



CIRCALGAE

Food • Feed • Cosmetic

4th CIRCALGAE Workshop :

Consumer perception and sustainability of algae products

Online, 27th April 2026



Co-funded by the
European Union

4th workshop: Consumer perception and sustainability of algae products

Introduction

- Ronan Pierre – CEVA

Part 1 : Consumer perception of seaweed products (14.00 – 15:20)

- **Seaweed consumers: Who they are and what they care about** - *Bjørn Tore Nystrand*, Møreforskning, Norway
- **Protein-enriched foods with seaweed: understanding acceptance among older adults** - *Apolline Barbot* – Laboratoire LEGO, University of Brest, France
- **Promoting Algae Consumption in France: insights from an ethnographic study** - *Maxime Michaud* - Institut Lyfe, France
- **Industrial testimony : consumer perception of algae-base products in cosmetics** - *Pascual Cuadrado Escamilla*, RNB Cosmetics, Spain

Questions

Pause



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Part 1 - Consumer perception of seaweed products



Co-funded by the
European Union

Seaweed consumers :

Who they are and what they care about



Seaweed consumers :

Who they are and what they care about

Seaweed consumers in the Nordics: the big picture

- Nordic consumers are positive but selective
- Interest in seaweed is growing, but consumption remains limited
- Acceptance varies strongly between consumers
- Understanding consumers requires looking at segments, not averages

Not one consumer, but distinct consumer types

- Nordic consumers cluster into clear segments
- Segments differ in:
 - Openness to new foods
 - Perceived risk
 - Underlying motivations
- Seaweed consumption is currently dominated by one segment

Seaweed consumers :

Who they are and what they care about

Who are the adventurous consumers ?

- High food curiosity and openness
- Enjoy trying unfamiliar foods
- Comfortable with novelty and learning
- Engaged with gastronomy and food culture
- More often:
 - Younger to middle-aged adults
 - Urban residents
 - Higher education levels

What adventurous consumers care about

- Taste and culinary experience
- Sustainability and environmental impact
- Health and naturalness
- Authenticity, story and origin

Seaweed consumers :

Who they are and what they care about

Why adventurous consumers accept seaweed more easily

- Lower sensitivity to unfamiliar flavours
- Less fear of “marine” taste profiles
- Prior exposure via restaurants or travel
- Knowledge reduces uncertainty and perceived risk

What this tells us about seaweed consumers overall

- Adventurous consumers act as pioneers
- They help normalise seaweed as food
- Most consumers remain interested but hesitant
- Wider uptake depends on turning novelty into familiarity

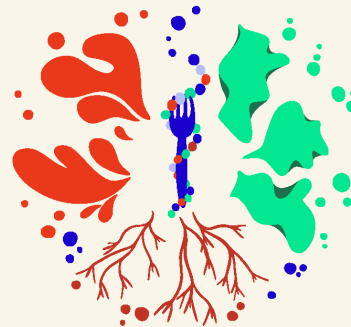
Protein-enriched foods with seaweed:

Understanding acceptance among older adults



**Demographic
transition**

Fighting malnutrition in
hospitals



PROMALG
health

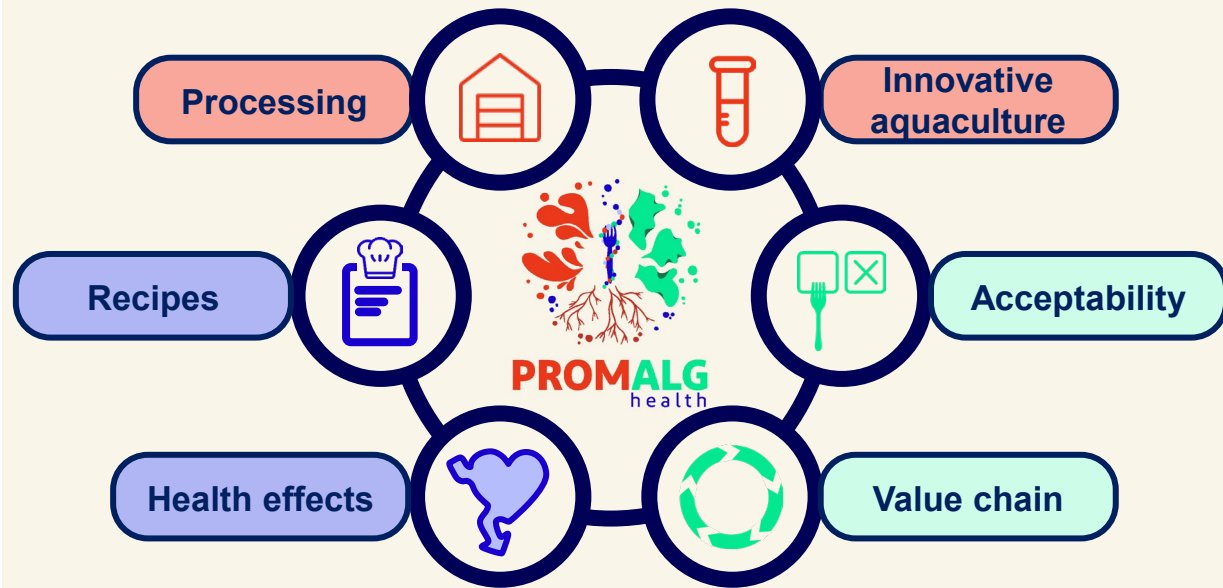


**Food
transition**

Seeking new sources of
protein with lower carbon
footprint

Protein-enriched foods with seaweed:

Understanding acceptance among older adults



What factors are influencing acceptability ?



Protein-enriched foods with seaweed:

Understanding acceptance among older adults



*« I'd like to try it,
it will remind me
of my childhood. »*

Promoting Algae Consumption : France

Insights from an ethnographic study

Maxime Michaud

- Centre de recherche et d'innovation de l'Institut Lyfe

Calixte Engelberg

- Centre de recherche et d'innovation de l'Institut Lyfe
- Centre Maurice Halbwachs
- EHESS



anr[®] INRAE

Acceptance as and issue for food transitions



A societal imperative to transform eating habits



A particular issue on vegetalization



Involves the introduction of new products (or their rediscovery)



Consider their nutritional value, their organoleptic qualities and their functional properties



In fine, le succès des produits repose sur leur **acceptabilité**

Two approaches of acceptance

Economy of consumer behavior



Management
Marketing
Behavioral economy

Anthropology and sociology of consumption



Sociology
Anthropology
Social Psychology

Acceptance

← Willingness to try

→ Integration in food routines

Social conditions of the renewal of food repertory

The case of French macroalgae



PhD. Thesis of

- Calixte Engelberg
- Main supervisor: Séverine Gojard (EHESS, CMW)

What about seaweed consumption in France?



REASONS FOR INTEREST IN SEAWEED :

HEALTH
SUSTAINABLE AND LOCAL
DISTINCTION



SEAWEED CONSUMPTION IN FRANCE :

JAPANESE PRODUCTS
FRENCH INSPIRED PRODUCTS (LE BRAS *ET AL.*, 2014 ; FICHEUX *ET AL.*, 2022)



FRENCH INSPIRED PRODUCTS : SPREADS, SEAWEED MUSTARD, SEAWEED FLAKES

REGION OF PRODUCTION (BRITTANY)
LOCAL SUPERMARKETS AND RESTAURANTS
NICHE CONSUMPTION.



INITIATIVES TO PROMOTE SEAWEED :

BEACH WALKS
COOKING WORKSHOPS
CONFERENCES
FOR TOURISTS BUT ALSO FOR LOCALS.

Description of the research

Describing and analysing the ways in which French seaweed is used and consumed today

A qualitative study across various locations and contexts:

- Seaweed discovery walks and foraging on the foreshore in Brittany
- Seaweed cookery classes
- Shops selling these products
- Interviews with consumers

Today's presentation: a qualitative study on seaweed discovery walks on the foreshore in Brittany.

A qualitative study of seaweed discovery walks on the foreshore in Brittany.



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Fieldwork by Calixte Engelberg between 2023 and 2025

The beach walk

A special context framed by time and place is necessary to enjoy the experience :

- Legal frame of harvest
- Time frame because of the tide
- Chosen location because of the species

“There are always those who arrive very early. Like J, on Saturday, it was J who arrived first. And then there are always those who arrive 5-10 minutes late. And as the tide is behind us, not waiting for us. We have to leave. So, I cut back a bit on my... As I absolutely must give the instructions of... of the regulations before leaving, because I think people will memorise them.”

Interview with a seaweed instructor, April 2024

The beach walk

A **special context framed by time and place** is necessary to enjoy the experience :

- Legal frame of harvest
- Time frame because of the tide
- Chosen location because of the species

An opportunity of culinary exotism

- Can be seen as a touristic experience **linked to the territory.**
- Breaks the daily routine with an unusual taste and product.

“So, in April this year, my sister and I went to Brittany. We saw this opportunity to do this little course in seaweed identification. And we really liked the idea. So, we signed up.”

Follow-up interview with Mme C, July 2024

“I live in the Drôme [department] and there's no seaweed in the Drôme. Or they are in the rivers, and I don't want to eat them.”

Follow-up interview with Mme O, August 2024

Bringing the experience home

Struggle to store the fresh seaweed despite the demonstration but a desire to do it right.

“But when we came back from our walk on the shore, my idea wasn't to let the seaweed dry out and rot. I wanted to... as Mrs. S showed us, to cook them, to dry them properly, and that's what I did, I've still got some in the freezer, because I had sea beans, I had lots of them, so we tasted all that, I made a seaweed spread...”

