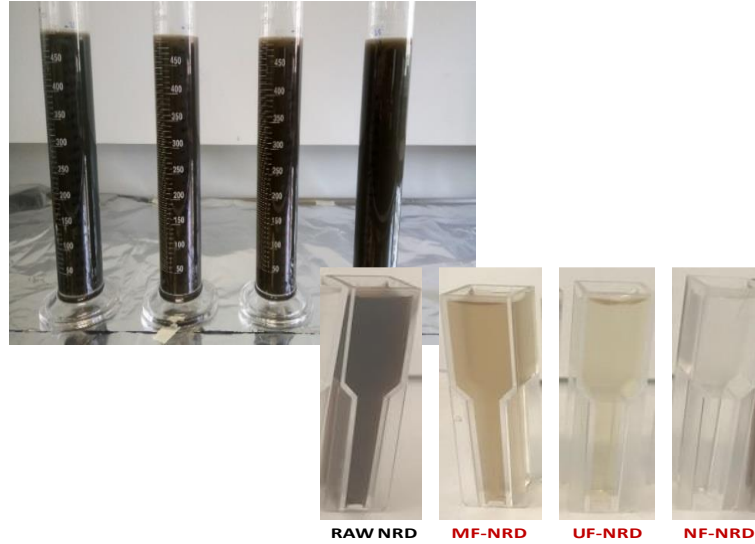
**Interreg**   
North-West Europe  
**ALG-AD**  
European Regional Development Fund

# Overview of the UK process

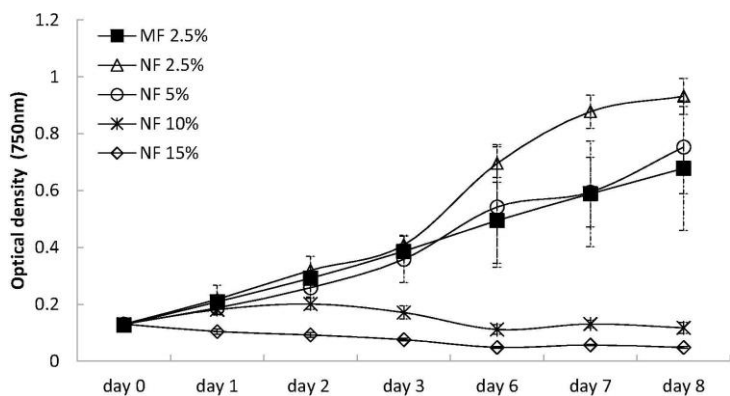


Combining a phototrophic-mixotrophic growth approach

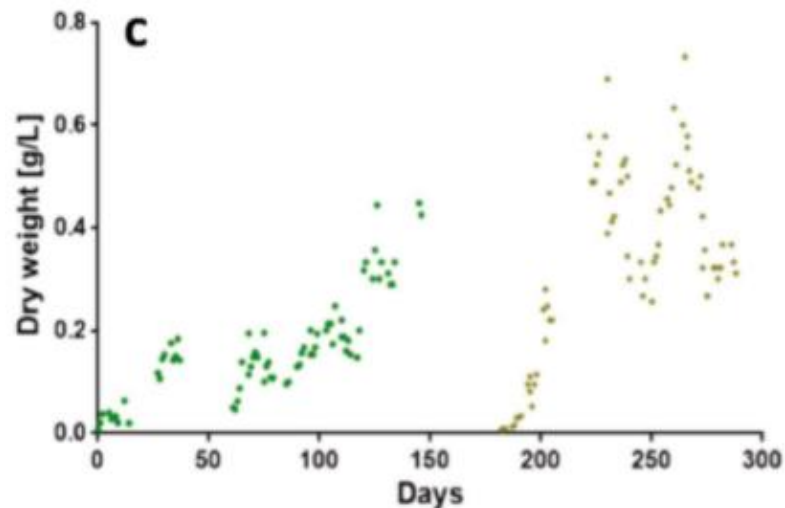
# Pilot facilities backed up with extensive laboratory experiments optimising digestate and cultivation



