

ROADMAP TOWARDS ENROLMENT OF ALGAE VALUE CHAINS IN (NW)EUROPE

Bastiaens L.¹, Severijns K.² & IDEA consortium³

- VITO, Conversion and Separation Technologies department, Boeretang 200, 2400 Mol, Belgium. leen.bastiaens@vito.be
- Innovatiesteunpunt, Diestsevest 40 3000 Leuven (Belgium)
- VITO (B), Forschungszentrum Jülich (D), Innovatiesteunpunt (B), centraleSupélec (F), Feed Design Lab (NL), Thomas More Kempen (B), Teagasc (IRE), University of Twente (NL), Algriculture Hairbaut (B) Swansea University (UK), PCFruit (B)

Introduction

The Interreg NWEurope project IDEA envisions the development and enrolment of economic viable value chains based on microalgae in NWEurope, with focus on phototrophic microalgae for higher-value applications like feed, food and cosmetics. **Aim:** Propose concept of an algae value chain implementation plan (roadmap) based on: 1) needs of actors along the value chain, 2) the reality of spatial distributions (logistic aspect), 3) quantities of biomass (fractions) required; 4) product specific requirements, 5) economic & legal aspects, 6) technological development.

Roadmap elements identified within IDEA

Four roadmap elements were identified as crucial topics for the implementation of algae value chains based on inventory of stakeholder's needs (Fig. 2):