Follow-up interview with Mme B, June 2024

Bringing the experience home

Struggle to store the fresh seaweed despite the demonstration but a desire to do it right.

Apprehension to cook the fresh seaweed because it's not easy to cook compared to more conventional products.

“It's what comes afterwards, how are we going to prepare it? It's really important to know what you're going to do with it, like when you go and look for blackberries in the countryside, what are you going to do with them afterwards (...). To go out and look for, and get our supplies from nature, when it's in season, well, we like doing that too, but afterwards you have to be able to use it. It's the easiest thing to do, because we know blackberries, we know nettles, we know wild garlic, but it's true that seaweed isn't something we do very often. It's not so easy to prepare. You really need recipes and an idea of what you're going to do.

Follow-up interview with Mme D, June 2024

Bringing the experience home

Struggle to store the fresh seaweed despite the demonstration but a desire to do it right.

Apprehension to cook the fresh seaweed because it's not easy to cook compared to more conventional products.

Difficulty to cook it and introduce it to others because of its specific taste.

“I think her omelette recipe is really cool. I tried it with a friend who doesn't eat seaweed at all. Apparently, I'd put a bit too much in because it was a bit... It was a bit too much. But he ate it anyway, he said it was interesting, but it was too much.”

Follow-up interview with Mme O, August 2024

“Now I've really gone back to using sprinkles because, well, fresh algae, if it's not well seasoned, chopped properly and there's too much texture, it can really put me off.”

Follow-up interview with Mme O, August 2024

Regular consumption

Regular consumers before the beach walk tend to **keep eating it for various reasons** :

- Health properties

“But yes, of course health and well-being are important to me. It's important for... for my sisters. And food and seaweed are all part of that, of course. Sport. Well, I don't go to the gym, but the fact that I'm always on my bike, I think I do my fair share of sport.”

Follow-up interview with Mme C, July 2024

“As someone who's always careful about what I eat, etc., that's how I really developed an interest in seaweed, because some of them have... pure protein characteristics that aren't, how should I put it, polluted by carbohydrates in particular.”

Follow-up interview with Mme O, August 2024

Regular consumption

Regular consumers before the beach walk tend to **keep eating it for various reasons** :

- Health properties
- Tasty food, have a more diverse diet

“So, I like it, I love it. I really like the iodine in seaweed. And not only that they say it's good for your health. I like the taste anyway. As soon as I rehydrate seaweed, that's it, dry it, I like to eat it.”

Follow-up interview with Mme D, June 2024

“First of all, quite simply the taste. She used to make seaweed spreads that were very good, very light, very... It's a change from salads and so on.”

Interview with Mme N, July 2024

Regular consumption

Regular consumers before the beach walk tend to **keep eating it for various reasons** :

- Health properties
- Tasty food, have a more diverse diet
- Local food

“For me, it's the health aspect and the local aspect. Because as a vegetarian, once again, I eat a lot of nuts and seeds. And actually... I love cashew nuts, but it's horrible to buy them from Vietnam ”

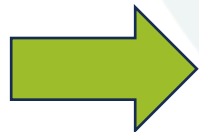
Follow-up interview with Mme O, August 2024

“It's not far to find it. It's something that grows without needing energy. It's a good thing. And so, yes, that's why we're attracted to this knowledge.”

Follow-up interview with Mme B, June 2024

Conclusion

- Discovering the product in the field sparks an interest in seaweed and creates a positive association (a link to the local area, culinary exoticism).
- Knowledge of the product's qualities, combined with an interest in a healthy and varied diet, is a source of motivation for incorporating it into eating habits.
- However, storage constraints, culinary difficulties and specific culinary requirements are major barriers to repeated domestic use.



Despite the interest and appreciation generated by field exploration activities, domestic consumption is severely limited by practical considerations.

Perspectives

- Interviews with regular consumers.
- Discussions and observations in shops (development of the product range over the past two years)
- Discussions with restaurant owners (the importance of influencers in promoting the consumption of seaweed)

Industrial testimony : Cosmetics

Consumer perception of algae-base products in cosmetics

Food waste is in the spotlight

Brands are finding new ways of managing and repurposing food waste to mitigate the associated carbon footprint; much food waste ends up in landfill, generating 8-10% of greenhouse gas emissions globally.

Globally, almost 2.5bn tons of food goes to waste annually, accounting for approximately 40% of food grown worldwide, according to a 2021 study by WWF and Tesco.

Food waste is talked about on social media, evidencing consumer interest. According to WGSN proprietary data, mentions and interest in 'food waste' and 'compost' have risen across all segments since 2018; the penetration rate grew from 0.5% to 4% within Mainstreamers. Peaks of interest took place in the first months of pandemic and in March 2021, coinciding with the UK's first Food Waste Action Week.

Food waste is being converted into useful materials. N&E Innovations, a Singapore-based medtech startup, created a wet wipe from discarded durian husk. According to founder Didi Gan, 12m tons of durian husk are discarded every year in Singapore.

To tackle food loss and encourage customers to reduce edible food waste, British retailer Marks & Spencer will remove the best before date from over 300 lines of fruit and vegetables across its stores.

In the beauty industry, South Korean brand KraveBeauty uses vineyard waste for its upcycled oil cleanser.

How to action this: explore the product potential of waste material streams. Collab with biotechnicians and designers to engineer products from food waste.

The rise of clean beauty

What does clean beauty really mean? Clean, green, and sustainable beauty are often used interchangeably. However, consumers in different markets understand how those terms are defined differently. In Western Europe, “clean beauty” is strongly tied to “green” and sustainability. Meanwhile, consumers in APAC ground their understanding of “clean beauty” in safety and “free-from” assurances. In the US, a lack of governmental regulation gives brands free reign to define for themselves what a “clean” product is. Particularly, North America has also seen the rise of the clean girl aesthetic, which has also made its way across the pond via social media. To embrace these varying interpretations, tailored messaging will be key to speak to all consumers across different markets.

A Clean Beauty Industry Trajectory

Concerns around greenwashing and distrust in claims will continue to risk consumers becoming apathetic towards conscious cosmetics. On-pack traffic light systems which account for a product’s emissions and give it a red, amber or green score will make sustainability easy to understand and is a familiar system thanks to nutrition scores seen in the food industry. *This tactic appeals to over half of UK adults who agree that it’s more important for big companies to act sustainably than individuals and **almost half of BPC users agree that brands need to do a better job at explaining what ingredients they use and why.***

Consumer concern regarding sustainability and environmental impact extends to a product’s entire lifecycle and begins at the stage of ingredient sourcing, extending all the way to products’ disposal and the impact on water systems. German consumers are observed to do their research before purchasing natural and organic products, with **ingredient sourcing a concern for almost 60% of shoppers.** This shows a strong relation between the interest in sustainable ingredients and purchase patterns and points to a highly engaged consumer group. Brands can learn from *Clarins’* T.R.U.S.T platform and allow users to check ingredient sources to ensure transparency.

The rise of clean beauty

Inject an element of fun

Although consumers recognise the importance of tackling environmental issues, introducing a bit of fun into sustainable practices can give consumers the extra boost they need to get fully on board. Get consumers excited about eco-action by bringing unexpected interest into familiar routines, and helping consumers to feel a sense of making a positive change in the world. Creating ingredients for conscious cosmetics and beauty products by upcycling waste and by-products from other manufacturing processes, such as food, is one example of how brands are surprising consumers positively.

Examples



Sealift[®] PF

Synergistic red alga extract complex as a natural filmogene protective shield

Immediate lifting – Shield and detox effects against pollution – Moisturizing shield

Consumer benefits (*in vivo* results)

-5%	-6%	+73%
Wrinkle average relief	Wrinkle maximum relief amplitude	Immediate tensor effect (<i>self evaluation</i>)
+20%	-62%	-36%
Moisturizing effect after 8 hours	Adhesion of pollutants on skin	Pollutants after rinsing



Active compound(s): Sulfated galactans

INCI: Aqua/Water (and) Chondrus crispus extract (and)

Gigartina stellata extract (and) Pentylene glycol

Organic certified alga (*Gigartina stellata*) from

Brittany, France

Water-soluble liquid

Use level: from 2%

Mechanism of action

- Binds to skin proteins such as keratin to provide a non-occlusive second skin effect with a lifting action
- Anti-pollution and moisturizing effects
- Reduces the interaction between pollutants and skin
- Acts as a shield against dehydration

Bioinspiration: *Gigartina stellata* is the most affected alga by tides phenomenon as it grows at the upper level of seashore. Thanks to the sulfated galactans, it is able to tolerate extreme changes in temperature, salinity, moisture and wave action to survive. Their powerful skin properties have been potentialized by the combination with *Chondrus crispus* in Sealift PF.

Sustainable harvesting: Algae are harvested by hand, and we meticulously leave a portion of the algae in place to ensure their reproduction. This sustainable practice promotes the regrowth of new algae for the following year.