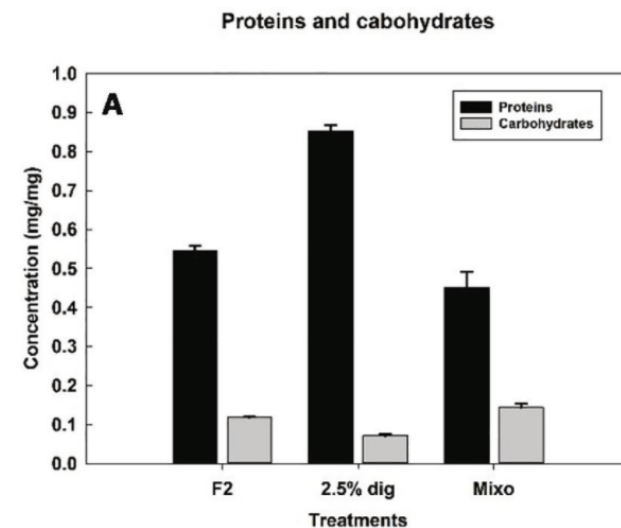
# WP2: Characterising and processing



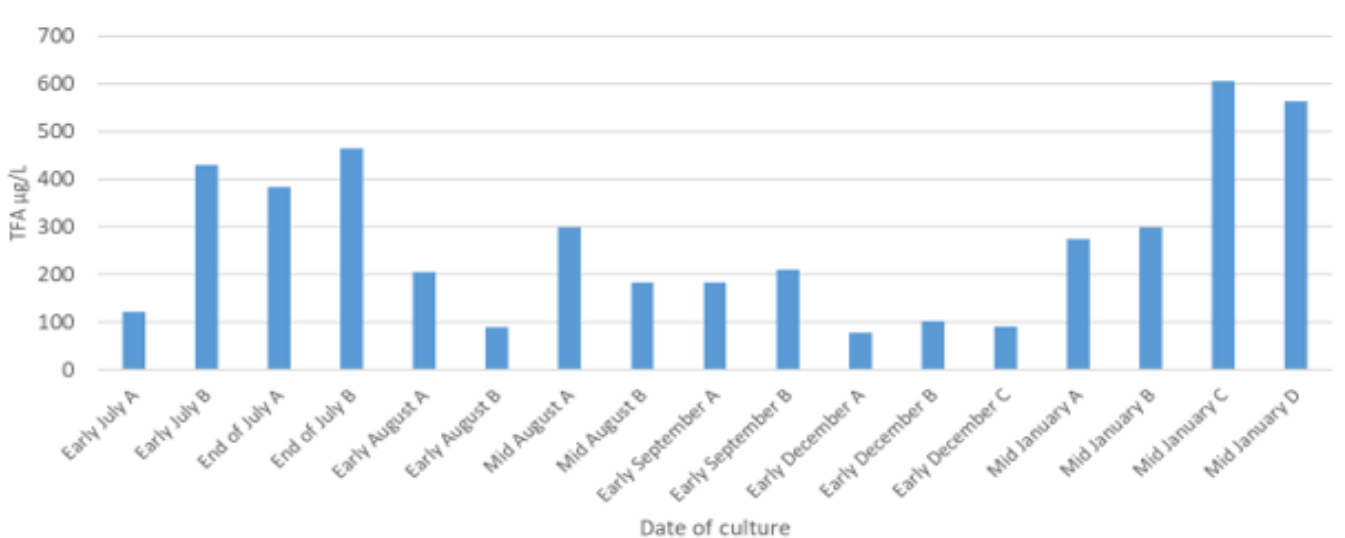
Digestate studies



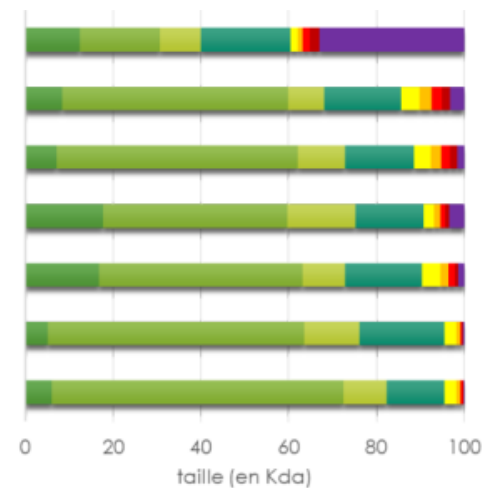
PBR long term studies



Characterisation studies



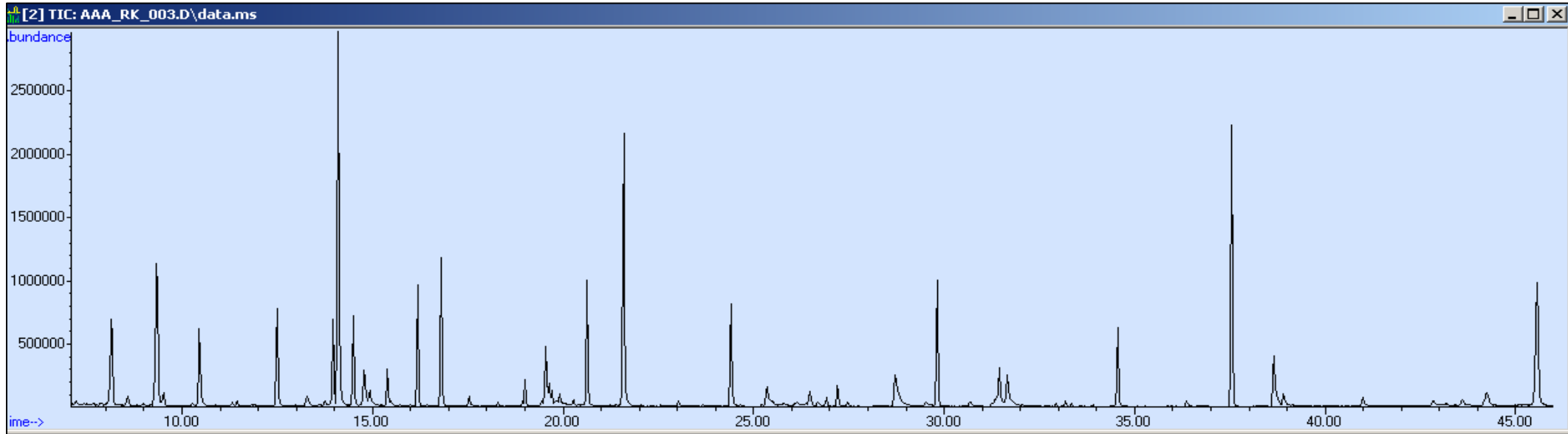
