September 28th, 2023
VITO, Mol

Welcome

Final IDEA+ event, September 2023

Bruno Reyntjens

Commercial Director (VITO, Belgium)

Algae value chains in NWEurope from an IDEA+ project perspective

Final IDEA+ event, September 2023

Leen Bastiaens

Coordinator IDEA project (VITO, Belgium)

Agenda

10h00 Algae value chains in NWEurope from an IDEA+ project perspective - Leen Bastiaens (VITO, Belgium) - IDEA coordinator

10h25 Keynotes

- Marco La Russa (Algaspring, The Netherlands) - Commercial microalgae production for aquaculture applications
- Stefania Lupinelli (ILSA, Italy) - Potential of algae for crop stimulation and protection –

11h00 Algae biomass production on low organic carbon-containing process water from a demineralization plant
- Dimitri Overmeire (YARA, The Netherlands)
- Leen Bastiaens (VITO, Belgium)
- Floris Schoeters (Thomas More Radius, Belgium)

11h30 Digestate as a nutrient source for algae cultivation
- Alla Silkina (Swansea University, UK)
- Behnam Taidi (CentraleSupélec – University Paris-Saclay, France)
- Alla Silkina (Swansea University, UK)

12h00 Algae growth on CO_2 from (burned) biogas
- Wim Brilman (University of Twente, The Netherlands)
- Kris Heirbaut (Heirbaut Algriculture, Belgium

12h20 Lunch & poster session

13h20 **Visit to VITO infrastructure**

14h30 Impact of side-streams on algae biomass use
- Maria Hayes (TEAGASC, Ireland)
- Joran Verspreet (VITO, Belgium)
- Maria Hayes (TEAGASC, Ireland)
- Yana De Ruyter (PCFruit, Belgium)
- Mohammed El Ibrahimi (VITO, Belgium)

15h20 Algae value chains - Views of companies
- Kristof Severijns (Innovatiesteunpunt, Belgium)
- Arthur Boven – (GRO_2, Belgium) - VITO4starter
- Leonard Greene (Puremeatsnax/Tonitreat, Ireland)
- Zakaria Grevisse (Astrofood, Belgium)
- Vlaamse microalgen (grouping of Flemish companies & start-ups) – Yves Vande Velde (PROVIRON, Belgium)

16h20 Conclusions & policy recommendations

16h30 Networking reception & poster session

Practical aspects

Book of abstracts

Audiovisuals

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Algae value chains in NWEurope from an IDEA+ project perspective

Final IDEA+ event, September 2023

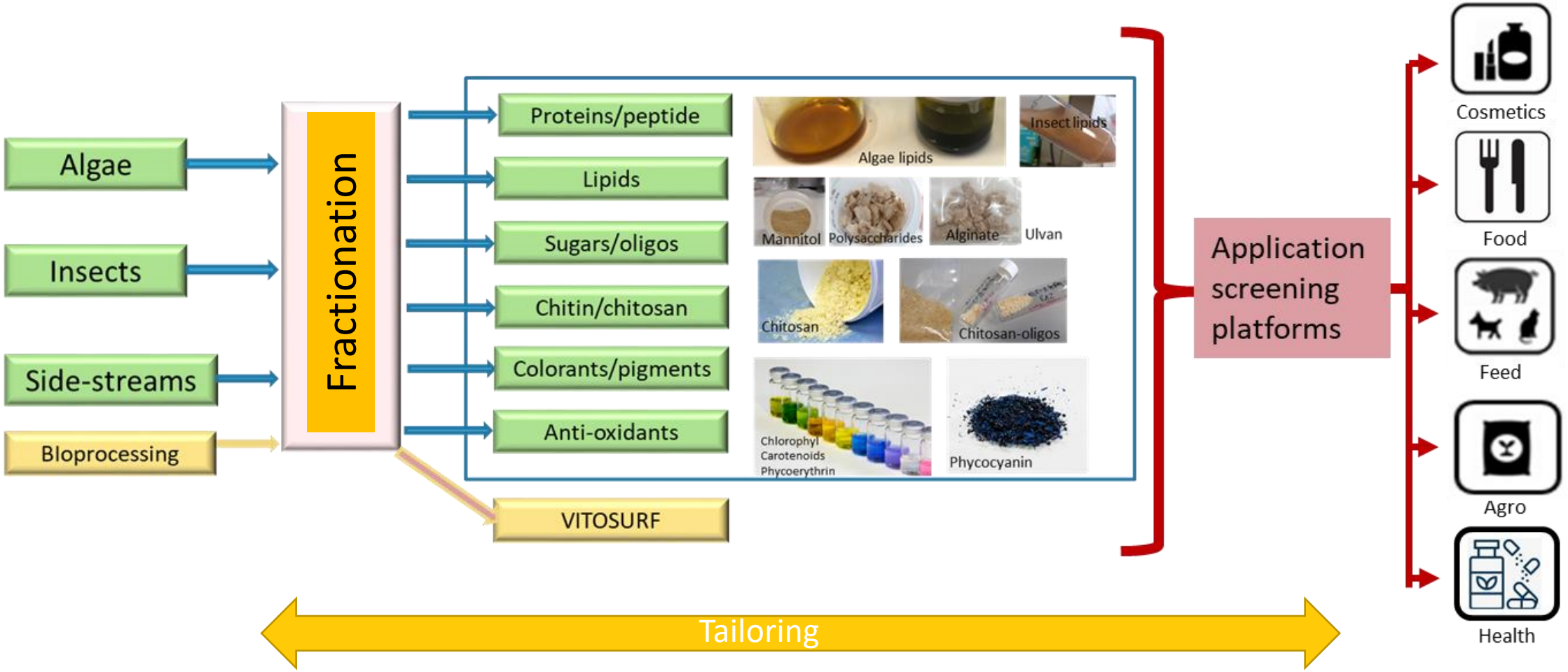
Leen Bastiaens

Coordinator IDEA project (VITO, Belgium)