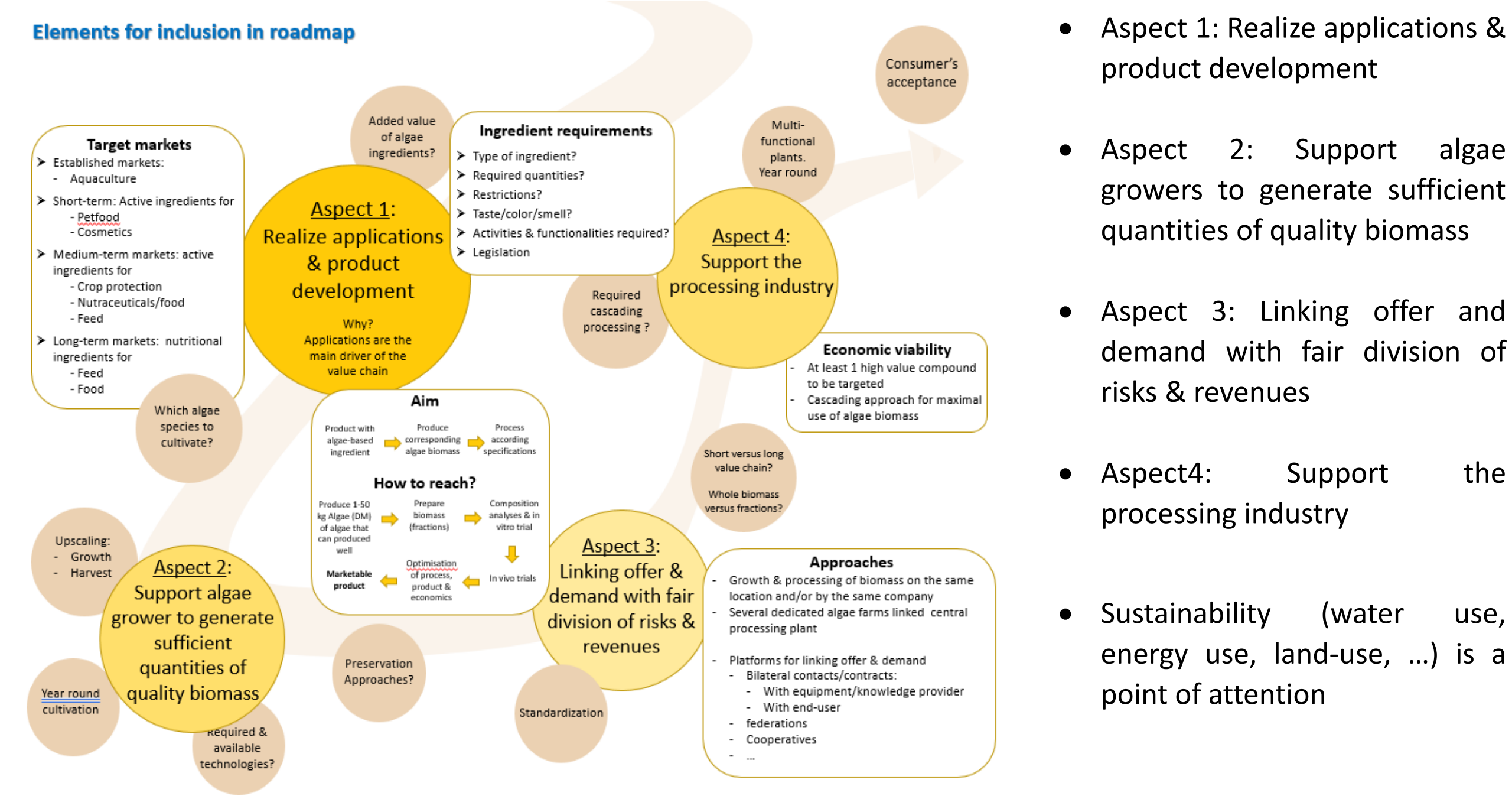


Figure 2: IDEA Roadmap towards implementation of algae-based value chains in (NW)Europe.

What is an algae value chain? Challenges & opportunities?

"Algae value chains" refer to trains of activities that are required 1) to produce algae biomass (at algae farm level), 2) to process this algae biomass into ingredients (by processing industry), and 3) to formulate the ingredients into marketable algae-based products (by formulating industry).

Challenges & opportunities?

- Multiple algae species are a source of a variety of compound:
 - Which algae species to focus on? Which compounds to target?
 - How to process the biomass? Required quality?
 - Tailoring algae biomass (fractions) towards specific ingredients
- Year-round cultivation in NWEurope climate
- Economic viability
- Algae as alternative crops for farmers → How to start?
- Contribution of algae to carbon capture and utilization and/or storage (CCU/CCS)
- Contribution of algae to circular economy for side-stream re-use
- Linking offer and demand of algae biomass