Seasonal studies



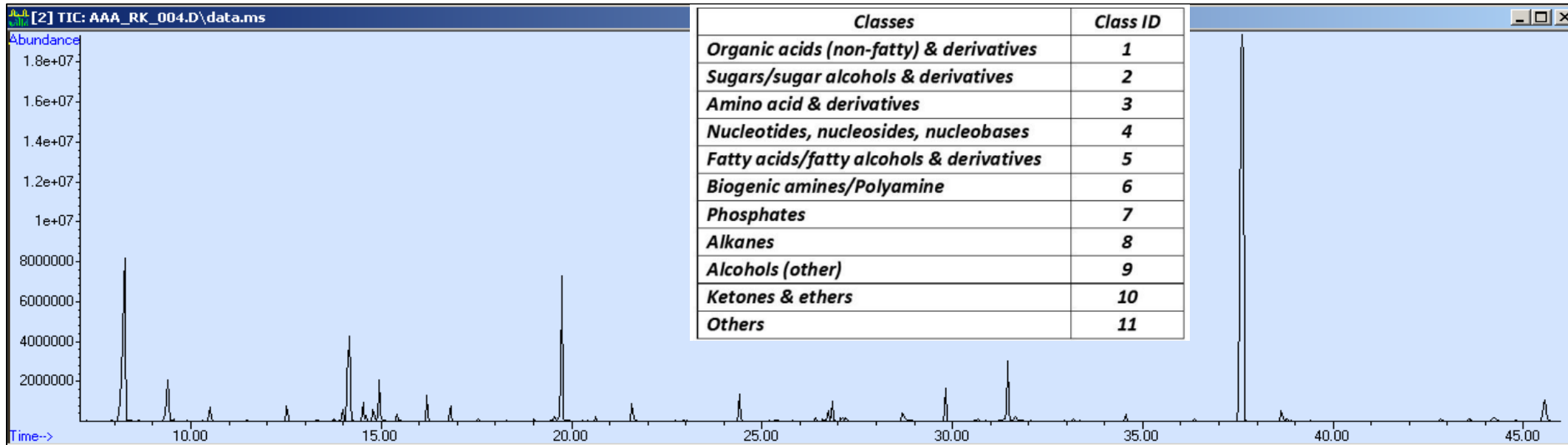
Algal Processing studies

# WP2: Characterisation of the algae using GC-MS Metabolomics

2.5%  
Digestate  
Chlorella

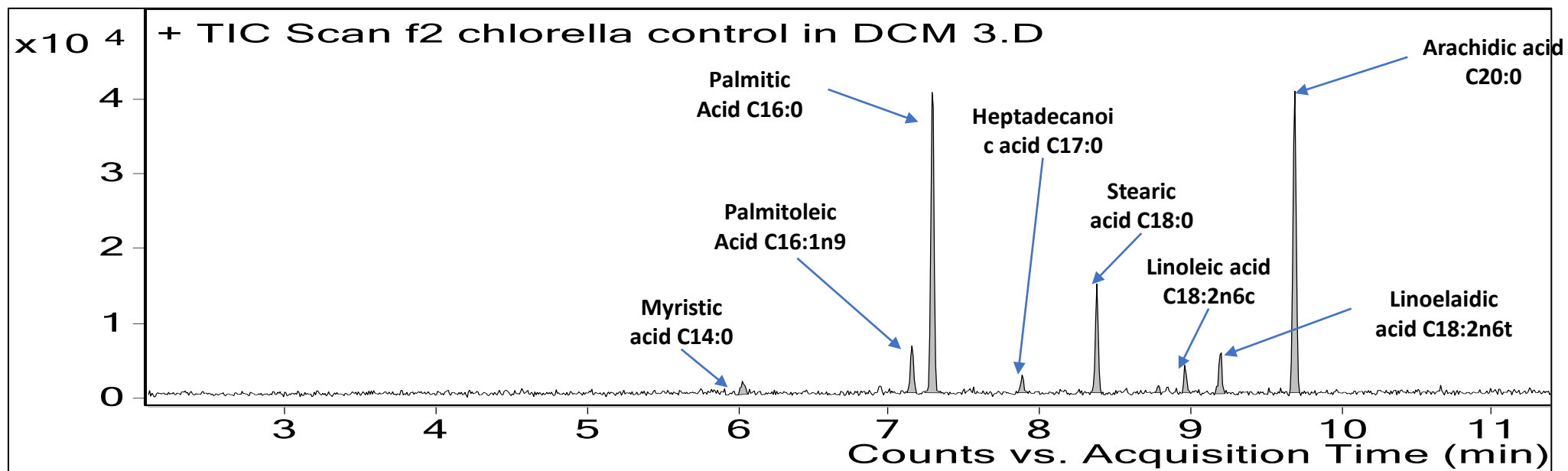


f/2  
Chlorella  
(Control)