Project Manager Sustainable chemistry

Processing biomass to Renewable compounds

PROBIO-team



IDEA project in a nutshell

Title: Implementation & Development of Economic viable Algae-based value chains in NWEurope (IDEA)

Consortium:

10 → **13** Full partners &
2 → **3** associated partners:
Belgium, Germany, France, The Netherlands, Ireland; **UK**

Duration: 9/2017 – 12/2020 →10/2021

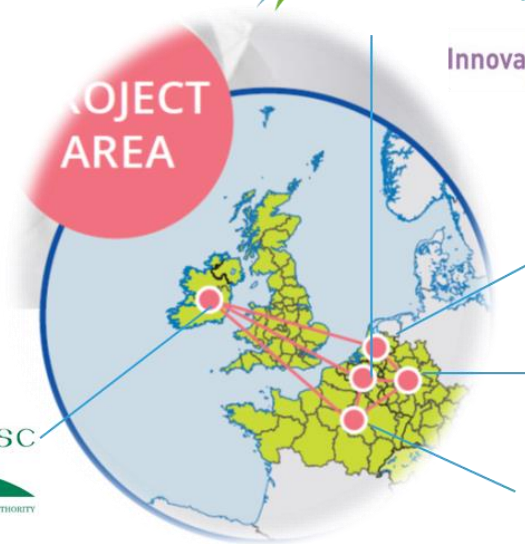
Capitalization project (IDEA+): till 12/2023

Project budget:

Total budget: 4.931.632 → **7.373.658** euro
Co-funding ERDF: 2.958.979 → **4.424.195** euro

Lead Partner: VITO (Belgium)

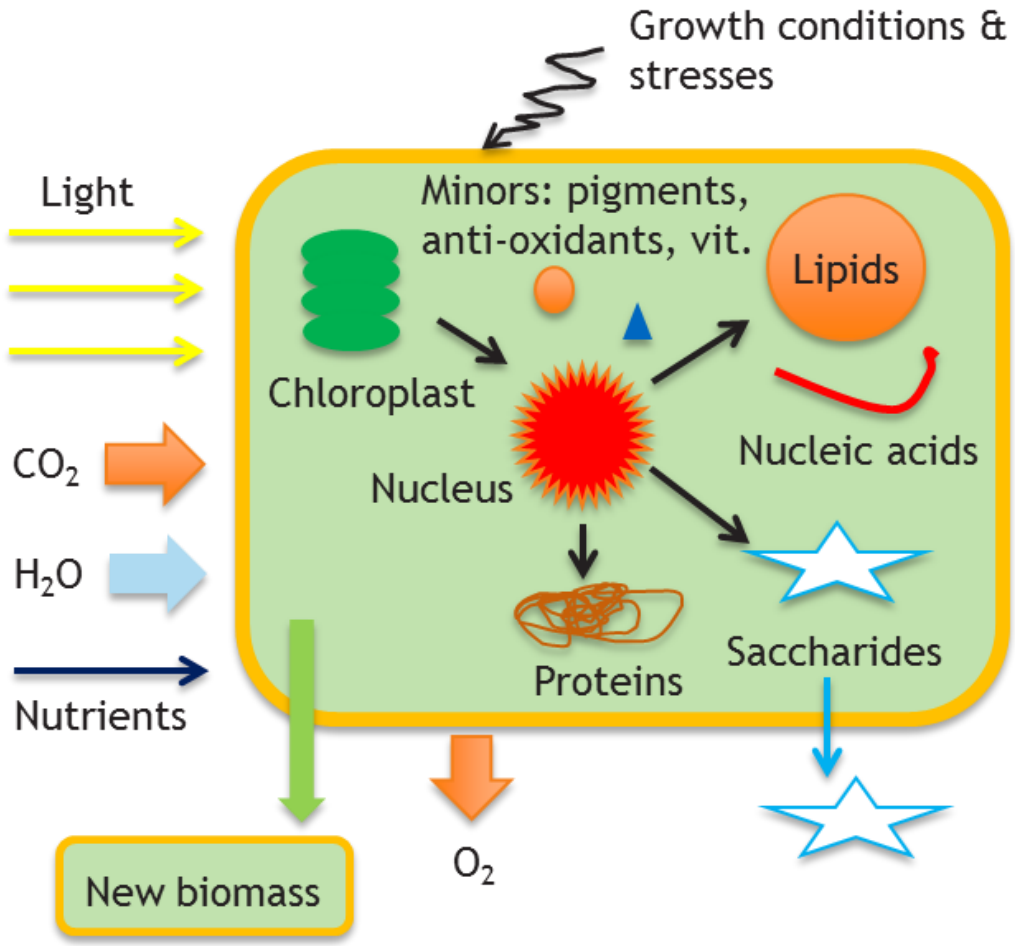
Website: www.nweurope.eu/idea

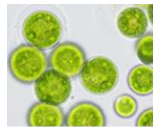


Associated partners:

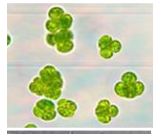
4 additional partners:

Microalgae

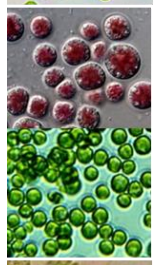




Nannochloropsis gaditana

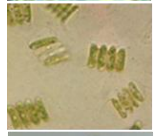


Chloromonas Typhlos



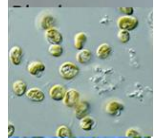
Porphyridium purpureum

***Chlorella* sp.**

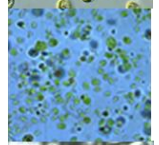


***Scenedesmus* sp.**

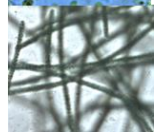
Rhodomonas sp.



Pavlova sp.



Mixed Algae from open pond



Spirulina

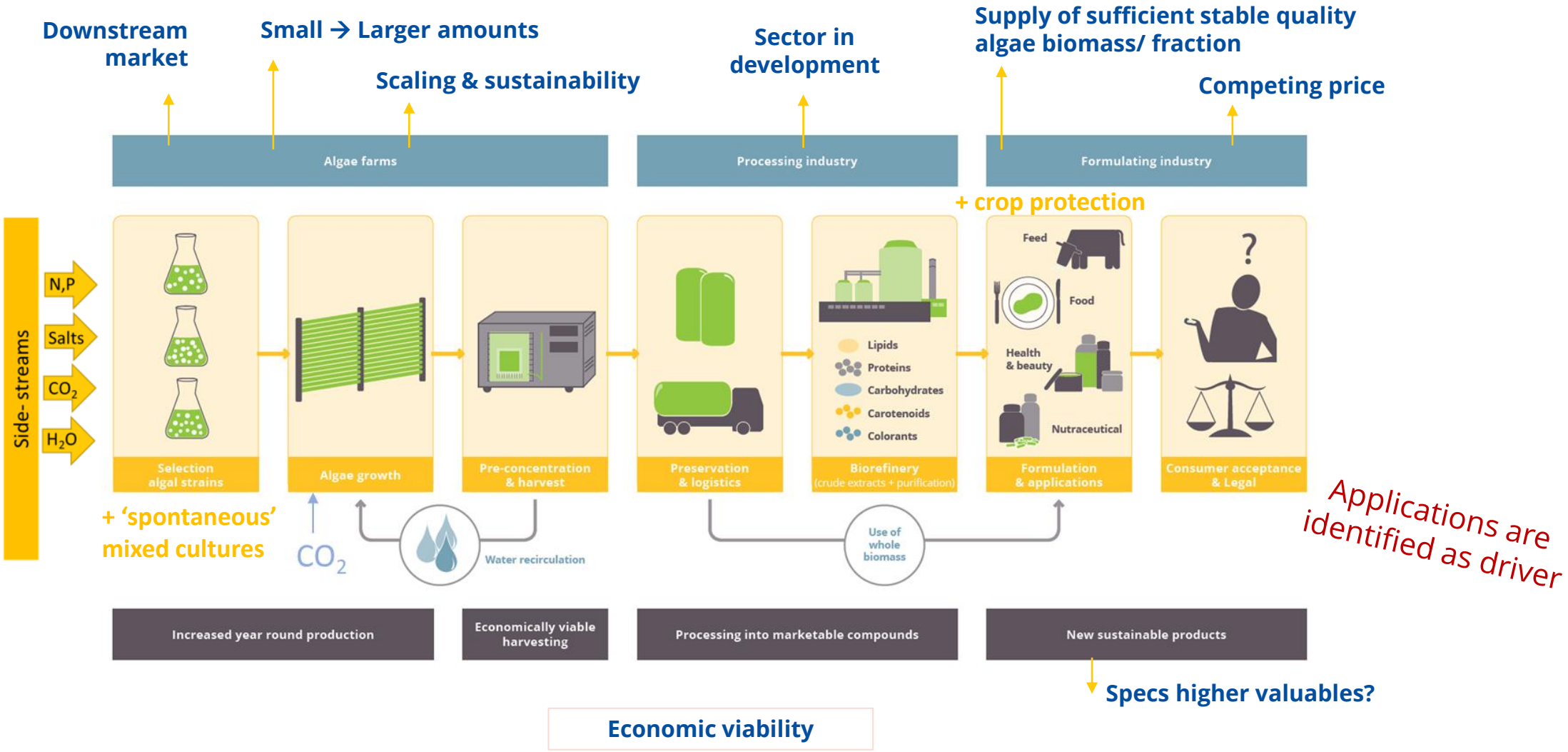
Main objective

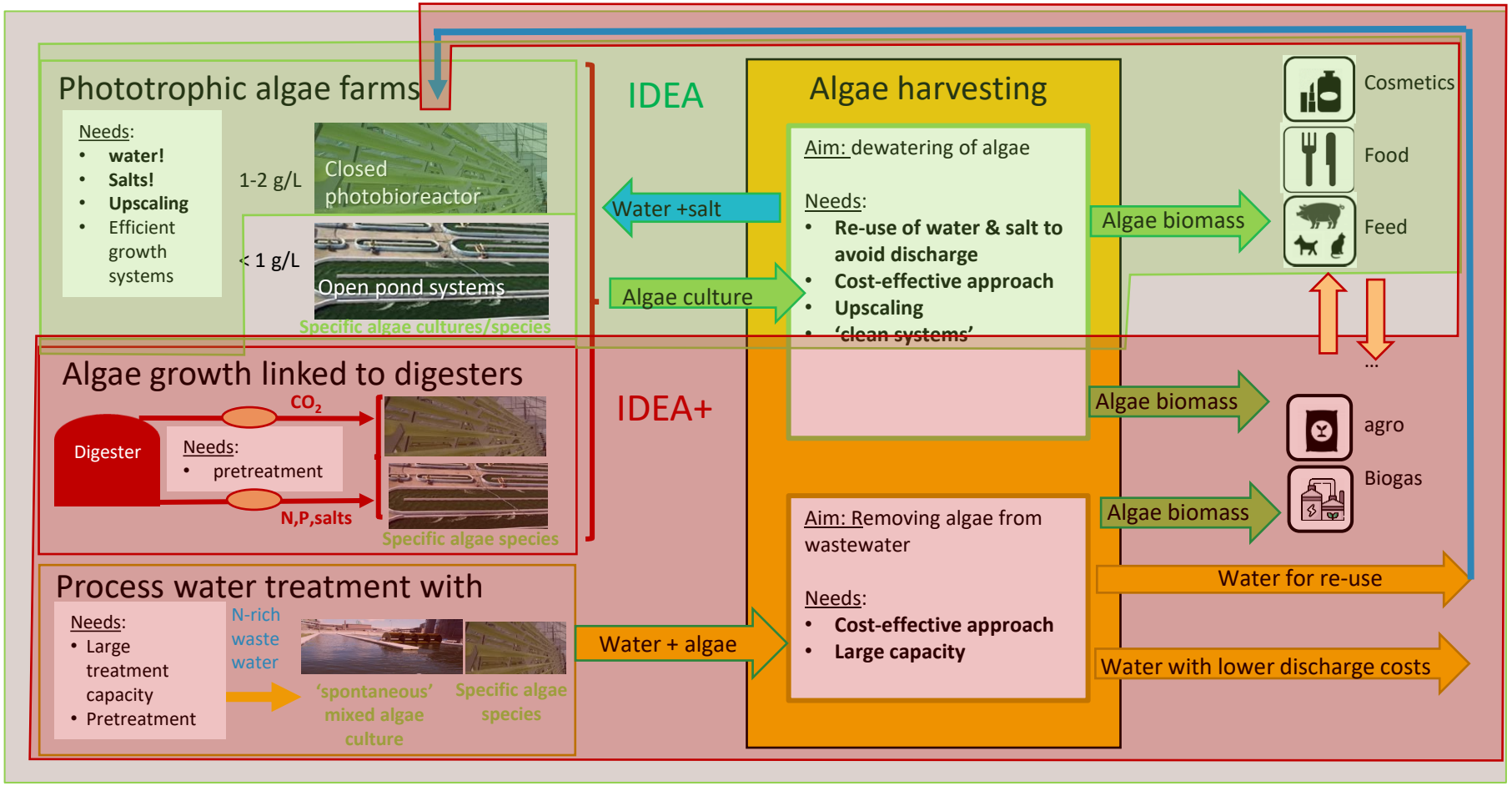
IDEA = Implementation & Development of Economic viable Algae-based value chains in NWE

Sub-objectives
1. Year-round algae production in NWE in a economic & sustainable way
2. Processing of algae biomass into marketable compounds
3. Concept of an algae value chain implementation plan
4. Long-term impact

IDEA+ → 5. Algae growth on side-streams & potential of the generated biomass towards valorization