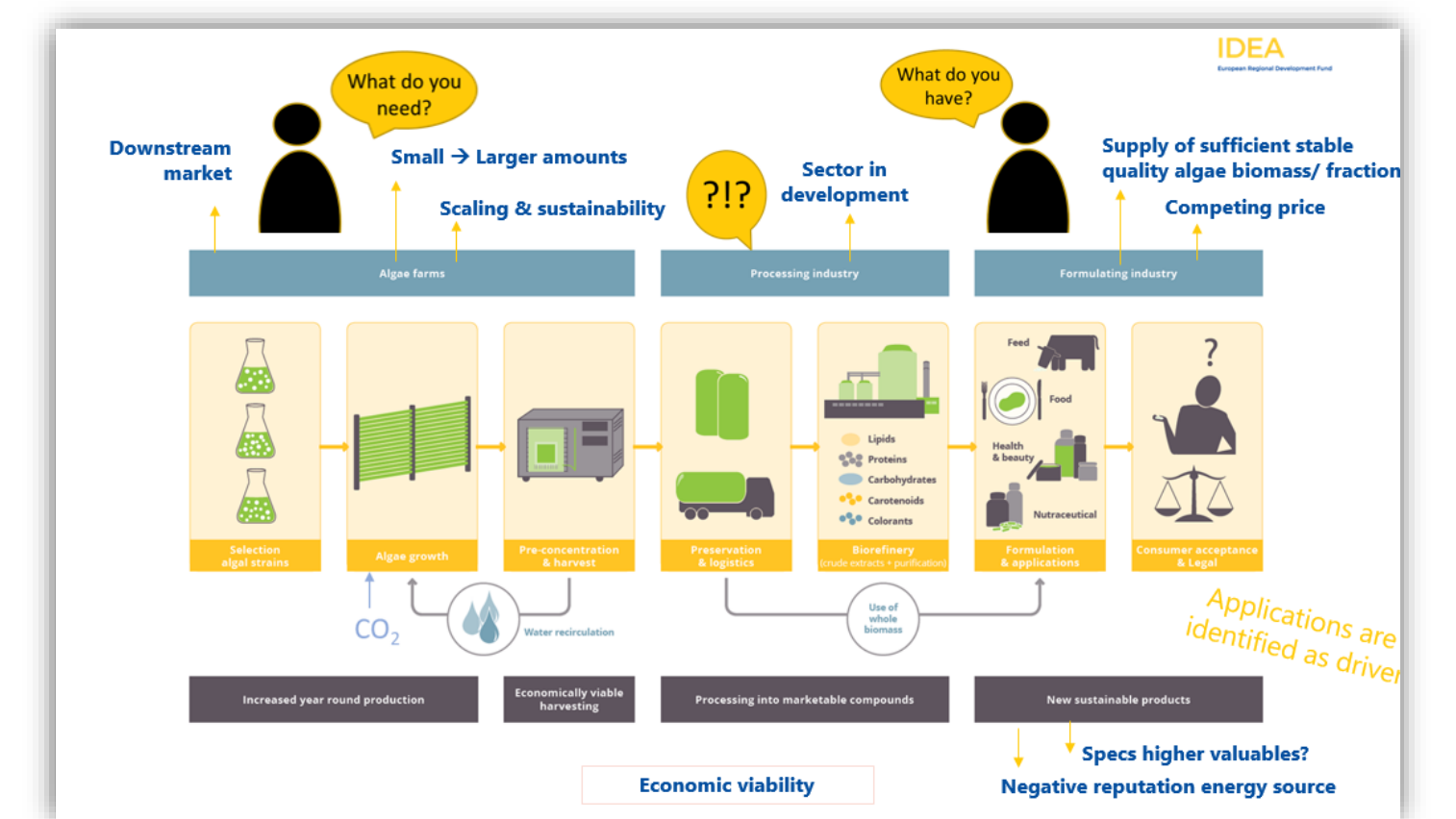


Figure 1: IDEA value chain with indication of challenges along the value chain.

How to realize applications & product development (aspect 1)

- As applications were identified as the driver of value chains, realization of applications and product development was considered as the most crucial and urgent aspect.
- Smart selection of target markets is recommended, considering 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. Some potential markets are summarized in Table 1.

Table 1: Overview of potential markets for algae-based products in different stages of the market development.

Market development stages	Target markets
Established markets	Aquaculture & Nutraceuticals
Short-term markets	Bioactive ingredients for: petfood & cosmetics
Medium-term markets	Bioactive ingredients for: food, feed and crop protection
Longer-term markets	Nutritional ingredients for: feed & food applications

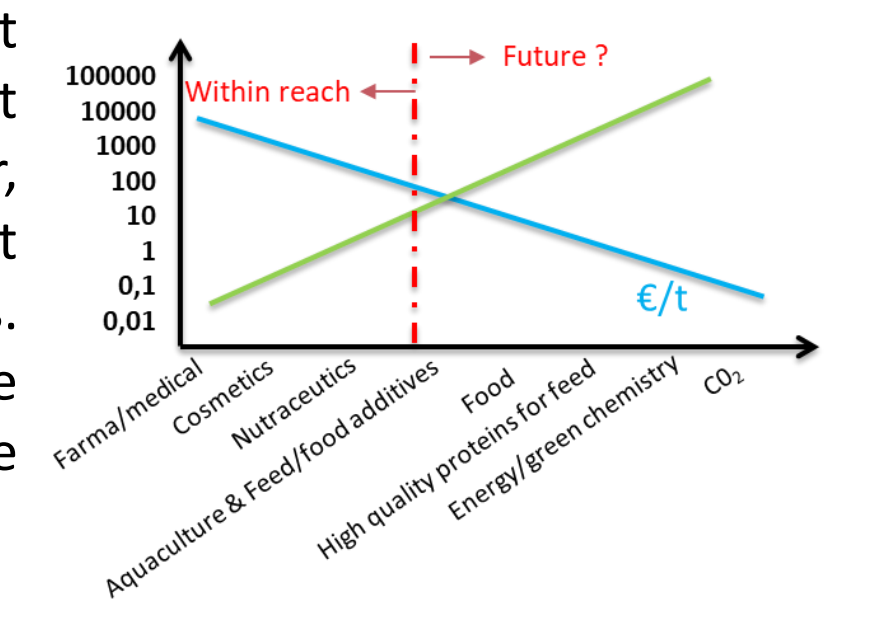


Figure 3: Schematic overview of required volumes of algae biomass and expected prices for different application areas.

- For each application, the type of ingredient (whole cells, whole disrupted cells, algae fractions or purified products) needs to be considered, as well as the required quantities to start commercial activities.
- The required quality and restriction are to be considered as well as bioactivities and techno-functional properties that are of importance.
- All these elements are to be taken into account to tailor algae-based biomass into specific ingredients.
- The value of the specific ingredients will be dependent on the added-value of the ingredient for the targeted formulation.