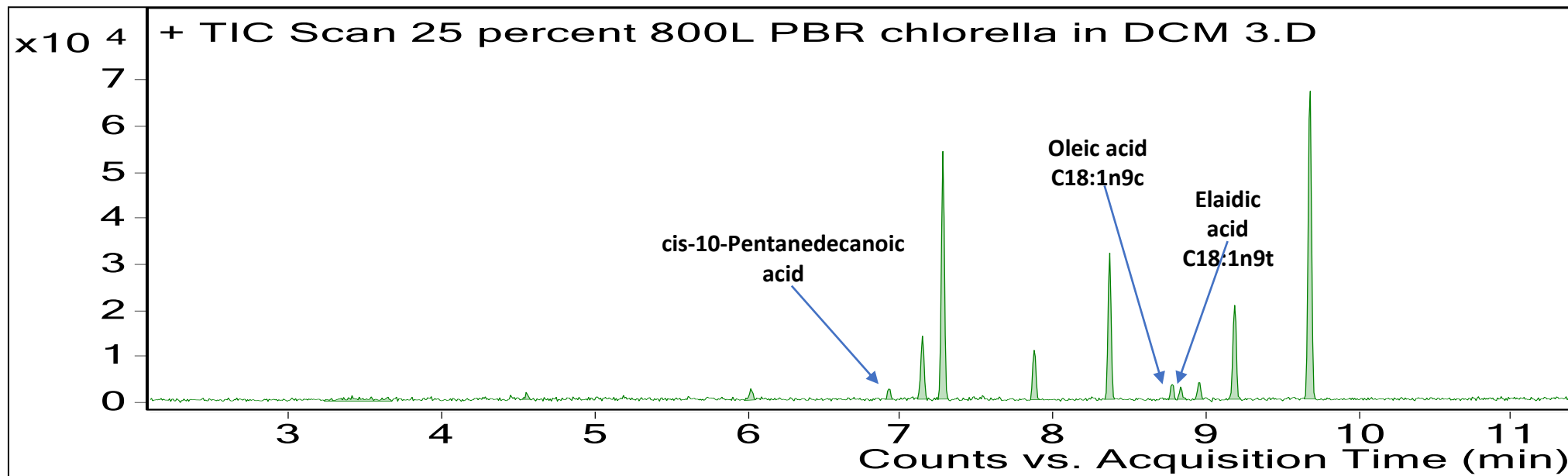


# WP2: Fatty acid characterisation of the algae using GC-MS Metabolomics

f/2  
Chlorella  
(Control)



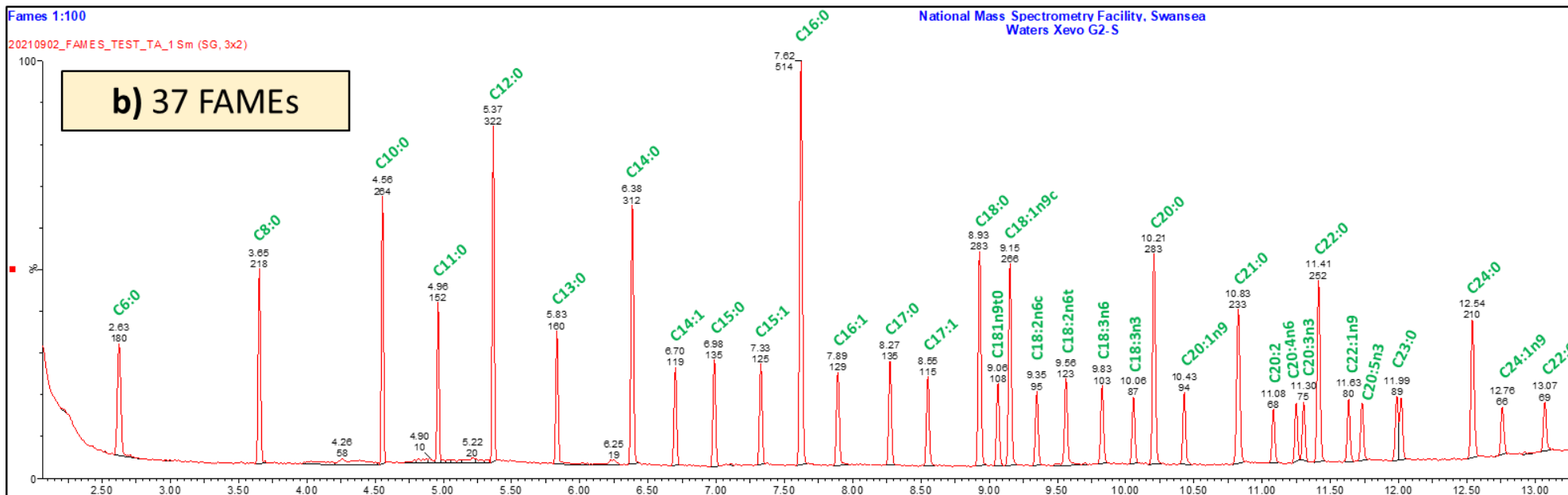
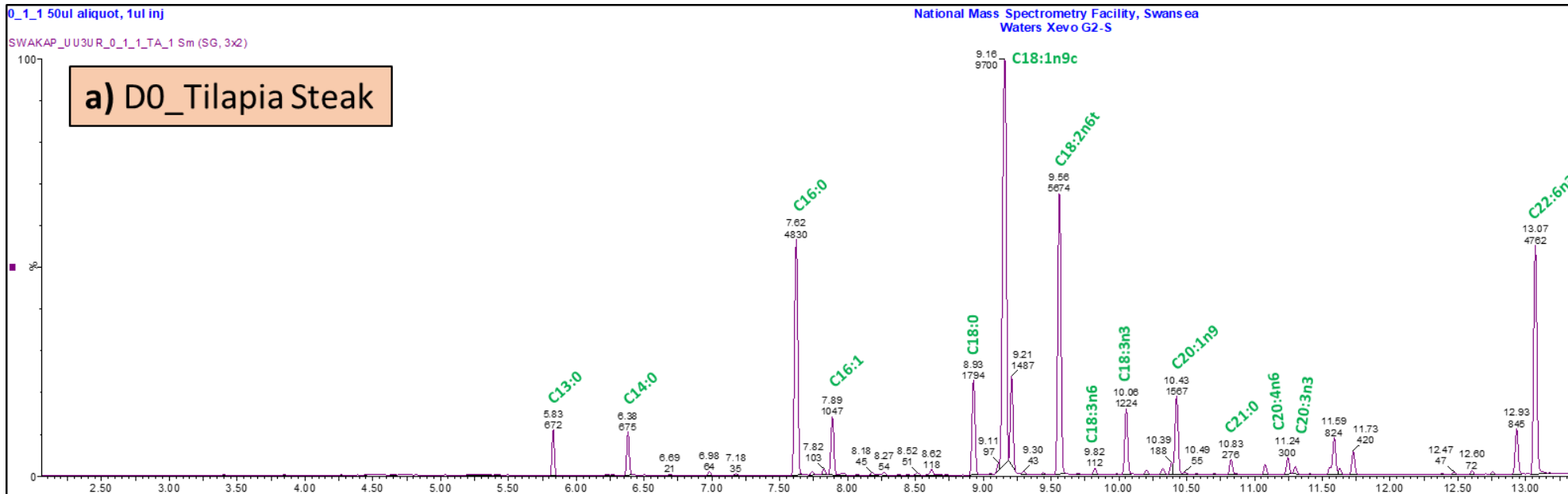
2.5%  
Digestate  
Chlorella