Sustainable French sourcing



ALGAKTIV

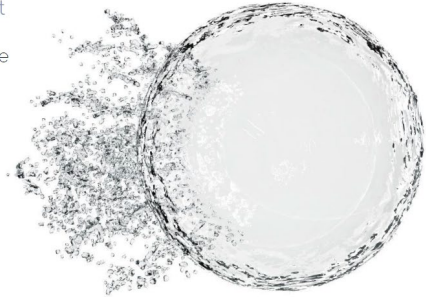
[Our actives](#) [Our microalgae](#) [Our history](#) [Contact us](#)

From the Genesis of Life
to the Genesis of Beauty

Sustainable microalgae biotech
for performance skincare and clean beauty brands

Examples

ALGAKTIV®
UpLift
Skincare



For a Better
Life

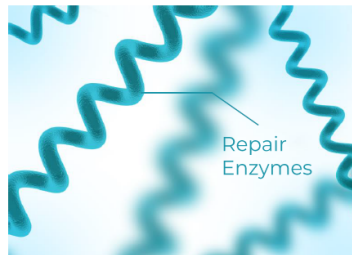
Pure arctic wellness
delivered by nature's marvels

ALGAKTIV® UpLift



MICROALGAE TECHNOLOGY

Combats photo and digital aging thanks to its light powered skin care technology



Spirulina maxima

Phylum: Cyanobacteria (Blue microalgae)

Habitat: Fresh water

Origin: Volcanic Lake (Canary Islands)

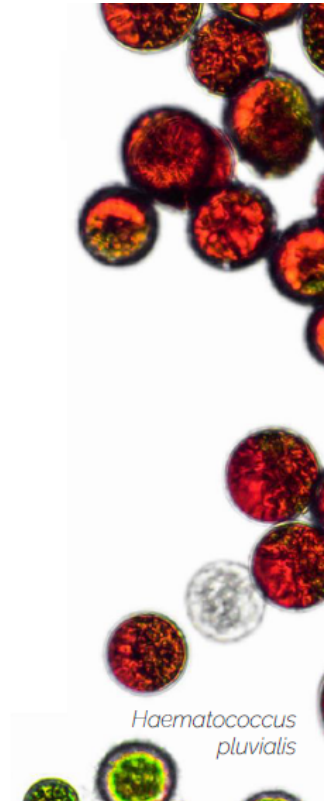
Properties: Radiation extremophyte

Feeding your skin,
naturally

Sustainable microalgae
biotech to boost collagen
production and
restore skin's architecture

INCI: Glycerin (and) Collagen Amino Acids
(and) Propanediol (and) Haematococcus
Pluvialis Extract

ALGAKTIV® Collage



*Haematococcus
pluvialis*

Examples

Products containing Algaktiv® Genofix Nite



MIDNIGHT SEAGENE- Deep night recovery cream

38,00 €

Elevate your beauty every night with Midnight Seagene — the restorative night cream that combines clinically proven efficacy with multi-award-winning quality, honored with 3 Gold Awards at the Best in Pharmacy Awards 2025: Best Facial Care Product, Best Skin Regenerating Product, and Best Green Product. Each application revitalizes your skin by activating its natural renewal mechanisms, thanks to its precious blend of marine algae with freshwater algae and three regenerative enzymes for intensive repair, while stimulating the natural production of collagen and elastin. Wake up to skin that looks radiant and

Augustinus Bader skincare is formulated with high potency botanicals and bio-engineered clean actives, where possible, to reduce environmental impact.

THE ELIXIR

Powered by our proprietary Advanced TFC8® technology and featuring an Exclusive Phyto-Peptidic Concentrate, Biomimetic Elastin, and Collagen Amino Acids Complex to support accelerated renewal.



ULVANEAN® POSIDONIA

Posidonia and Ulva marine synergy

ULVANEAN® POSIDONIA is a natural active extract that combines the benefits of *Posidonia oceanica*, hydrating and depigmenting, with the antioxidant and protective properties of *Ulva lactuca*.

Promotes tissue regeneration, deeply moisturizes, protects against oxidative stress and unifies the tone, offering an effective and sustainable solution for skin care.

Technical specifications:

- **INCI:** Glycerin, Aqua, *Ulva lactuca* Extract, *Posidonia oceanica* Extract, Benzyl alcohol, Dehydroacetic acid, Benzoic acid, Sorbic acid.
 - **Recommended dose:** 3% - 5%
 - **Origin:** Spain
 - **Natural Origin Index:** 0,99
 - **REF:** UPOS
 - **Format:** Liquid
- *Available without preservatives.



Tone unification



Skin barrier reinforcement



Hydration



SEABALANCE®

an UP CYCLED multifunctional O/W emulsifier made from SEAWEED

Find the beauty in **Sargassum**



SEA BALANCE® 2000

SeaBalance® 2000 is an O/W emulsifier with excellent stabilizing properties. It works with a wide range of oils and offers smooth, silky textures with a light skin feel and is well suited for a variety of textures.

ID Card

- **INCI Name:** Sargassum Fluitans/Nitens Extract, Xanthan Gum, Pentaerythritol Glycol
- **Aspect:** Pale green paste
- **Origin:** Seaweed and plant-based ingredients
- **Classification:** Anionic biopolymer
- **pH range:** 3.5-8.0
- **Use level:** 2-6%



Key Benefits

- Marine based, upcycled ingredient
- Silky silicon-like skin feel
- Moisturisation effect
- Skin barrier reinforcement
- Reduces whitening effect & greasiness in sunscreen products

Technical Features

- Versatile ingredient: emulsifier and stabilizer
- Cold and hot process
- Excellent TiO2 and ZnO compatibility
- Very good electrolyte tolerance
- Low viscosity allows to play with textures



Co-creation of the new cosmetic formulations

Body milk

Shower gel

Facial solution

Seaweed ingredients (raw material):

- Laminaria fucoidan
- Phaeodactylum tricornotum
- Spirulin protein
- Alginate
- Cellulose

Co-creation of the new cosmetic formulations

Body milk

32164FA_01	32164FA_26
19 RAW MATERIAL	20 RAW MATERIAL
25 INGREDIENTS	26 INGREDIENTS (without allergens)
9 NATURAL	9 NATURAL
1 UPCYCLED	10 UPCYCLED
9 SYNTHETIC OR PETROCHEMICAL	1 SYNTHETIC OR PETROCHEMICAL
≈92% NATURAL ORIGIN	≈99% NATURAL ORIGIN

Ocean RM: 5

Shower gel

32165FA_01	32165FA_37
15 RAW MATERIAL	23 RAW MATERIAL
28 INGREDIENTS	32 INGREDIENTS (without allergens)
7 NATURAL	14 NATURAL
0 UPCYCLED	7 UPCYCLED
8 SYNTHETIC OR PETROCHEMICAL	2 SYNTHETIC OR PETROCHEMICAL
≈89,5% NATURAL ORIGIN	≈97% NATURAL ORIGIN


4

Facial solution

32166FA_10	32166FA_33
12 RAW MATERIAL	16 RAW MATERIAL
22 INGREDIENTS	19 INGREDIENTS (without allergens)
3 NATURAL	6 NATURAL
1 UPCYCLED	9 UPCYCLED
8 SYNTHETIC OR PETROCHEMICAL	1 SYNTHETIC OR PETROCHEMICAL
≈91 % NATURAL ORIGIN	≈96% NATURAL ORIGIN

4

Articles

► [Mar Drugs](#). 2023 Mar 8;21(3):170. doi: [10.3390/md21030170](https://doi.org/10.3390/md21030170) 

Marine Natural Products as Innovative Cosmetic Ingredients

[Sara Fonseca](#)^{1,†}, [Mariana Neves Amaral](#)^{2,3,†}, [Catarina Pinto Reis](#)^{2,3,*}, [Luísa Custódio](#)^{4,*}

Editor: Félix López Figueroa

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PMCID: PMC10054431 PMID: [36976219](https://pubmed.ncbi.nlm.nih.gov/36976219/)

[Review](#) ► [Polymers \(Basel\)](#). 2025 Mar 18;17(6):798. doi: [10.3390/polym17060798](https://doi.org/10.3390/polym17060798).

Current Approaches in Cosmeceuticals: Peptides, Biotics and Marine Biopolymers

[Ulya Badilli](#)¹, [Ozge Inal](#)¹

Affiliations + expand

PMID: 40292641 PMCID: [PMC11946782](https://pubmed.ncbi.nlm.nih.gov/PMC11946782/) DOI: [10.3390/polym17060798](https://doi.org/10.3390/polym17060798) 

[Review](#) ► [Mar Drugs](#). 2024 Dec 23;22(12):575. doi: [10.3390/md22120575](https://doi.org/10.3390/md22120575).

Marine Invasive Algae's Bioactive Ingredients as a Sustainable Pathway in Cosmetics: The Azores Islands as a Case Study

[Marta Matos](#)¹, [Luísa Custódio](#)², [Catarina Pinto Reis](#)^{3 4}

Affiliations + expand

PMID: 39728149 PMCID: [PMC11678633](https://pubmed.ncbi.nlm.nih.gov/PMC11678633/) DOI: [10.3390/md22120575](https://doi.org/10.3390/md22120575) 

[Review](#) ► [Indian J Microbiol](#). 2024 Dec;64(4):1445-1460. doi: [10.1007/s12088-024-01263-0](https://doi.org/10.1007/s12088-024-01263-0).

Epub 2024 Apr 1.

Algae a Potential Source in Cosmetics: Current Status, Challenges, and Economic Implications

[Khem Chand Saini](#)¹, [Alka Rani](#)², [Sonu Kumar Gupta](#)³, [Preeti Sharma](#)¹

Affiliations + expand

PMID: 39678953 PMCID: [PMC11645359](https://pubmed.ncbi.nlm.nih.gov/PMC11645359/) DOI: [10.1007/s12088-024-01263-0](https://doi.org/10.1007/s12088-024-01263-0) 

Articles

'Blue beauty': what's new in marine ingredients for cosmetics?



