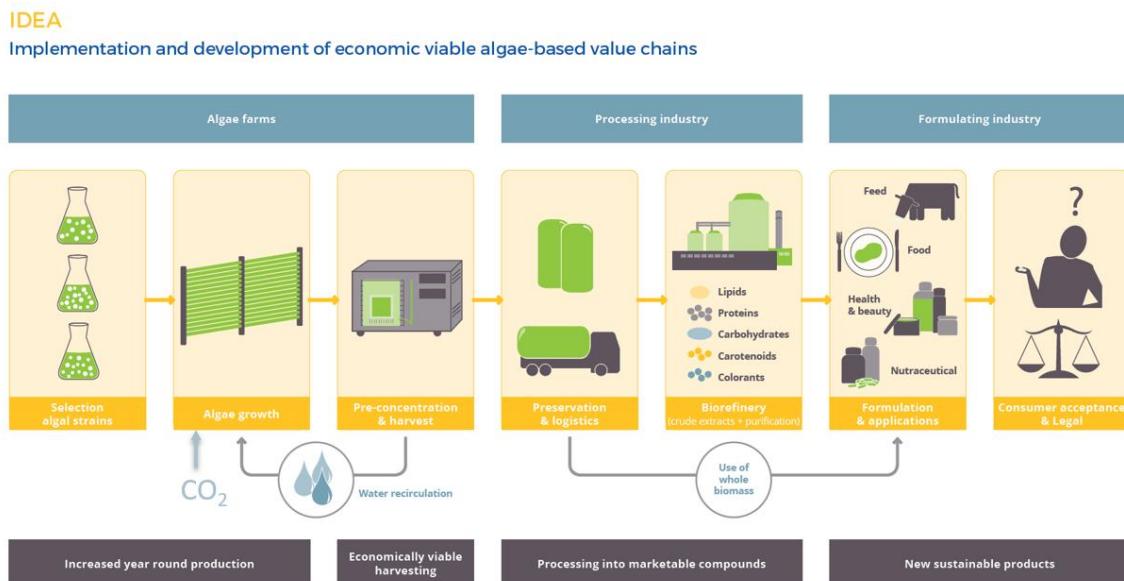


# IDEA position paper – Algae value chains

Within the Interreg NWEurope IDEA project, the enrollment of algae value chains in Europe was investigated. This document summarizes the views of the IDEA consortium on a number of questions related to the establishment of algae-based value chains. Ultimately, the key elements mentioned facilitate to accelerate the implementation of a profitable algae value chain in Northwest Europe.

## What is an algae value chain? Which aspects are considered?

- “**Algae value chains**” refer to trains of activities that are required 1) to produce algae biomass, 2) to process this algae biomass into ingredients, and 3) to formulate the ingredients into marketable algae-based products. The value chain elements considered within IDEA are depicted below.



- The production of algae biomass** is organized at **algae farm level** with the following chain parts:
  - Selection of the algae species to cultivate and to maintain the culture at small scale (IDEA focused on micro-algae);
  - Large scale algae biomass production (IDEA focused on phototrophic growth);
  - Algae harvesting, with at least partial dewatering at algae farm level;
  - Re-use of the medium;
  - Other aspects:  $\text{CO}_2$  source, water source, medium composition, discharges, climate control, etc.
- Processing of algae biomass**, the middle part of the value chain, can partially be performed at algae farm level or can be organized in centralized processing factories. Algae processing can comprise the following aspects:
  - Storage of wet (pre)-harvested algae biomass and logistics related to transport;
  - Further dewatering and drying;
  - Potential (cascading) fractionation of algae biomass & tailoring of ingredients (IDEA focused mainly on feed, food and cosmetics applications, and extended to crop-protection);
  - Other aspects: packaging, storage of ingredients, etc.
- Downstream, the **formulating industry** uses the algae-based ingredients to prepare **marketable products**. This comprises the following aspects:
  - Selection/tailoring of suitable ingredients to the application;

2. Designing product formulations;
3. Selling of the products to the end-users;
4. Other aspects: consumer's awareness & acceptance, marketing, legal aspects, etc.