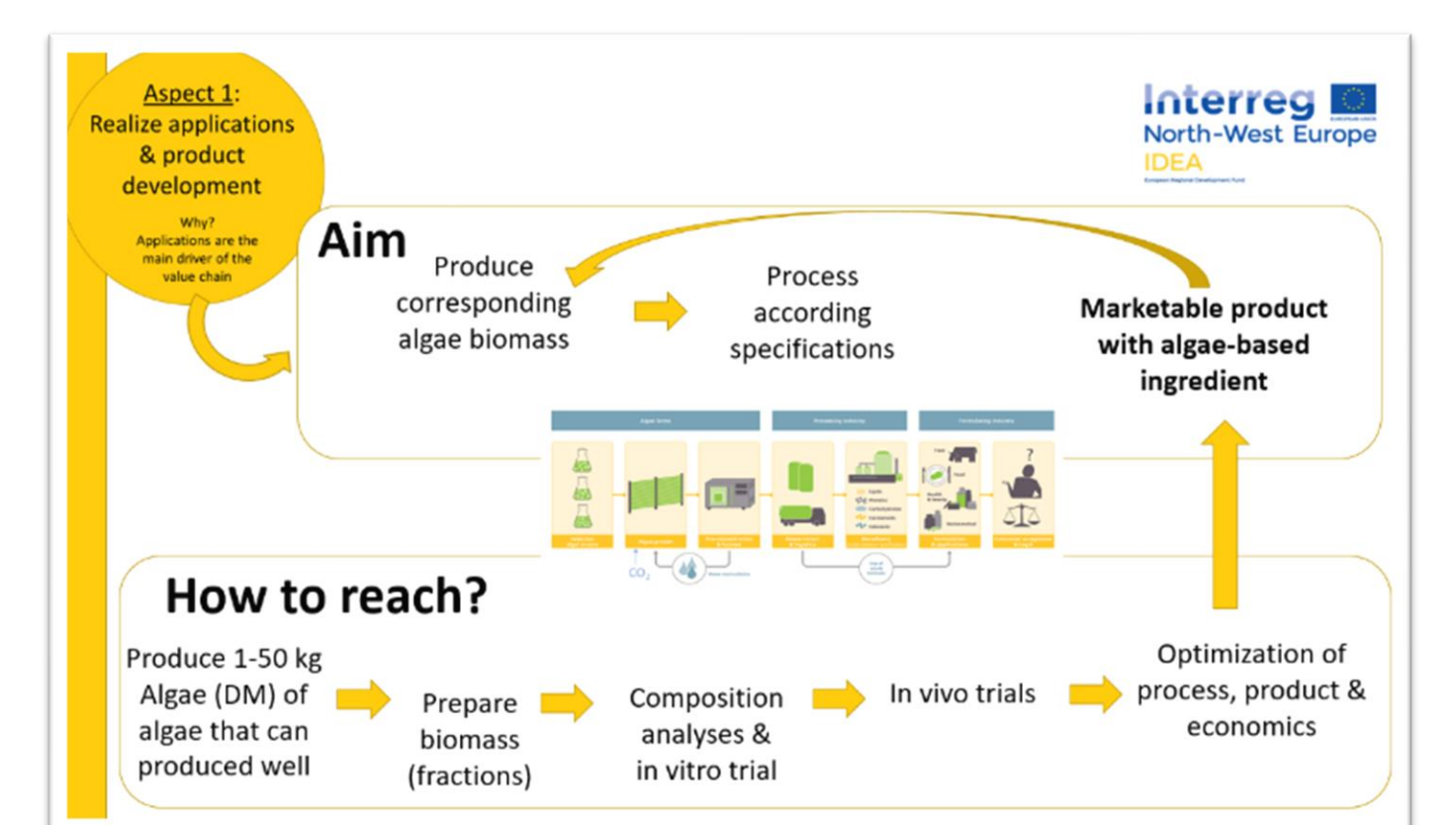


Figure 4: Visualization of some needs and point of attention related realizing application as identified within IDEA.

Options for linking offer and demand with fair division of risks & revenues (aspect 3)?

For linking offer and demand, different platforms are possible, of which some are listed in table 2. Important features for such platforms are reliability, accreditation, solvency check, data protection while services like quality control and transport can add value.

Table 2: Examples of potential platform types for linking offer and demand of algae biomass.