By **Kirsty Doolan**

03-May-2024 Last updated on 03-May-2024 at 16:07 GMT



Beauty Kitchen founder Jo Chidley believes that microalgae offers the beauty industry (and the planet) a multitude of benefits

Marine ingredients such as microalgae and seaweed are a sustainable, upcycled and efficacious ingredient option being used in more topical and ingestible cosmetics products. Find out more on the latest developments...

Searching for cosmetics ingredients that are natural, clean-label, kind to the environment AND efficacious is no easy task. However, the current re-focus on marine ingredients: known as 'blue beauty' is one viable way to meet these demands.

Microalgae – in particular – is in the spotlight. These are photosynthetic organisms that produce useful metabolites due to constant exposure to stressful environments, such as high salinity, osmotic pressure, extreme temperatures, photo-oxidation, and ultraviolet radiation.

['Blue beauty': what's new in marine ingredients for cosmetics?](#)

Articles



Tariro Makoni  • 3er+

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[Ver mi newsletter](#)

5 meses • Editado • 

[+ Seguir](#) ...

In my latest for [Vogue Business](#) (and first ever beauty piece!!), I explore the viability of algae as luxury's next hero ingredient — and outline a scalable playbook for the next generation of brands, drawing on the success, challenges, and learnings from algae's most successful early adopters.

Featuring conversations with:

- The internet's favorite "from scratch" tastemaker, Nara Smith, and [Kas Saidi](#) (founder of [Algae Cooking Club](#)) on their sold-out garlic-yuzu algae cooking oil
- [Dr Yannis Alexandrides MD](#), world-renowned plastic and reconstructive surgeon and founder of [111SKIN](#) (backed by [SKKY Partners](#)). We spoke about the breadth of algae's clinical benefits and how the brand is translating them into luxury — across 111SKIN's product line and through an algae-focused collaboration with [Aman](#)
- [Allison McNamara](#), founder of [MARA Beauty LLC](#) — an oft-sold out algae skincare brand that counts Hailey Bieber amongst its fans
- [Ása Brynjólfssdóttir](#), head of R&D at [Blue Lagoon Skin Science](#), on the 30 years of algae-specific scientific research that underpins the brand's provenance and clinical claims

Special thanks to [Hilary Milnes](#) and the [Vogue Business](#) team!

I hope you give it a read — let me know what you think :)

<https://lnkd.in/etqmrPHQ>

SKINCARE

Is Algae Luxury Beauty's Next Hero Ingredient?

BY TARIRO MAKONI

November 14, 2025

<https://www.vogue.com/article/is-algae-luxury-beauty-s-next-hero-ingredient>



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Q&A

www.circalgae.eu





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PAUSE

We will be back at 3:30 CET for Part 2



Co-funded by the
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4th workshop: Consumer perception and sustainability of algae products

Part 2 : Sustainability and Life-cycle assessments (15:30 – 16:45)

- **Streamlined European practices for improved algae LCAs** - *Léa Braud, European Algae Biomass Association, Italy / Sustainable Food Processing Laboratory, ETH Zurich, Switzerland*
- **From waste to value: environmental and economic assessment of algae residue valorization using Life Cycle Assessment (LCA) and Costing (LCC)** - *Riin Kaldma + Hendrik Ploom, Civitta, Estonia*
- **The AlgaeProBANOS Sustainability Assessment Framework for Algae Systems: do's and don'ts of sustainability claims** - *Linus Hasselström Langer, KTH, Sweden*

Questions

Conclusion

- *Sonia Lassal, AQUIMER, France*



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Part 2 - Sustainability and Life-cycle assessments



Co-funded by the
European Union



EABA LCA
Task Force

Streamlined European practices for improved algae LCAs

Dr. Léa Braud ^{1,2}

(1) European Algae Biomass Association (EABA)

(2) Sustainable Food Processing Laboratory, ETH Zurich, Switzerland

CIRCALGAE webinar | Monday 27 April 2026

Ecklonia radiata, Taputeranga Marine Reserve,
New Zealand. Photo by Rossella Nicolai.
EABA Picture Contest 2025.

An underwater photograph showing a vibrant coral reef. The coral is primarily orange and purple. Interspersed among the coral are several pieces of clear plastic debris, including thin, tangled strands and larger, irregular fragments. The background is a deep blue, slightly hazy water.

**“92% of ecosystems are contaminated by debris,
88% of which is plastic”**

Algae-based products are **promising** but **not sustainable by default**

When are algae-based products environmentally preferable than conventional alternatives?

**Where do their environmental impacts come from?
Cultivation? Processing? Transport?**

Outline

- 01 What is Life Cycle Assessment?
- 02 Streamlining algae LCAs: What for?
- 03 How does the **EABA LCA Task Force** support streamlined algae LCA practices?



Life Cycle Thinking

Conceptual basis for Life Cycle Assessment (LCA)

- Includes **all stages** of a product's life, from raw materials extraction to end-of-life
- Considers **environmental, social, and economic** impacts
- Aims to **reduce resource use & emissions**
- Supports **better decisions** across the value chain

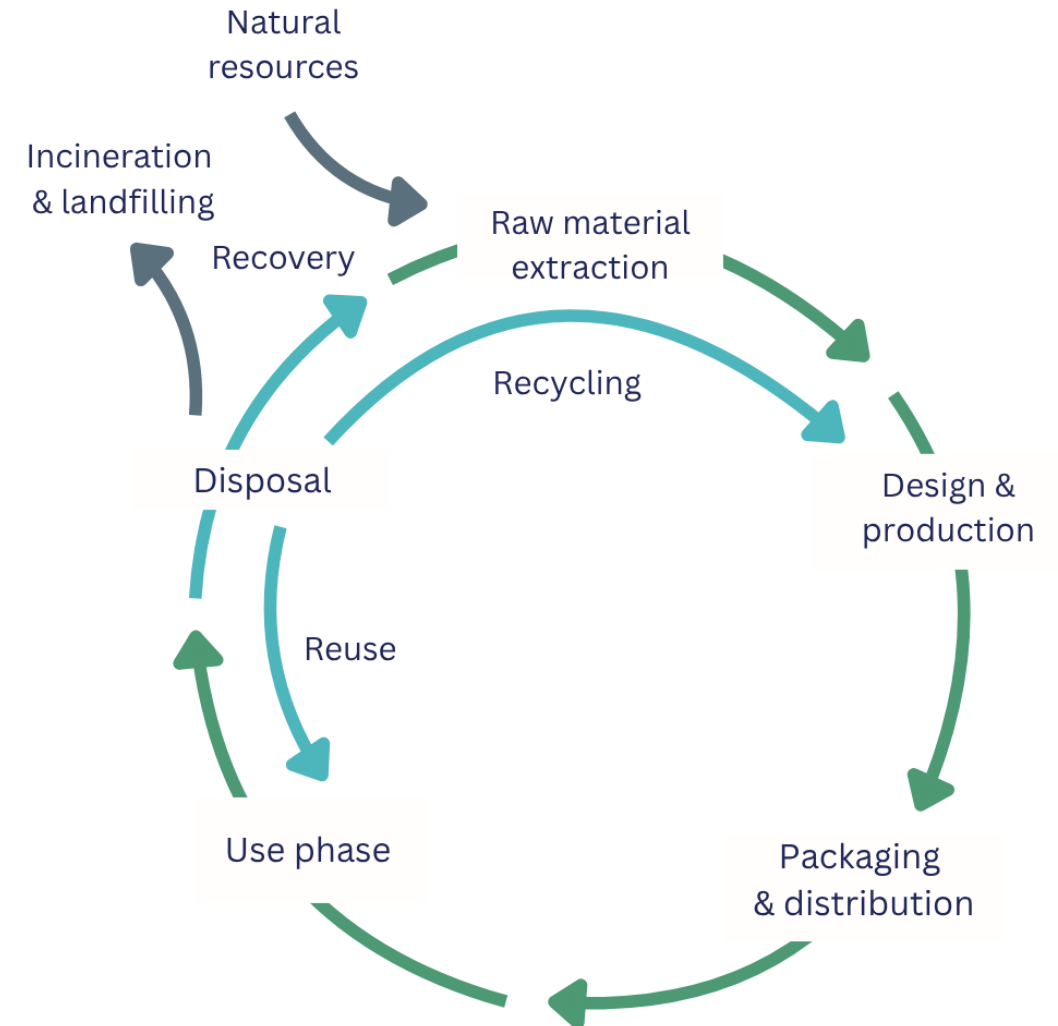


Figure adapted from: Life Cycle Initiative, UNEP. [What is Life Cycle Thinking?](#)

Three pillars of sustainability

Environmental

Economic

Social



Environmental LCA (E-LCA)



Life Cycle Costing (LCC)