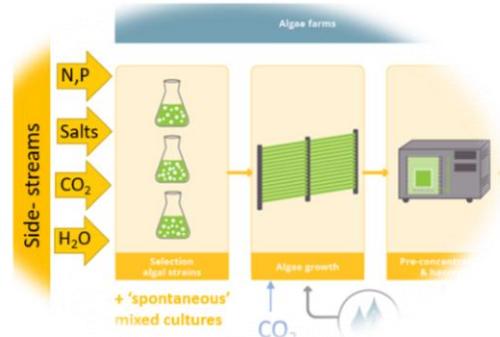
### Which stakeholders are involved?

Stakeholders are actors along the value chain that have their own specific tasks and needs in the establishment and functioning of value chain. Key stakeholder categories for the development and establishment of algae value chains are diverse and comprise:

- For algae cultivation part: algae producers; equipment providers (growth, harvest, ...); consultancies (growth, harvest); companies with side-streams (CO<sub>2</sub> nutrients, heat, water, ...); etc.
- Algae processing part: logistic companies; fractionation companies; equipment/expertise providers; etc.
- Algae formulation part: Ingredient providers & formulators of cosmetics, nutraceuticals, food, aquafeed, petfood, Feed, agro-products, materials, energy, etc.
- Others: authorities, investors, groupings, research organizations, etc.

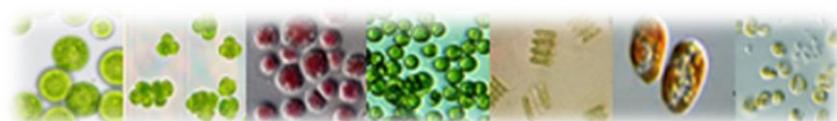
### What drives the establishment of algae value chains in (NW)Europe?

- Opportunities: Algae are rich in diverse high value compounds. There is a trend towards more circularity and sustainable alternative compounds like alternative proteins. Vegan applications are increasing. The importance of local and/or healthy food production is increasing. There is a pressure to reduce CO<sub>2</sub> emissions.
- Needs for: alternative use of empty greenhouses; innovation in farming sector; non-petro-based compounds; healthy ingredients; etc.
- Sustainability aspects: Algae convert CO<sub>2</sub> and light and nutrients into complex & high value compounds; opportunities to use side-streams for algae cultivation, etc.



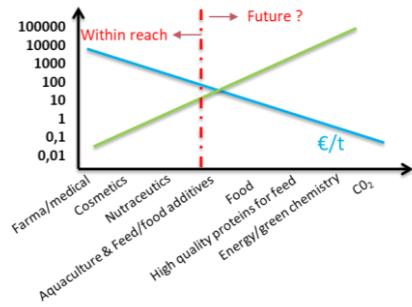
### Diversity of algae an opportunity or a burden?

- The term 'microalgae' refers to a very diverse group of species. Technically, multiple microalgae species can be cultivated in Europe, comprising *Tetraselmis*, *Spirulina*, *Chlorella*, *Synechococcus*, *Pavlova*, *Dunaliella*, *Rhodomonas*, *Nannochloropsis*, *Porphyridium*, *Scenedesmus*, *Chloromonas*, etc.
- Opportunities: As microalgae species differ in composition, algae biomass is a potential source for diverse compounds like proteins, fatty acids (incl. omega-3), carbohydrates, colorants, antioxidants, etc. The richness in algae species and compounds offers potential for multiple value chains.
- A point of attention is that each species has specific growth requirements, compositions (and therefore process conditions) differ and the legislation is different for different applications and can be algae species specific. This implies that findings for one species cannot necessarily be copied to other species, leading to scattering of time & resources, and situations that might be perceived as complex and confusing.
- Solution: Focus on selected application/cases with high probability of success. By focusing on limited well-selected cases, the time required to connect stakeholders and to develop technologies and products can be reduced, resulting in a faster time to market.