Platform type	Pro	Contra
Information platform	Inspirational site One-stop-shop for market development	No commercial/trading function
Web-based trading platform	Offers & demands can be specified, future demands posted (=> grow on demand) All documents in the cloud	Offer and demand may not fit => risky No background information Trust? => reputation
Web-based blockchain	Security mechanism for (financial) transactions Accepted by most traders	Complex security system
Clock auction system	Connects farmers with many buyers Joint storage & handling Centralised trading platform Financial security mechanism	Does not exist for algae Current auctions not yet interested in algae No guaranteed take-off; no fixed prices (prices depend on demand and offer)
Bilateral trading at auction	Quick response on changing buyers' needs (e.g. due to good weather) You know the customer's demand Financial security mechanism through the auction	Risky if you depend on a small number of customers
Contract growing	Time + costs saving: no physically pass at auction Guaranteed take-off with fixed prices (depending contract type) Potential support by the integrator You don't need market knowledge	Less freedom of choice => less possibility to innovate
Bilateral contract between grower & processor	Requires no investment in a platform Most common for starters You know the customer's demand	Risky (small number of customers) Market knowledge needed Time consuming
Algae grower creates his own market	Requires no investment in a platform Most common for starters You know the customer's demand	Risky (small number of customers) Market knowledge needed Time consuming

Why supporting algae growers (aspect 2)?

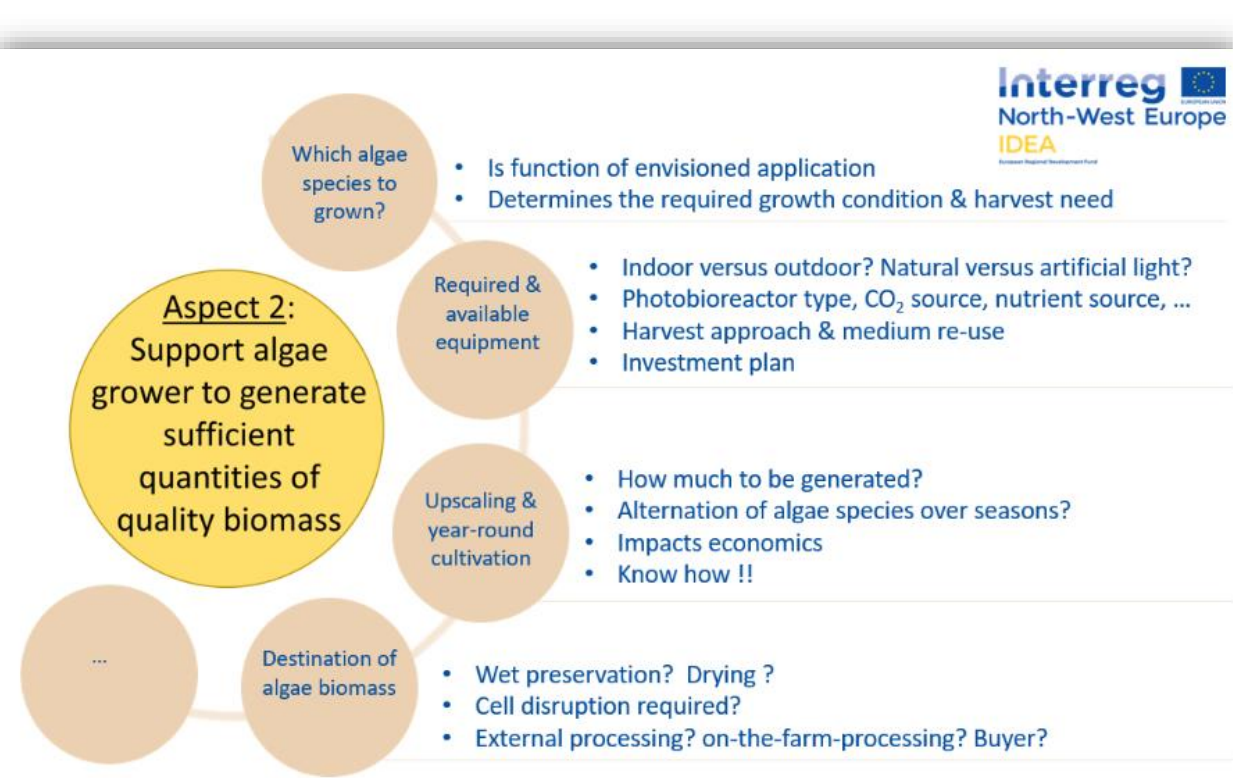


Figure 5: Some needs and point of attention related to algae cultivation as identified within IDEA.