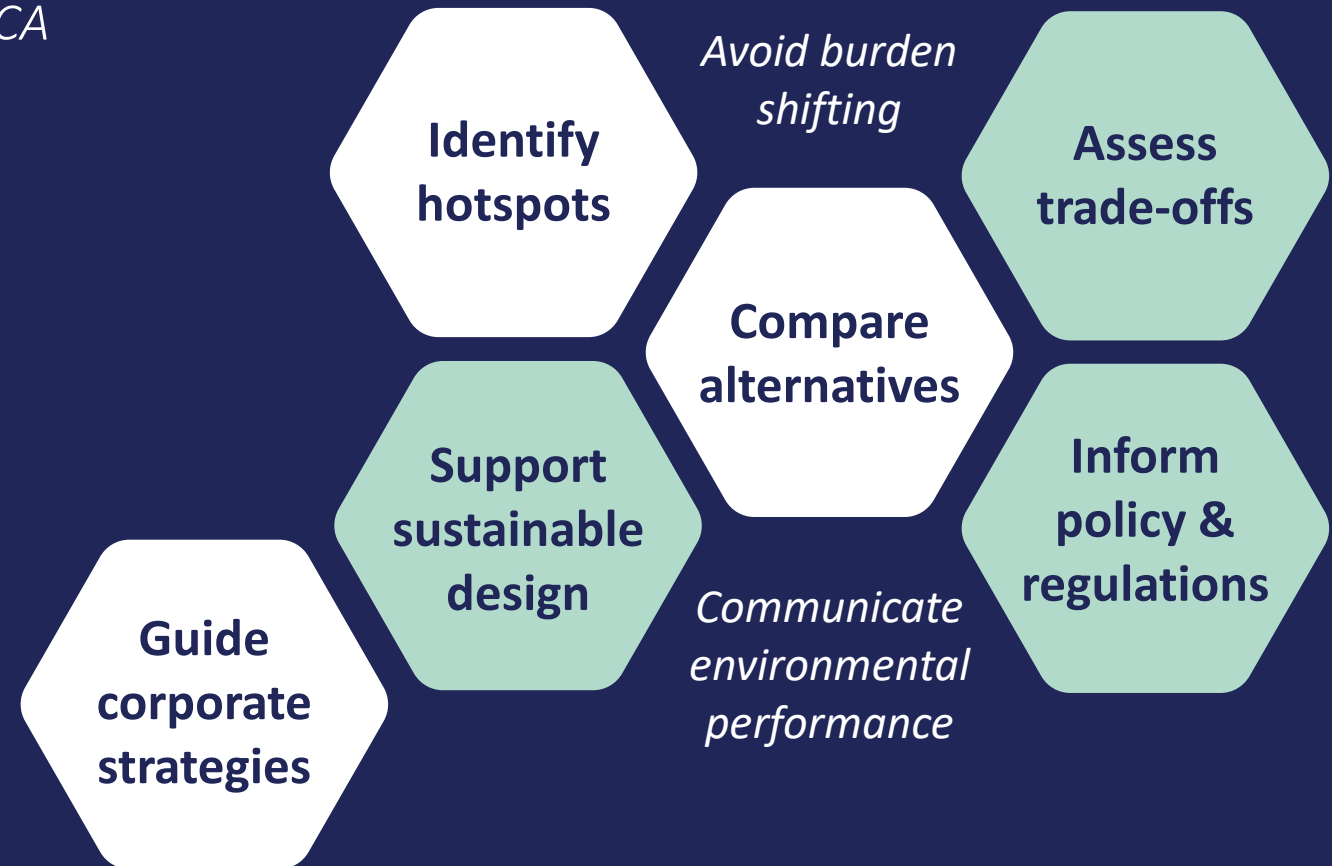
Social LCA (S-LCA)

Life Cycle Sustainability Assessment (LCSA)

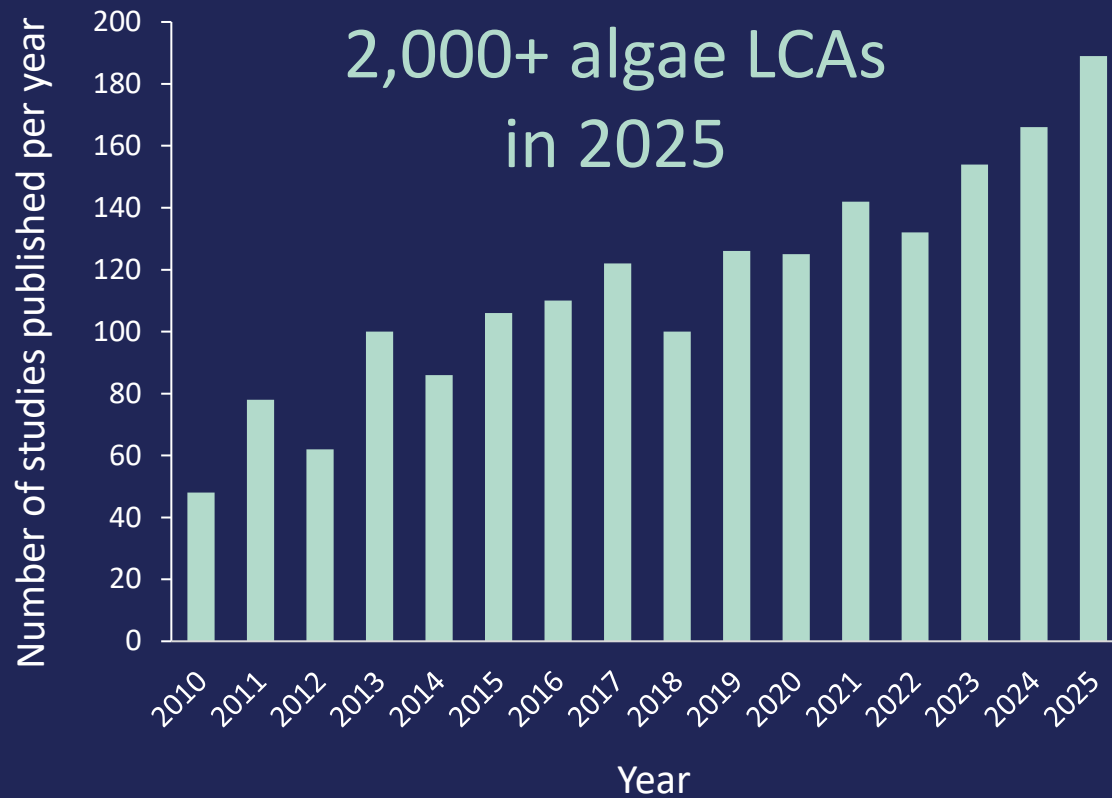
What is Life Cycle Assessment?

Based on ISO 14040 and 14044 standards on LCA

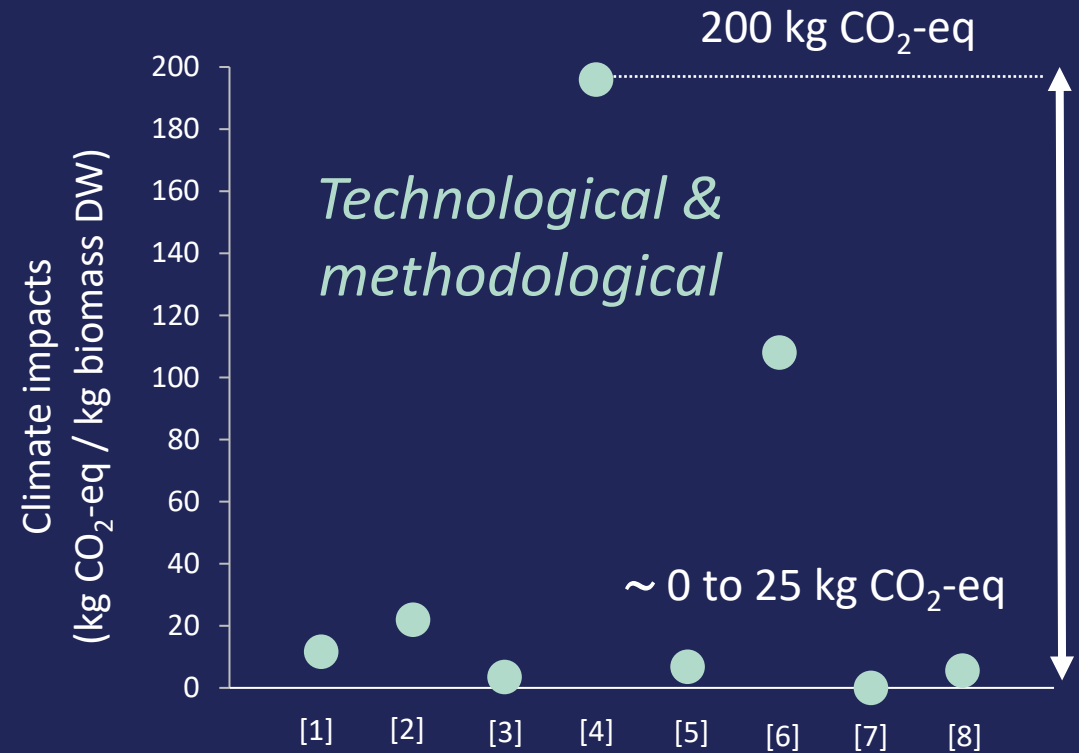
Standardised **methodology** to quantify the **environmental impacts** of a product, process, or service across its **entire life cycle**.



Algae LCAs since 2010



Climate impacts of Spirulina cultivation



Adapted from Braud et al. *Bioresour. Technol. Rep.* (2025)

2,000+ algae LCAs



2,000+ **different** results?

Streamlining algae LCA practices

Existing LCA studies

*Recalculating LCA results using
a common framework*

- **Cons:** Time-consuming
- **Pros:** Make the most of what exists already

Future LCA studies

*Conducting LCA studies following
a common framework*

- **Cons:** Difficult to implement
- **Pros:** Ensure increased comparability & transparency

EABA LCA Task Force

Since 2024

- 25 members from 12 countries
- 50% industry – 30% universities – 20% institutes
- Monthly meetings + parallel events

MISSIONS

- Harmonise algae LCA methodologies
- Tackle methodological & practical challenges
- Align with the broader bio-based industry



Information papers

Info paper 1: The “basics” of algae LCAs

- August 2025
- 1,230+ downloads ([Zenodo](#))
- Broad audience



EABA INFORMATION PAPER
Version 1.0 - August 2025

Life cycle assessment of algal products: A step-by-step guide to application

EXECUTIVE SUMMARY

This information paper provides an accessible introduction to Life Cycle Assessment (LCA) for researchers, industry professionals, and policymakers in the algae sector, with limited or no experience in the methodology. LCA evaluates the environmental impacts of a product, process, or service across its entire life cycle, from raw material extraction to end-of-life.