Microalgae value chain - stakeholder's needs



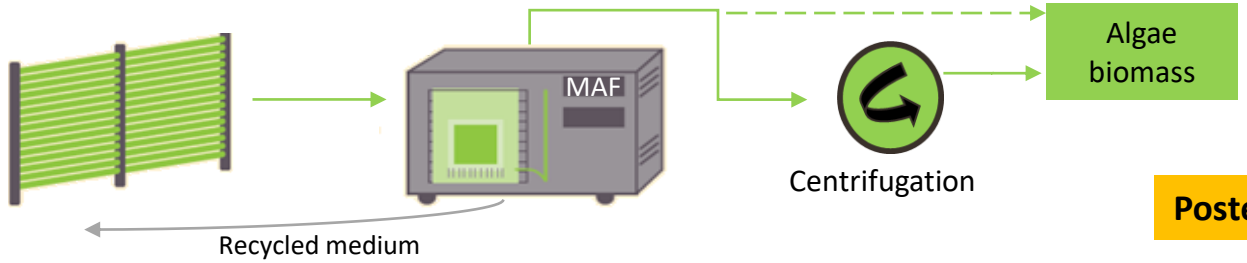

Phototrophic algae farms
Needs:
water!
Salts!
Upscaling
Efficient growth systems
1-2 g/L
Closed photobioreactor
< 1 g/L
Open pond systems
Specific algae cultures/species
IDEA
Water +salt
Algae culture
Algae harvesting
Aim: dewatering of algae
Needs:
Re-use of water & salt to avoid discharge
Cost-effective approach
Upscaling
'clean systems'
Algae biomass
Cosmetics
Food
Feed
...
Algae growth linked to digesters
CO2
Digester
Needs:
pretreatment
N,P,salts
Specific algae species
IDEA+
Algae biomass
agro
Biogas
Process water treatment with
Needs:
Large treatment capacity
Pretreatment
N-rich waste water
'spontaneous' mixed algae culture
Specific algae species
Water + algae
Aim: Removing algae from wastewater
Needs:
Cost-effective approach
Large capacity
Algae biomass
Water for re-use
Water with lower discharge costs