## Which application markets & algae-based ingredient types to be targeted?

- Smart selection of target markets is recommended, taking into account the product value, required amounts at regional/global level, and the market share that can be reasonably acquired (drop in vs new products, regulatory barrier, qualification barriers etc.). First focus can be on high value markets that require only limited amounts of algae and have relatively low entry barriers. Within time, a shift is expected to be possible towards markets that require higher amount of algae biomass at a lower price.
- Use of whole (disrupted) biomass versus algae biomass fractions as ingredients largely depend on application and final product value. The envisioned application determines to a large degree the need for cell disruption and/or fractionation. In aquaculture whole intact cells are crucial, while for other applications disruption is required to increase the accessibility of algae compounds.
- Fractionation of algae biomass aims at obtaining fractions that are enriched/depleted in specific compounds.
- For each application, tailoring of the algae-based ingredients is crucial. *In vitro* and *in vivo* tests are useful to verify the (bioactive) properties and digestibility of fractions.



## Current status of microalgae values chains in NWEurope?

- For a full enrollment of algae value chains, all necessary chain parts in the value chains need to be developed & operational.
- Algae farms are in development and up-scaling is ongoing. Multiple farmers are starting algae growth activities and there is potential to further expand the algae growth activities. Algae farmers are looking for clients/applications for the biomass before upscaling their production.
- Algae processing is currently situated rather at research/pilot level, and is to be considered as a sector to be developed. The activity can be upscaled via shift of activities of current biomass processing companies or via establishment of dedicated new companies.
- Algae formulation activities are ongoing. Some commercial products are established for aquaculture and nutraceuticals, and first food products with algae-based ingredients are on the market. To enroll the algae-value chain fully, more types & quantities of algae-based products are to be developed. Good products are considered as the main driver of the value chain.

## How to link offer and demand of algae?

- A challenge is to link offer and demand of algae biomass in terms of algae species, type of processing, quantities, quality & purity, and prices.
- Algae represent a new value chain. This implies that end-users are often not yet aware of what type of algae biomass (fraction) they exactly need or can use. This creates uncertainty and risk for algae growers: which algae to grow? Who will buy biomass? The fact that a yet-to-be-established processing industry is situated in many cases between the growers and formulating industry, complicates further the situation.



- “Platform” types to share information and exchange offer and demand of algae, as identified within IDEA, comprise web-based trading platforms, clock auctions, bilateral trading, contract growing, local value chains, etc.
- Important criteria for such “platforms” are reliability, accreditation, solvency check, data protection and services like quality control and transport.
- Challenges: Moment of launch of the platform, data protection and reaching the possible users offering them the right added value.
- Groupings of farmers (like federations, ...) can help to strengthen the position of algae farms in the value chain.

### **How to make algae value chain more economic viable?**

- Cost reductions where possible, without jeopardizing the quality of the algae(products). Especially in the algae growth the costs are still high.
- Maximal valorization of the biomass, via whole cell use or cascading fractionation with fractions targeting different application markets among which at least 1 high value market.
- Use of side-streams to reduce operative costs and/or discharge costs.
- Policy measures to support the establishment of new value chains by discouraging import of less sustainable (and cheaper) proteins/biomass sources (including via taxes) or encouraging of local production of alternative biomass.

### **What are the current needs of the different stakeholders, as identified within IDEA?**

- At algae farm level: More specific information on type of biomass (fractions) that is required to select the species to grow; Downstream market to reduce risks of investments; Technology improvements to increase the efficiency of growth & harvest and reduce efforts via automatization; Support to establish algae farm investments & activities; etc.
- At processing level: Standardization of raw materials; Specs of ingredients required for the applications; technological improvements for algae processing with special attention to cell disruption and drying; a demand to process higher volumes of algae biomass to process (so beyond pilot scale); etc.

At application level: standardization of ingredients; guaranteed supply of an algae biomass with stable composition; tests results from *in vivo* trials that prove the added value of algae-based ingredients for applications (like health benefits for food/feed; bioactivity for cosmetics); increased consumer's acceptance; etc.

**In conclusion:** Enrollment of algae value chains requires the collaboration of diverse stakeholders in a multidisciplinary approach. Important steps are being made to elaborate and connect the different chain parts.