Developed collaboratively by LCA experts and non-specialists, this information paper outlines key concepts, applications, and best practices for assessing the environmental performance of algae-based products.

LCA is now a common component of EU-funded algae projects, with its range of applications expanding from the assessment of biofuels to high-value compounds and complex production systems. It plays a central role in corporate sustainability, policy development, and in evaluating algae's contribution to the bioeconomy.

However, applying LCA to algae production technologies and algae-based products presents unique challenges such as system variability, data availability, and methodological choices that can strongly influence results and limit comparability. Raising awareness of these issues within the algae community is essential to ensure that LCA outcomes are interpreted meaningfully and used effectively.

This information paper supports newcomers in understanding key terminology and practices related to LCA in algae systems, enabling more informed decision-making as well as the development of innovative and sustainable algae-based products.

Information papers

Info paper 1: The “basics” of algae LCAs

- August 2025
- 1,230+ downloads ([Zenodo](#))
- Broad audience

Info paper 2: Standards & guidelines

- January 2026
- 300+ downloads ([Zenodo](#))
- Technical series



Photo by Anders Kavin, 2022*

EABA INFORMATION PAPER
Technical Series #1

Silvio Mangini¹, Léa Braud², Juan José Gallardo Rodríguez³, Ana Morão⁴, Luis Speranza⁵, Igor Pedra⁶, Tom Bradley⁷, Jonathan Forbes⁸, Laura Monteiro⁹, Luis Costa¹⁰, Karina Bálboa¹¹, Lorna Cham¹², Saska Klipphuis¹³, Pi Nyvall¹⁴, Carole Pengnon¹⁵, Roman Pierre¹⁶, Ardiamaheleasa Rajanison¹⁷, Sophie Saget¹⁸, Nora Scheller¹⁹, Stefan Schmid²⁰, Vitor Verdelho²¹, Jean-Paul Cadoret²², Carlos Unamanzaga²³

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² Sustainable Food Processing Laboratory, ETH Zurich, Zurich, Switzerland
³ Department of Chemical Engineering, Higher Engineering School, University of Almería, Almería, Spain
⁴ Corbion Global R&D, Gorinchem, The Netherlands

⁵GreenColab, Associação Oceano Verde, Universidade do Algarve, Campus de Gambelas, Faro, Portugal
⁶A4F - Algae for Future, S.A., Campus do Lumiar, Lisboa, Portugal
⁷Decena Limited, Cramlington, Northumberland, Newcastle, UK
⁸Institute of Microbiology and Biotechnology, University of Latvia, Riga, Latvia
⁹Viride GmbH, Steinbach, Germany
¹⁰Olimix Group, Brehan, France
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¹³Mines Paris, PSL University, Centre for Observation, Impacts, Energy (O.I.E.), Sophia Antipolis, France
¹⁴Ryan Institute, University of Galway, Galway, Ireland
¹⁵Sustainable Systems Engineering, Department of Green Chemistry and Technology, Faculty of Bioscience Engineering, Ghent University, Ghent, Belgium

Standards and Guidelines for Algae LCAs

EXECUTIVE SUMMARY

Life cycle assessment (LCA) is a crucial tool to evaluate the environmental impacts of products and systems, including algae-based products and algae production and processing facilities. To conduct meaningful LCA studies, practitioners must navigate a complex framework of standards, guidelines, and initiatives. This information paper provides a concise overview of these resources, clarifying their roles and interrelationships. Standards, such as the International Organization for Standardization (ISO) 14040 and 14044, alongside the European Standard EN 17983, establish the foundational principles and requirements for algae LCAs, ensuring consistency and comparability across studies. Complementing these, guidelines such as the Product Environmental Footprint (PEF) introduced by the European Commission, the International Reference Life Cycle Data System (ILCD) Handbook, and Publicly Available Specification (PAS) 2050 deliver practical instructions to implement these standards effectively.

In addition, projects and initiatives such as ALIGNED (“Aligning life cycle assessment methods and bio-based sectors for improved environmental performance”) and LCAMBIO (“Harmonised life cycle assessment methods for sustainable and circular bio-based systems”) promote methodological innovation and sector-specific alignment (or harmonisation) by addressing emerging challenges and enhancing collaboration. Understanding the complementary functions of these standards, guidelines, and initiatives enables practitioners to produce scientifically robust and transparent algae LCAs aligned with best international practices. This information paper serves as a foundational resource for selecting and applying the most appropriate frameworks and tools in algae LCA studies.

*Cover image: Photo by Anders Kavin, 2022. The CEO and founder of Pure Algae Denmark, Esben Rimi Christiansen, demonstrating a feature in the cultivation technology that makes the harvesting of the sea lettuce *Ulva compressa* easier. Katrine Abildskov, Pure Algae, Denmark.

Information papers

Info paper 3: Comparative LCAs

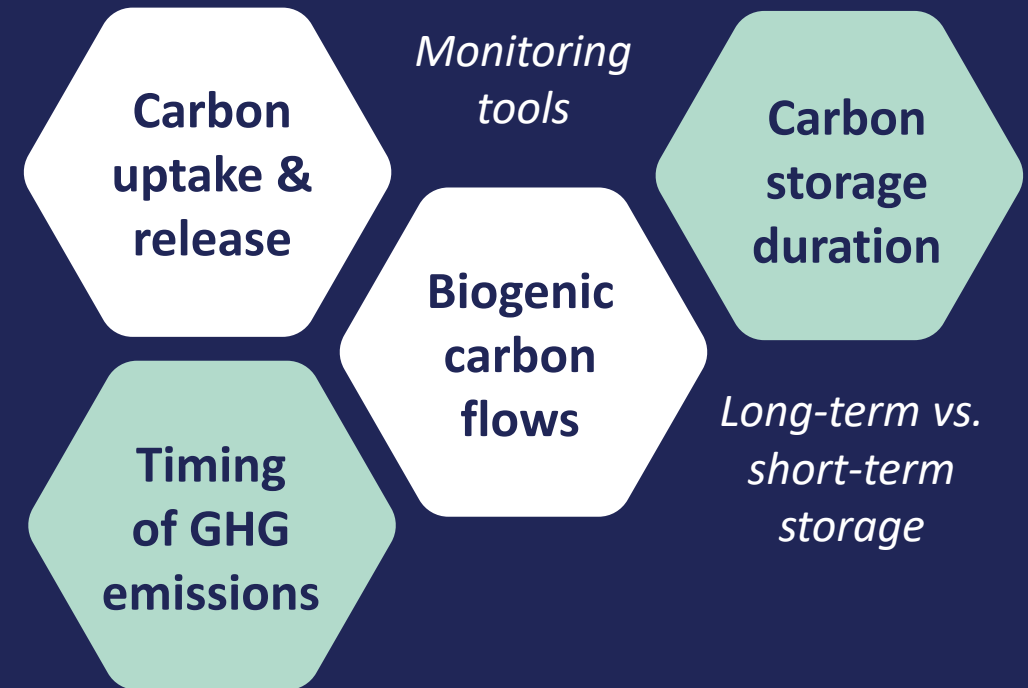
- May 2026
- Algae-based versus conventional products
- Influence of **methodological choices** on LCA results
- Recommendations to **interpret comparative LCAs**
- Focus on **food/feed, agricultural, and packaging** products (in first version – will be updated)



Information papers

Info paper 4: Carbon modelling

- Project started in **March 2026**
- Aligning with broader **bio-based industry**
- LCI UNEP “**Biogenic Carbon Project**” – Phase 2



Life Cycle

hosted by



Initiative



SETAC Europe 27th LCA Symposium

19 - 21 October, Bruges, Belgium



- **EABA LCA Task Force** chairing a session on aligning algae and bio-based LCAs
- **Session 4.01** - Advancing and Aligning Life Cycle Approaches for Emerging Bio-Based Systems: Lessons from Algae and Beyond
- Submit an abstract by **April 29!** ([link](#))

Additional projects



- Provide **LCA-related videos** for Algaflix
- Improve **algae LCA datasets** available in open-source databases (e.g., Agribalyse for food products)
- Participate in **European & international initiatives** relevant to algae LCAs (e.g., sector-related developments)
- Etc.

Upcoming conferences

International Conference on
Algae and Sustainability
2026

24-26 July 2026
Nanchang, China



SETAC Europe
27th LCA Symposium

19-21 OCTOBER 2026 • BRUGES, BELGIUM

Submit an abstract
by 29 April.

setac.org/lca2026



algæurope 2026
8-11 DECEMBER • VALLETTA • MALTA

Connect with us!