Aspects capitalized

- IDEA algae species & culture methods

IDEA algae species
Nannochloropsis geditana
Porphyridium purpureum
Chloromonas typhlos
Scenedesmus/chlorella-mixed culture

- MAF-technology: algae pre-harvesting & medium re-use & preservation



Poster 7

- Fractionation/Application tests for feed/food/cosmetics

- Value chain insight

to new sectors/systems:

- Wastewater streams
- Digesters
- Other sectors with side-streams
- Crop protection sector

Overview IDEA+

1. Algae cultivation on process water

2. Algae cultivation on digestate

3. Algae cultivation on recycled CO_2

4.

Processing

Formulation

Part 1: Low organic containing process water

Three process waters (PW)

1. PW1 = N-rich process water 1 (PW1) (location 1) – (NL)

2. PW2 = P-rich process water (location 1) – (NL)

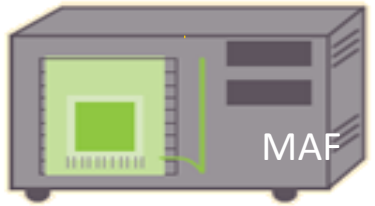
3. PW3 = process water from crab industry – (IE)

Poster 3

1A

Open pond cultivation – mixed culture
Influence seasons!

Option 1: discharge (less discharge costs)



Pre-harvesting & medium regeneration

Algae biomass

Poster 1

Longer-term demonstration

Part 1: Low organic containing process water

Three process waters (PW)

1. PW1 = N-rich process water 1 (PW1) (location 1) – (NL)

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3. PW3 = process water from crab industry – (IE)

Poster 3

1A

Open pond cultivation – mixed culture
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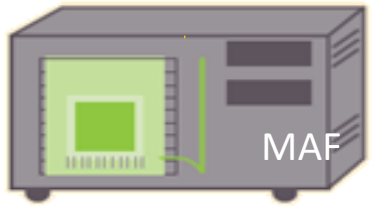
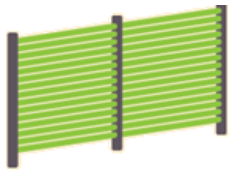


Option 1: discharge (less discharge costs)

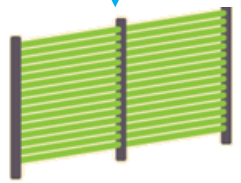
Pre-harvesting & medium regeneration

Algae biomass

1B

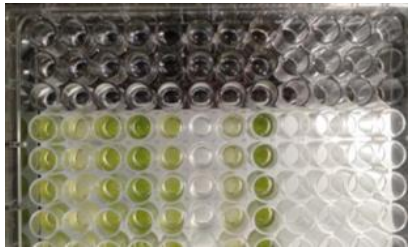


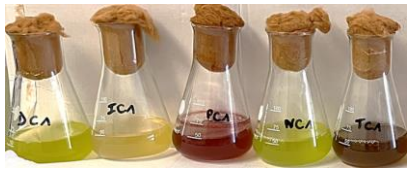
Closed system– 'axenic' culture

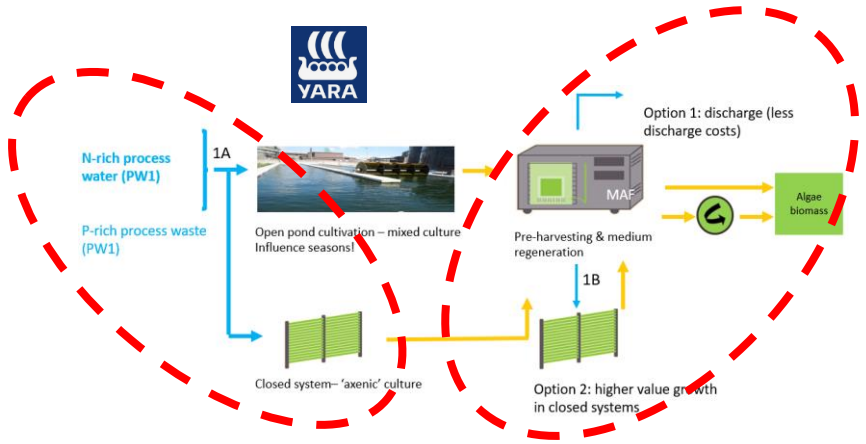


Option 2: higher value growth in closed systems

Part 1: Low organic containing process water







Lab trails:

- Can PW1 support unialgal growth?
- Is PW2 a suitable P-source?
- Wastewater-born algae

Poster 6

Poster 5

Lab trails:

- Can PER-PW1 support unialgal growth?
  - 'IDEA-strains'

Poster 2

Pilot growth trails:

- *Nannochloropsis gaditana*
- *Chloromonas typhlos*
- Wet preservation

Poster 4

Poster 19

Poster 8

Part 2: Digestate as nutrient source

Poster 11

1. Lab trials:

- Verify pretreatment requirements
- determination of growth conditions for specific digestate