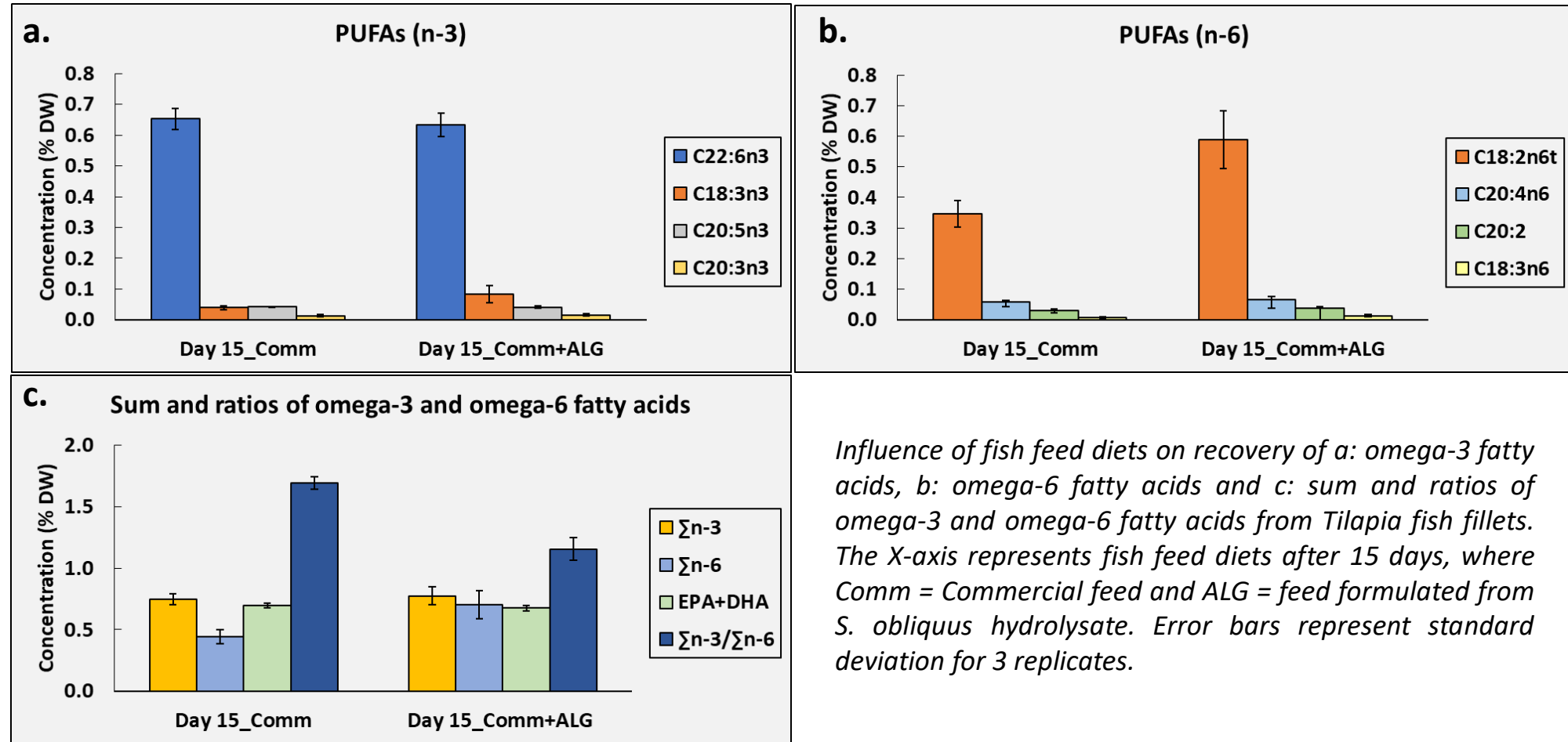
## WP-Cap: Fish trials using algae cultivated on digestate