Together, we can make algae LCAs
transparent, comparable, and reliable

Join the conversation now

 LinkedIn: [EABA LCA Network](#)

 Website: <https://lca.eaba-association.org/>



Dr. Léa Braud

EABA Innovation Manager
Postdoctoral Researcher at ETH SFP
lea.braud@eaba-association.org

From waste to value

Environmental and economic assessment of algae residue valorization using LCA and LCC



Riin Kaldma
LCA EXPERT



Hendrik Ploom
LCC EXPERT

Consulting, funding, digital solutions

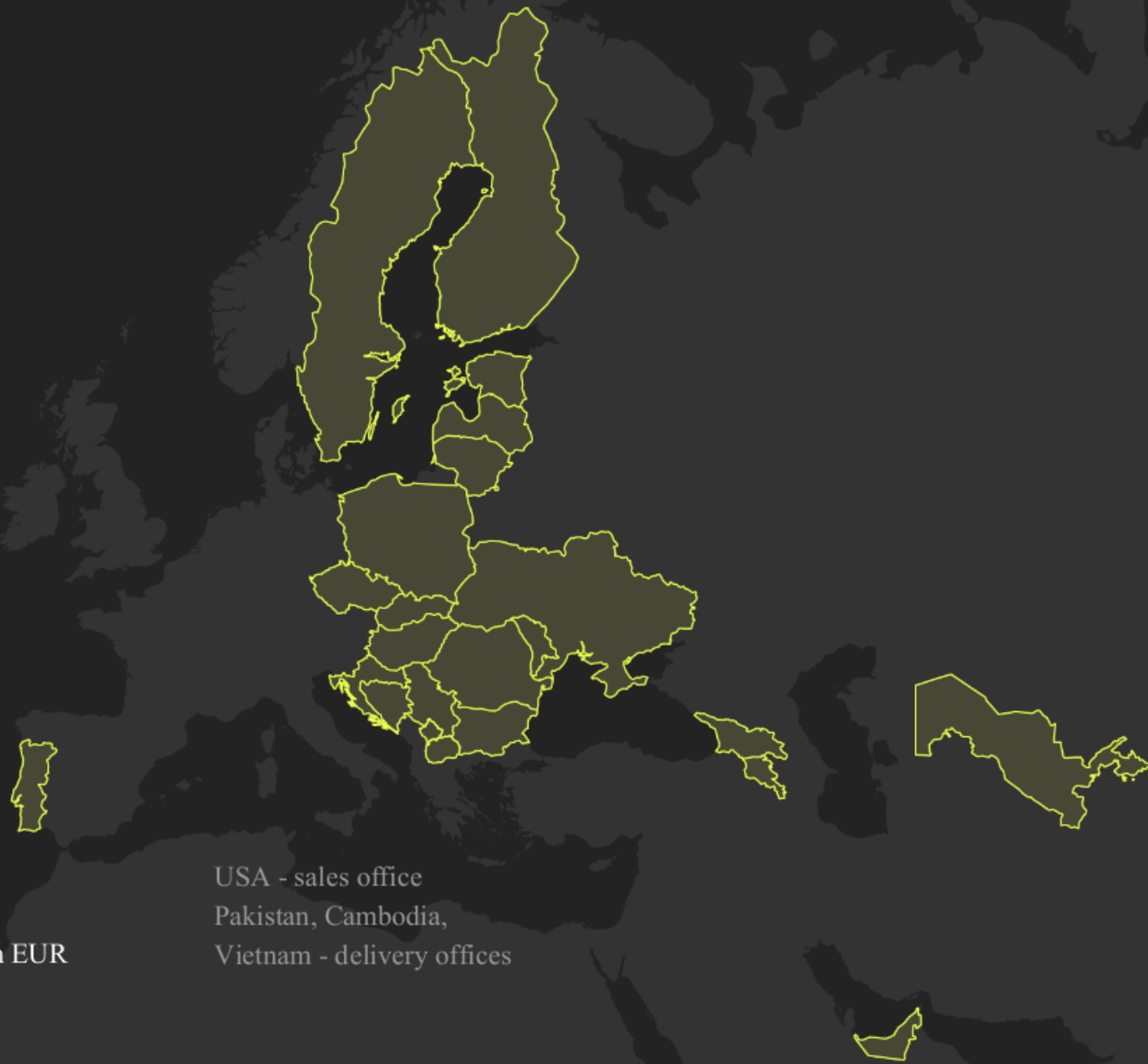
Civitta started in Central and Eastern Europe
and we are proud to be the largest
consultancy emerging from our region.
Today, we deliver projects worldwide.

750+
Team members

20+
Countries

50
Turnover, million EUR

USA - sales office
Pakistan, Cambodia,
Vietnam - delivery offices

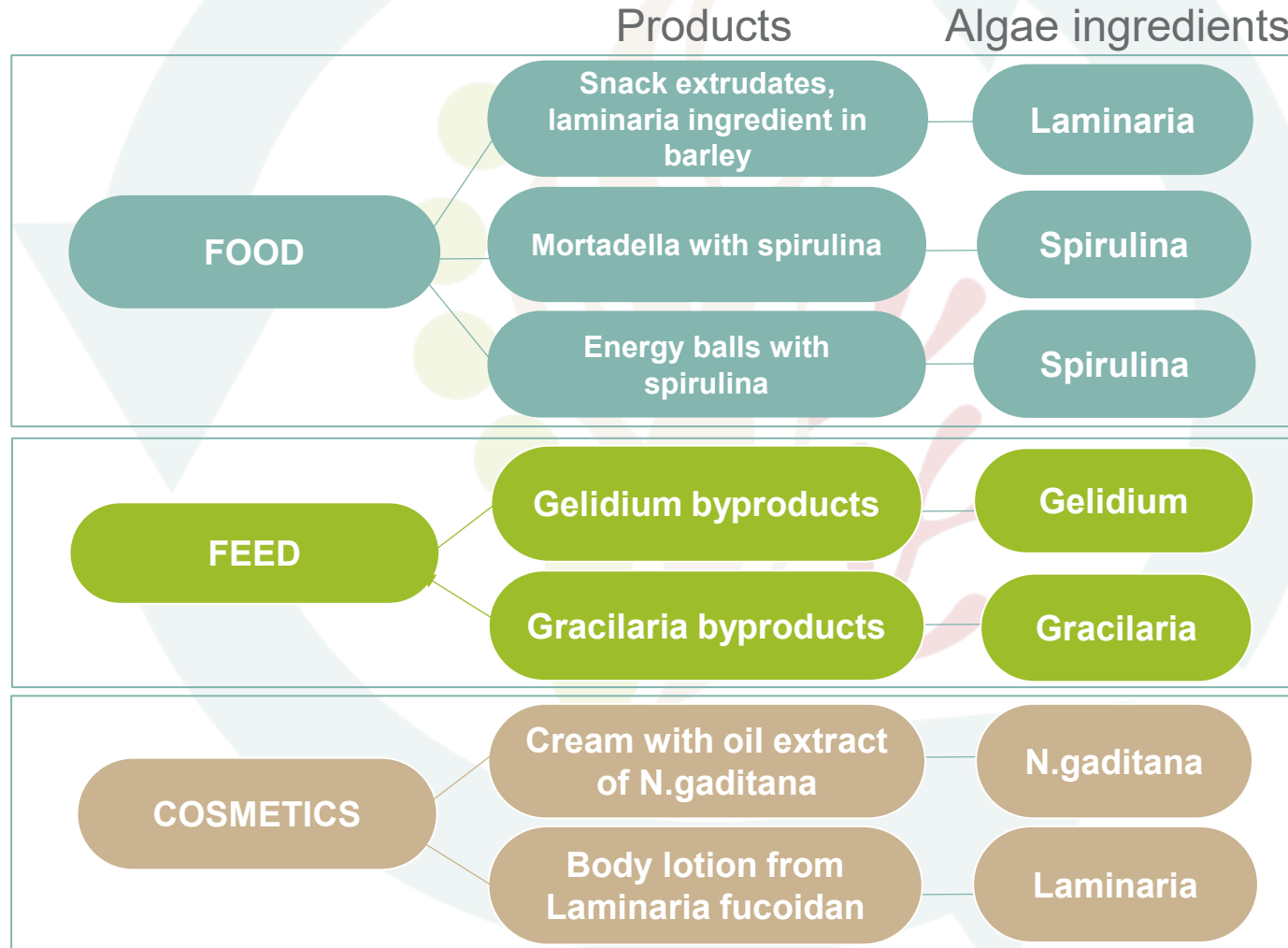


From waste to value

Environmental and economic assessment of algae residue valorization using LCA and LCC

- Additional to other topics (health aspects, consumer interests, etc.) – environmental/sustainable and economic and aspects need to be considered.
- Algae industry is growing, but it is highly underexploited. Currently, the (micro)algae industries discard <95% algal biomass as waste.
- Linear model -> circular bioeconomy by using green extraction technologies to recover proteins and bioactive compounds from algae side streams.
- LCA/LCC objective: assessing if turning algae residues into high-value products is actually more sustainable than conventional alternatives.