Manure fed digester

Digester

Pre-treatment

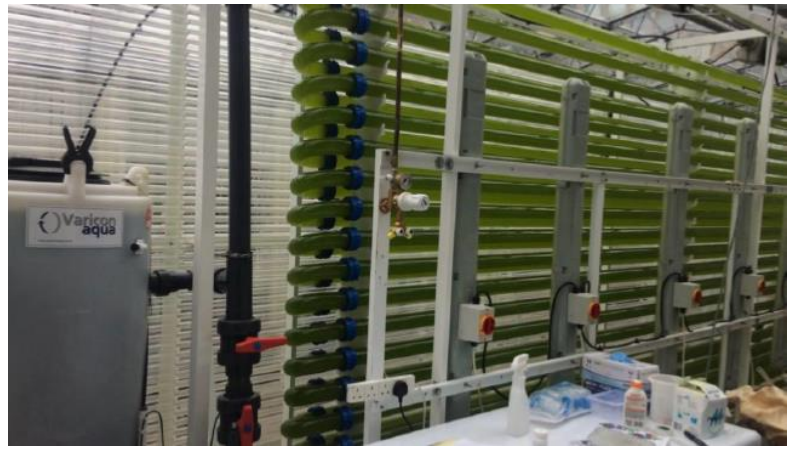
N,P,salts

Option 1: digestate + water (no other nutrients)
Option 2: digestate as N/P-source added to medium

Poster 10

2. Pilot trials:

- Larger scale
- Longer-term



Scenedesmus growth on digestate

Part 3: Algae cultivation on recycled CO_2

Approach 1 (most mature)

Manure fed digester

Digester

Biogas

combustion

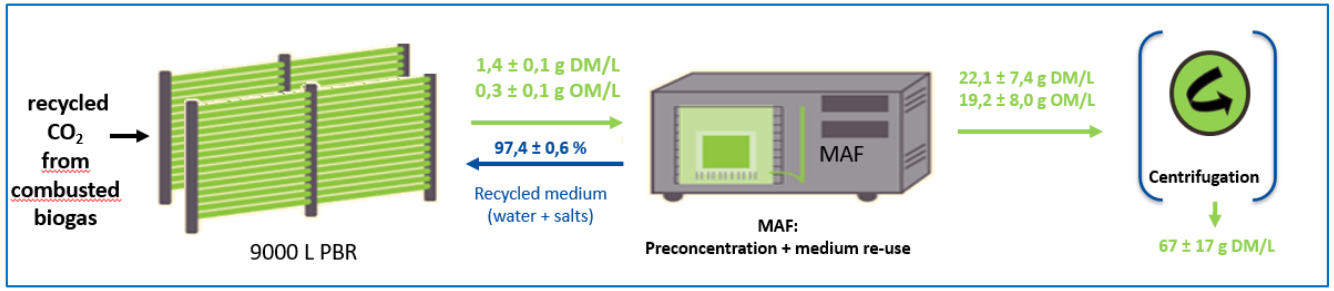
Flue gas

Heirbaut aLgriculture

vito

Poster 13

- Technical adaptation required?
- Demonstration of algae growth
- Demonstration of continuous harvest & medium recycling with MAF



Part 3: Algae cultivation on recycled CO_2

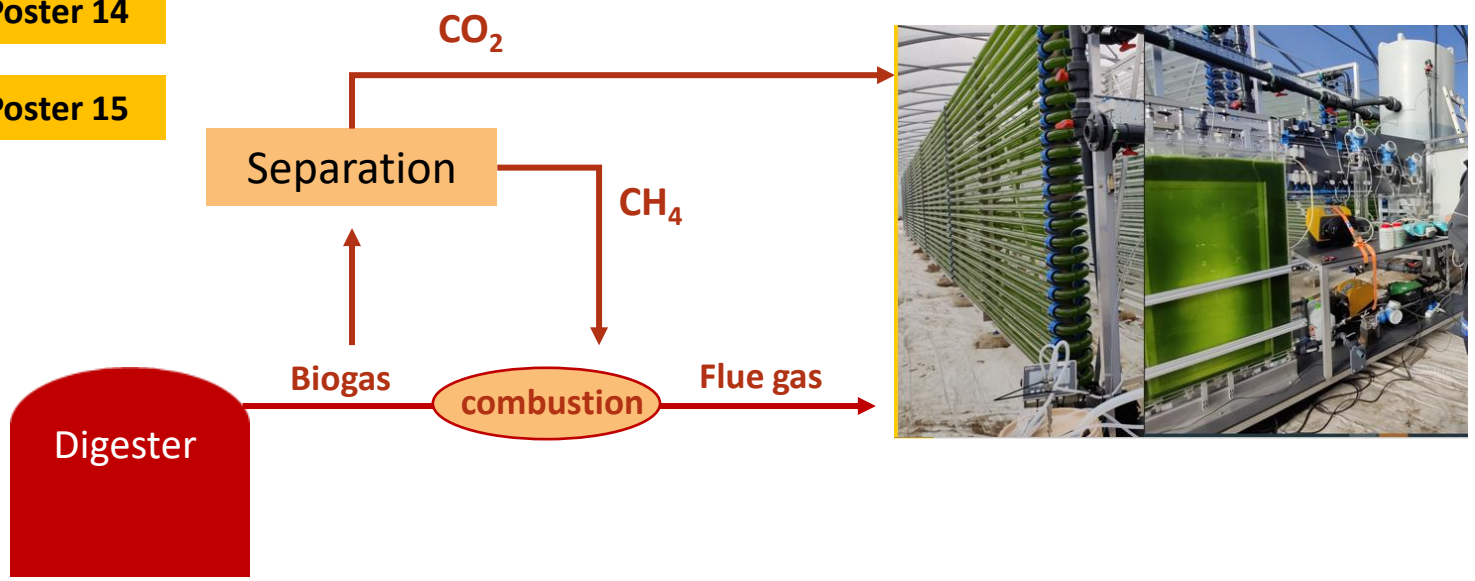
Approach 2

UNIVERSITY OF TWENTE.