# WP-Cap: Fatty acid analysis of fish flesh – GC-MS



# WP-Cap: Fatty acid analysis of fish fed on algae



*Influence of fish feed diets on recovery of a: omega-3 fatty acids, b: omega-6 fatty acids and c: sum and ratios of omega-3 and omega-6 fatty acids from Tilapia fish fillets. The X-axis represents fish feed diets after 15 days, where Comm = Commercial feed and ALG = feed formulated from *S. obliquus* hydrolysate. Error bars represent standard deviation for 3 replicates.*

Advantage of including microalgal ingredients grown on digestate in the diet of Nile Tilapia, with **added value to the aquaculture sector.**

# WP3: Scenario Planning/ Decision Support



## The ALG-AD Decision Support Tools

The ALG-AD Decision Support Tools can help you to understand and explore how algal cultivation technologies might work for you.



### Search AD Plants

The ALG-AD Project is focused on the use of digestate from AD for algae cultivation. This tool provides a GIS map of existing AD plants in North West Europe.



### Document and Resources

DST enables you to search for relevant information on algae and AD technologies, policy, research etc.



### Search Stakeholders

DST provides a stakeholders search tool that helps you identify and connect with partners across North West Europe.

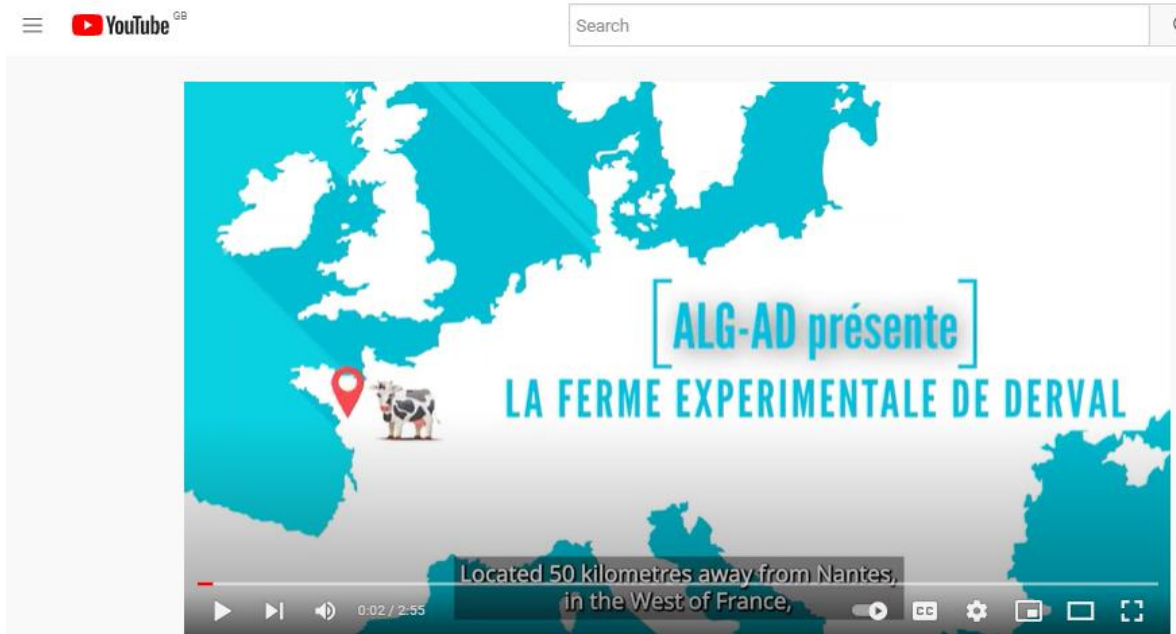


### Process Pathway Tool

This tool helps you better understand algal cultivation and PBR implementation, based on your AD process conditions and future requirements.

<https://www.alg-ad-dst.com/>

# Derval experimental farm



**DERVAL Experimental Farm**

« a Living Lab for energy transition and circular economy »

AGRICULTURES & TERRITOIRES  
CHAMBRE D'AGRICULTURE  
PAYS DE LA LOIRE

LA FERME LAITIÈRE  
BAS CARBONE

**Derval, an experimental farm to reduce environmental footprints in agriculture**

<https://www.youtube.com/watch?v=ZHInWN6Q54E>

# Published ALG-AD research



Contents lists available at ScienceDirect

Waste Management

journal homepage: [www.elsevier.com/locate/wasman](http://www.elsevier.com/locate/wasman)



Valorising nutrient-rich digestate: Dilution, settlement and membrane filtration processing for optimisation as a waste-based media for microalgal cultivation



Fleuriane Fernandes<sup>a,\*</sup>, Alla Silkina<sup>a</sup>, Claudio Fuentes-Grünewald<sup>a</sup>, Eleanor E. Wood<sup>a</sup>, Vanessa L.S. Ndovela<sup>a</sup>, Darren L. Oatley-Radcliffe<sup>b</sup>, Robert W. Lovitt<sup>b</sup>, Carole A. Llewellyn<sup>a</sup>