How to support the processing industry (aspect 4)?

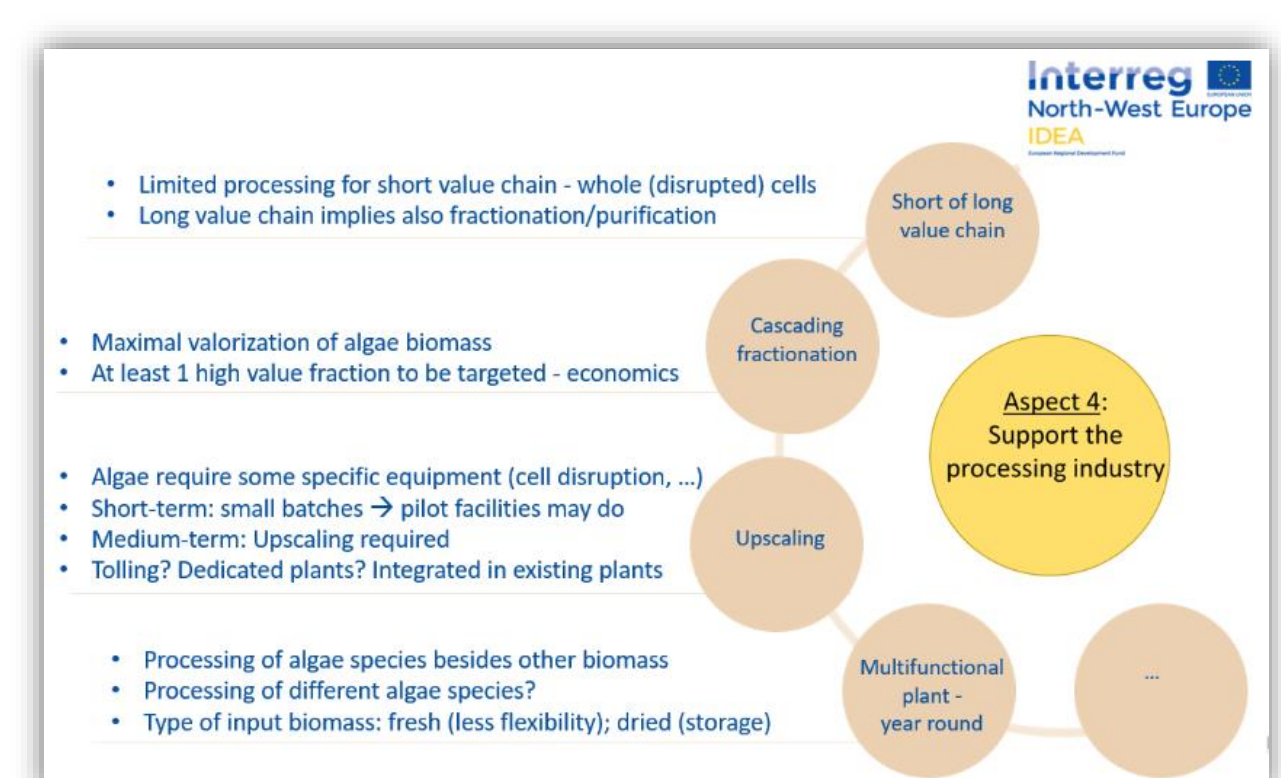


Figure 6: Some needs and point of attention related to algae processing as identified within IDEA.

Impact of side-stream use for algae cultivation on algae value chains?

- Use of side-streams (process water, nutrients, digestate, CO₂, heat) is technically feasible and is positive in terms of circularity. Several further developments are needed to optimize the processes and enroll the logistics. However, side-stream use can add additional complexity to the algae value chain in terms of reproducibility, safety, legislation, purity, etc.
- Timing of algae value chain enrolment with respect to side-streams considered within IDEA+:
 - No side-stream use (short-term): well-controlled growth > less controlled growth
 - Use of recycled CO₂ – source dependent: biogenic (breweries, ...) > biogas > off-gas factories
 - Use of process water (low organic matter, N/P-containing)
 - Use of nutrients from digestate (longer term): plants > manure - standardization required

Conclusions

- Enrolment of algae value chains requires the collaboration of diverse stakeholders in a multidisciplinary approach.
- Value chain development requires new technologies, new logistic systems, new product development & adjustment of stakeholder, which requires time.
- Competition with existing products is challenging – financial support needed.
- A focused development on a limited number of value chains might help.