Poster 14

Poster 15

Manure fed digester



IDEA+ pilot trials that generated biomass that required further processing

Interreg North-West Europe IDEA
European Regional Development Fund

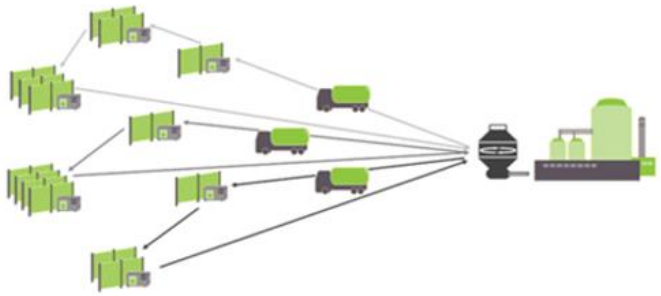
2022 2023

3 4 5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9 10

Mixed culture from open pond
Processing
Processing
Open pond (NL)

Nannochloropsis
Processing
Chloromonas
Processing
Chloromonas
Processing
PBR Sunbuilt (B)

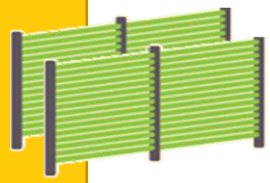
Chlorella
Processing
Temse (B)



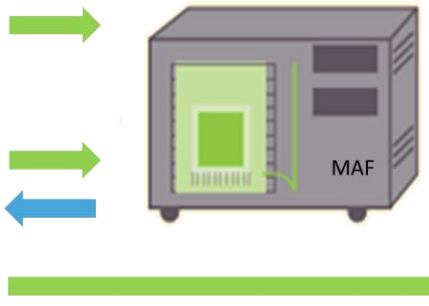
Scenedesmus
Processing
Swansea (UK)

vito GrO_2
Mol (B)
Nannochloropsis
Processing

Part 4: Processing of algae biomass



Algae growth



Preconcentration & medium recycling

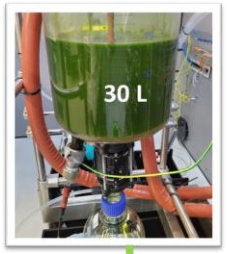
Centrifugation

Freezing (preservation)