Article

## Microalgae cultivation on nutrient rich digestate: the importance of strain and digestate tailoring under pH control

Fleuriane Fernandes<sup>1,\*</sup>, Alla Silkina<sup>1</sup>, José Ignacio Gayo-Peláez<sup>1</sup>, Rahul Vijay Kapoore<sup>1</sup>, Denis de la Broise<sup>2</sup>, Carole A. Llewellyn<sup>1</sup>

BioEnergy Research  
<https://doi.org/10.1007/s12155-022-10397-2>



## Animal Feed from Microalgae Grown on Biogas Digestate as Sustainable Alternative to Imported Soybean Meal

Mohamed Elshamy<sup>1,2</sup> · Christine Rösch<sup>1</sup>

Received: 2 November 2021 / Accepted: 18 January 2022  
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Chemosphere  
Volume 290, March 2022, 133180



Maximizing nutrient recycling from digestate for production of protein-rich microalgae for animal feed application

Jai Sankar Seelam<sup>a,\*</sup>, Marcella Fernandes de Souza<sup>a</sup>, Peter Chaerle<sup>b</sup>, Bernard Willems<sup>c</sup>, Evi Michels<sup>a</sup>, Wim Vyverman<sup>b</sup>, Erik Meers<sup>a</sup>

Bioresource Technology 320 (2021) 124349



Contents lists available at ScienceDirect

Bioresource Technology

journal homepage: [www.elsevier.com/locate/biortech](http://www.elsevier.com/locate/biortech)



Towards a circular economy: A novel microalgal two-step growth approach to treat excess nutrients from digestate and to produce biomass for animal feed

Claudio Fuentes-Grünewald<sup>\*</sup>, José Ignacio Gayo-Peláez<sup>\*</sup>, Vanessa Ndovela<sup>\*</sup>, Eleanor Wood<sup>1</sup>, Rahul Vijay Kapoore<sup>\*</sup>, Carole Anne Llewellyn



Article

## Evaluation of *Aurantiochytrium mangrovei* Biomass Grown on Digestate as a Sustainable Feed Ingredient of Sea Bass, *Dicentrarchus labrax*, Juveniles and Larvae

Philippe Soudant<sup>1,\*</sup>, Mariana Ventura<sup>1</sup>, Luc Chauchat<sup>1</sup>, Maurean Guerreiro<sup>1</sup>, Margaux Mathieu-Resuge<sup>1</sup>, Fabienne Le Grand<sup>1</sup>, Victor Simon<sup>1</sup>, Sophie Collet<sup>1</sup>, José-Luis Zambonino-Infante<sup>1</sup>, Nelly Le Goïc<sup>1</sup>, Christophe Lambert<sup>1</sup>, Fleuriane Fernandes<sup>2</sup>, Alla Silkina<sup>2</sup>, Marcella Fernandes de Souza<sup>3</sup> and Denis de la Broise<sup>1</sup>

Biotechnology Advances 49 (2021) 1077



Contents lists available at ScienceDirect

Biotechnology Advances

journal homepage: [www.elsevier.com/locate/biotechadv](http://www.elsevier.com/locate/biotechadv)



Research review paper

Algae biostimulants: A critical look at microalgal biostimulants for sustainable agricultural practices

Rahul Vijay Kapoore<sup>\*,1</sup>, Eleanor E. Wood<sup>1,2</sup>, Carole A. Llewellyn



Article

## Scale-Up to Pilot of a Non-Axenic Culture of Thraustochytrids Using Digestate from Methanization as Nitrogen Source

Denis de la Broise<sup>1,\*</sup>, Mariana Ventura<sup>1</sup>, Luc Chauchat<sup>1</sup>, Maurean Guerreiro<sup>1</sup>, Teo Michez<sup>1</sup>, Thibaud Vinet<sup>2</sup>, Nicolas Gautron<sup>1</sup>, Fabienne Le Grand<sup>1</sup>, Antoine Bideau<sup>1</sup>, Nelly Le Goïc<sup>1</sup>, Adeline Bidault<sup>1</sup>, Christophe Lambert<sup>1</sup> and Philippe Soudant<sup>1,\*</sup>

# Selected output documents

Interreg  
North-West Europe  
ALG-AD  
European Regional Development Fund

THEMATIC PRIORITY  
RESOURCE AND MATERIAL EFFICIENCY



**BEST PRACTICES GUIDELINE FOR CULTIVATION OF MICROALGAE ON NUTRIENT RICH DIGESTATE**

PART 1 :

**BEST PRACTICES FOR THE TREATMENT AND PREPARATION OF NUTRIENT RICH DIGESTATE FOR ALGAL CULTIVATION**

EDITION : MARCH 2020

Interreg  
North-West Europe  
ALG-AD  
European Regional Development Fund

THEMATIC PRIORITY  
RESOURCE AND MATERIAL EFFICIENCY



**BEST PRACTICE GUIDELINES FOR CULTIVATION OF MICROALGAE ON NUTRIENT RICH DIGESTATE**

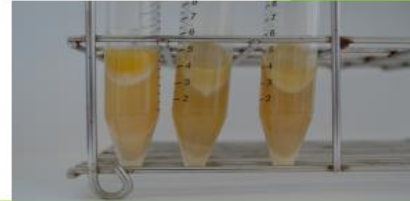
PART 2 :

**BEST PRACTICES FOR OPTIMUM NUTRIENT REMOVAL AND ALGAL CULTIVATION**

EDITION : JUNE 2021

Interreg  
North-West Europe  
ALG-AD  
European Regional Development Fund

THEMATIC PRIORITY  
RESOURCE AND MATERIAL EFFICIENCY



**TECHNICAL REPORT: OPTIMISATION OF ENZYMATIC HYDROLYSIS**

**ENZYMATIC HYDROLYSIS FOR EXTRACTION OF OILS RICH IN N-3 PUFAS AND BIOACTIVE PEPTIDES FROM A BIOMASS OF HETEROTROPHIC PROTISTS (THRAUSTOCHYTRIDS).**

EDITION : NOVEMBER 2020

Interreg  
North-West Europe  
ALG-AD  
European Regional Development Fund

THEMATIC PRIORITY  
RESOURCE AND MATERIAL EFFICIENCY



**A REGULATORY REVIEW ON THE USE OF DIGESTATE TO CULTIVATE ALGAL BIOMASS FOR ANIMAL FEED**

Prepared by NNFC for ALG-AD

The Bioeconomy Consultants  
**NNFC**

EDITION : DECEMBER 2020

Interreg  
North-West Europe  
ALG-AD  
European Regional Development Fund

THEMATIC PRIORITY  
RESOURCE AND MATERIAL EFFICIENCY



**POLICY RECOMMENDATIONS FOR THE COMMERCIALISATION OF ALG-AD TECHNOLOGY**

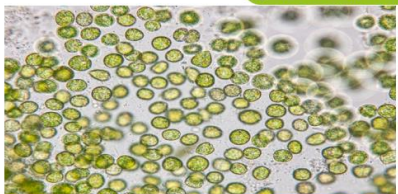
Prepared by NNFC for ALG-AD

The Bioeconomy Consultants  
**NNFC**

EDITION : DECEMBER 2020

Interreg  
North-West Europe  
ALG-AD  
European Regional Development Fund

THEMATIC PRIORITY  
RESOURCE AND MATERIAL EFFICIENCY



**SAFETY ANALYSIS: DIGESTATE AND ALGAL BIOMASS PRODUCED BY THE THREE ALG-AD PILOTS**

CONDUCTED BY ANSES,  
PARTNERS ON THE  
ALG-AD PROJECT.



EDITION : JANUARY 2022

Interreg  
North-West Europe  
ALG-AD  
European Regional Development Fund

THEMATIC PRIORITY  
RESOURCE AND MATERIAL EFFICIENCY



**SEASONAL VARIATION OF ALGAL BIOMASS CULTIVATED USING NUTRIENT RICH DIGESTATE**

## News

**Webinar: production of recycling-derived fertilizers and algal biomass**

22 July 2021  
Webinar: production of recycling-derived fertilizers and algal biomass Circular Bioeconomy: production of recycling-derived fertilizers and algal biomass Alg-AD and RenuFarm are pleased to invite you to their showcase event on...

[Live la suite](#)

**Webinar | Microalgae, digestion & fermentation: ALG-AD pilot site in Brittany**

13 April 2021  
Webinar | Microalgae, digestion & fermentation: ALG-AD pilot site in Brittany Thursday, April 8, 2021 was the fourth episode of our webinar cycle on the ALG-AD project, on the theme...

[Live la suite](#)

**Webinar ALG-AD | Belgian pilot site - 17th march 2021**

9 March 2021

**Webinar | The ALG-AD British pilot site**

8 June 2021  
Webinar | The ALG-AD British pilot site On Thursday, May 13th, we held our 5th ALG-AD webinar to discover the UK pilot site and its facilities. To conclude the cycle...

[Live la suite](#)

**Replay webinar | Growing microalgae on plant-based digestate: ALG-AD Belgian pilot site**

28 March 2021  
Replay webinar | Growing microalgae on plant-based digestate: ALG-AD Belgian pilot site On Wednesday 17 March 2021, took place the third webinar of the ALG-AD project, "Growing microalgae on plant-based..."

[Live la suite](#)

**Replay Webinar | The microalgae for the treatment of wastewater and digestate**

**From Anaerobic Digestion to Algae, the Alg-AD exhibition**

8 May 2021  
From Anaerobic Digestion to Algae, the Alg-AD exhibition Discover the cultivation of microalgae on digestate through the ALG-AD project and its fully virtual exhibition. At this unique event, members of...

[Live la suite](#)

**ALG-AD exhibition is on and ready to receive visitors!**

9 March 2021  
ALG-AD exhibition is on and ready to receive visitors! ALG-AD exhibition is on and ready to receive visitors! Last december, ACSA team set up ALG-AD exhibition at the experimental Farm...

[Live la suite](#)

**Replay webinar | Microalgae & anaerobic digestion**

23 January 2021

# ALG-AD - Creating value from waste nutrients by integrating algal and anaerobic digestion technology

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[PROJECT NEWS](#)

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[EVENTS](#)

[PUBLICATIONS](#)

[MEET THE TEAM](#)

[GDPR](#)

[ONLINE EVENTS](#)

- <https://vb.nweurope.eu/projects/project-search/alg-ad-creating-value-from-waste-nutrients-by-integrating-algal-and-anaerobic-digestion-technology/>
- <https://www.alg-ad-dst.com>