Cell disruption
Beadmilling

Freezedrying

Whole disrupted biomass



Oil extraction

Algae oil

Defatted algae

Poster 16

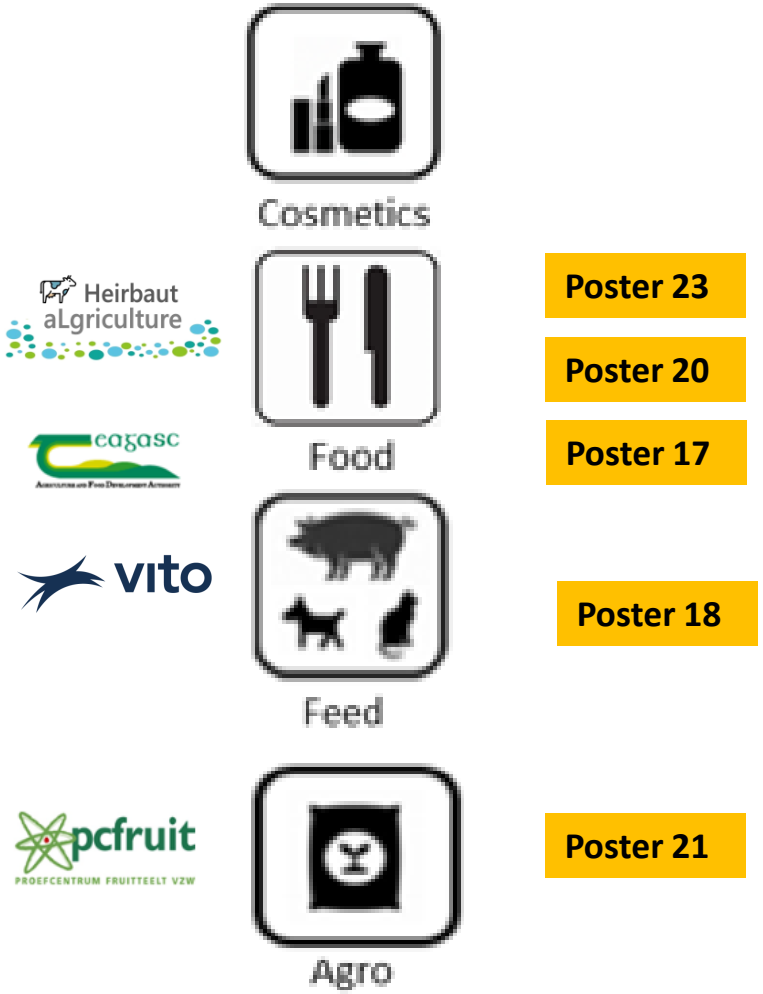
Part 4: IDEA+ Algae biomass processing

	Nannochloropsis	Chloromonas	Chlorella	mixed culture	Scenedesmus	Total
Side-stream used for growth	MAF permeate of Process water	MAF permeate of Process water	Recycled CO_2	Process water	Digestate	
Harvested (VCF 1) - L	11000 L	12200 L	16500 L	244300 L		> 430 m^3
MAF-preconcentrated (L)	Yes	No	yes	yes	No	
After centrifugation (L)	> 68 L	119 L	71 L	651 L	120 L	> 1 m^3
beadmilling	> 65 L	129 L	71 L	475 L	156 L	> 0,8 m^3
freezedrying	> 65 L	125 L	70 L	500 L	150 L	> 0,9 m^3
DM	3,8 + 1,7 + 0,35 kg	1,7 + 3,6 kg	4,4 kg	10,5 + 18 kg	> 1,7 kg	
Oil extraction	Yes	Yes	Yes	No	No	
Oil produced	427 g	60 g	197 g			

Input for application test

Part 4b: Applications considered

- Composition analyses
- Safety evaluation
- In vitro bioactivity trials
  - Health promoting
  - anti-microbial
  - Anti-fungal
  - Pest control
  - Digestibility
  - …
- In vivo bioactivity trials
  - Dogs
  - plants



Poster 23

Poster 20

Poster 17

Poster 18

Poster 21

Value chain overarching aspects

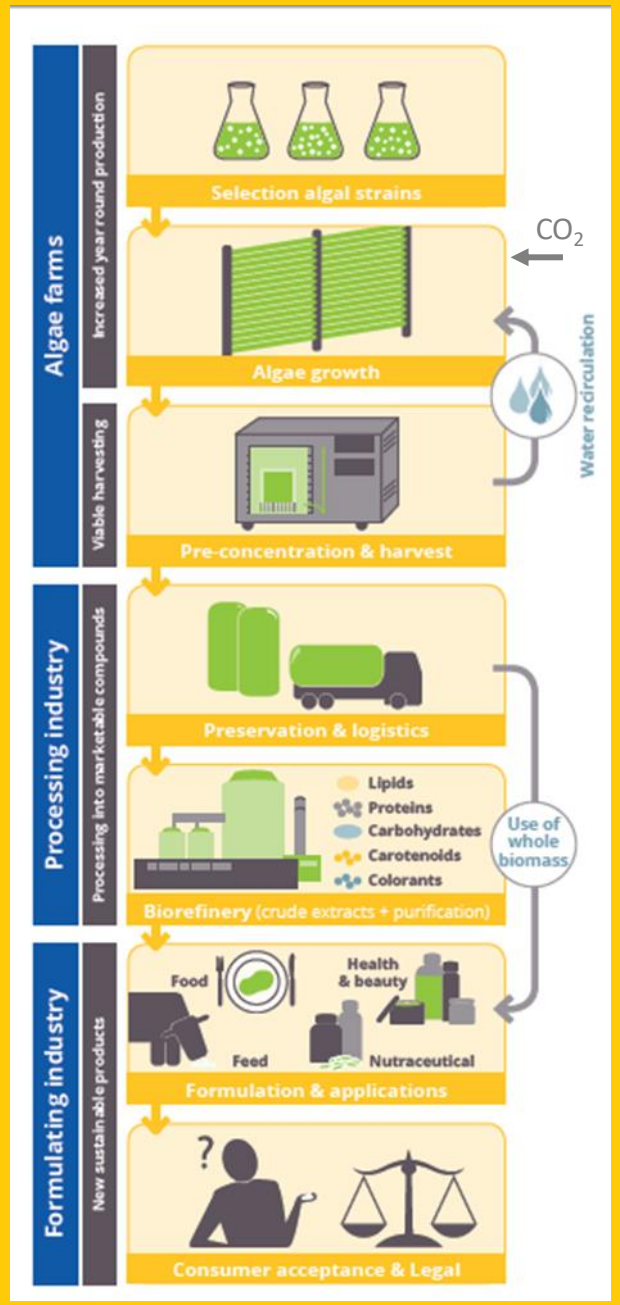
Key questions:

- Can side-streams be used to cultivate algae – technically? **YES**
- Is it safe to use side-stream for algae cultivation? **Poster 25**
  - To be evaluated per application
- Is it legal to use side-streams? **Poster 16**
  - Application type is important
- Impact on economics? Sustainability? **Poster 17**
  - Economics: not always positive at this moment
- Impact on value chain enrolment? → **requires more time**

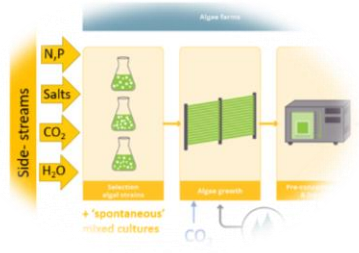
Developing new value chains remains challenging

'Landscape' changes recently
Alternative proteins
Circular economy
Higher energy costs

New drivers for algae sector



Acknowledgements



This research was funded by NORTH-WEST EUROPE INTERREG, grant number NWE 639 as part of the IDEA project (Implementation and development of economic viable algae-based value chains in North-West Europe).

Website: www.nweurope.eu/idea

Full partners:

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THOMAS MORE

cagasc

UNIVERSITY OF TWENTE.

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Heirbaut aLgriculture