From waste to value



From waste to value

Algae-based products are benchmarked against conventional land-based alternatives:

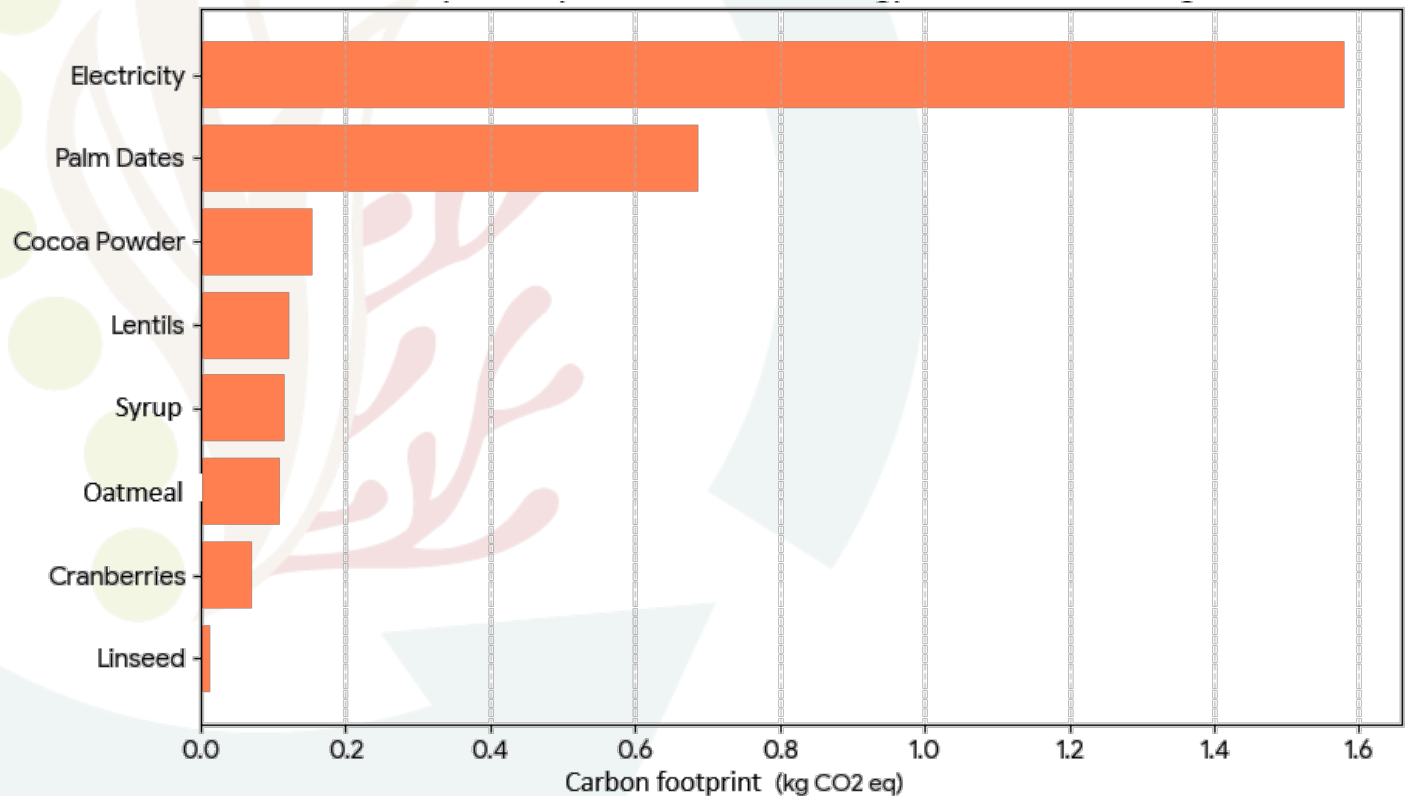
- **Energy balls with Spirulina** vs energy balls
- **Vegan mortadella with Spirulina** vs vegan mortadella (with soy)
- **Body lotion with Laminaria fucoidan** vs body lotion (with more emulsifier)
- **Feed for piglets with Gelidium** vs feed for piglets with wheat/soy

From waste to value

Preliminary results on conventional products

1. Energy balls

- Hotspots: there are 2 major drivers: electricity and dates.
- Carbon footprint is 2.85 kg CO₂eq/kg (GWP).



Disclaimer: These are preliminary and indicative results. CIRCALGAE deliverable will present the full view

From waste to value

Preliminary results on conventional products

2. Barley snacks hotspots: milled barley is responsible for ~99% of almost every impact category (eutrophication, land use, water use).

Carbon footprint is 0.67 kg CO₂eq/kg (GWP).

- These define our “baseline” for the comparison with CIRCALGAE product.
- When CIRCALGAE focuses on low-energy, water-based systems, lower land use – this should reduce the carbon impact of our final products.
- Environmental and economic goal: achieve at least a 15-20% reduction in carbon footprint compared to conventional products on the market.

Disclaimer: These are preliminary and indicative results. CIRCALGAE deliverable will present the full view

From waste to value

Life cycle cost summary for energy balls

Annual operating costs are discounted to present value using the selected discount rate. The model covers the upstream chain: algae ingredient production + end-product manufacturing + inter-site transport. CAPEX is treated as Year 0 investment. Spirulina ingredient cost is the dominant variable

Full supply chain scope:

Algae → Ingredient → End product

Horizon: 15 years

ALGAE PRODUCER

Portugal

INGREDIENT MANUFACTURER

Belgium

END-PRODUCT MANUFACTURER

Germany

TOTAL CAPEX

€2.5M

ANNUAL OPEX

€510K

LCC (15yr)

€6.9M

PER KG PRODUCT

€22/kg

From waste to value

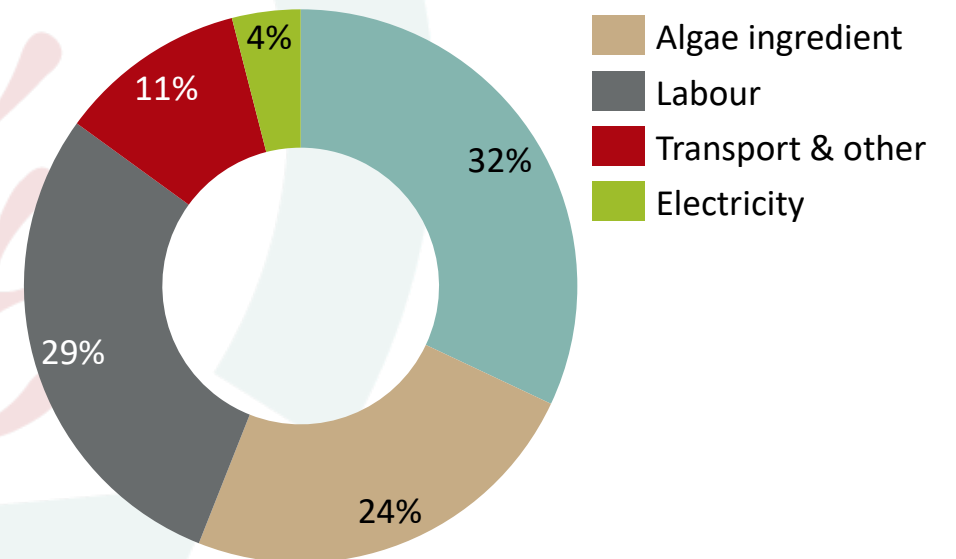
15-year Life cycle cost summary for energy balls

ANNUAL OPERATING COSTS

LCC = €2,527K CAPEX₀ + €4,384K PV(OPEX, 15yr @ 8%) = €6,911K TOTAL

KEY SENSITIVITIES






Variable	Low	Base (15yr/8%)	High
Ingredient price (€/kg)	€30	€120	€400
LCC impact	€5.4M	€6.9M	€11.5M
Production scale (kg/yr)	5,000	20,475	100,000
LCC/kg impact	€78/kg	€22.50/kg	€16/kg
Discount rate	5%	8%	12%
LCC impact	€7.3M	€6.9M	€6.4M



Disclosure: Not all cost elements are final and provided, which likely understates the total LCC by €50 200K/year. CIRCALGAE deliverable will present the full view

From waste to value

Energy balls – conventional vs algae-derived product

	CONVENTIONAL		CIRCALGAE
	Production costs (LCC/kg) €8-16/kg	60-180% ↑	€22.5/kg 15yr LCC incl. full supply chain and algae ingredient extraction
	Carbon footprint (GWP, kg CO ₂ eq/kg) 2.85	5-20% ↓	Prediction: ~2.0 Algae displaces high-GWP crops microalgae protein: low per-kg GWP
	Energy use (kWh/kg product) ~0.05 kWh/kg of product	50-100x	~1.5-2.9 kWh/kg product Dominated by algae extraction step
	Water use (L/kg product) ~2-4 L/kg	≈ Comparable	~4.2 L/kg Dominated by end-product manufacturing
	Novel innovation Premium NONE	✓ Added value	5% Spirulina extract, high in additional ingredients

The algae-enhanced product carries a ~60–180% cost premium vs conventional but delivers measurable environmental and nutritional advantages. At scale (100k kg/yr), the LCC/kg gap could narrow to ~€16–18/kg, approaching conventional premium-tier product pricing.

*Disclaimer: Not all cost elements are final and provided, as a result the comparison is preliminary and indicative. CIRCALGAE deliverable will present the full view
Sources: LCA snack bar study (MDPI Sustainability 2025); LCA microalgae protein review; industry cost benchmarks*



AlgaePro BANOS

Sustainable monitoring and
evaluation framework

Do's and don'ts of sustainability
claims

Background

- What is "sustainable" ?
- We see only selected parts of the system.
- Need for transparent communication.
- Need for continuous progress, not sufficiently good work.

Main Objectives & Tasks

The main objective is to create a balanced algae sector framework that assesses the sustainability of the value chain along different dimensions (environmental, economic, social, governance) and that can be applied to different use cases.

Purpose

Very often, ecological, socio-economic, governance analyses are carried out separately. Therefore, there was a need to develop an integrated but relatively simple and practical framework that would allow e.g. industry, environmental managers, spatial planners to carry out sustainability analysis.

NB! simple ≠ simplistic



Our report is available



MONITORING AND EVALUATION SUSTAINABILITY ASSESSMENT FRAMEWORK OF MICRO- AND MACROALGAL VALUE CHAINS

D1.1
31.03.2024

<https://algaeprobanos.eu/wp-content/uploads/2025/02/D1.1-Monitoring-Evaluation-Framework.pdf>

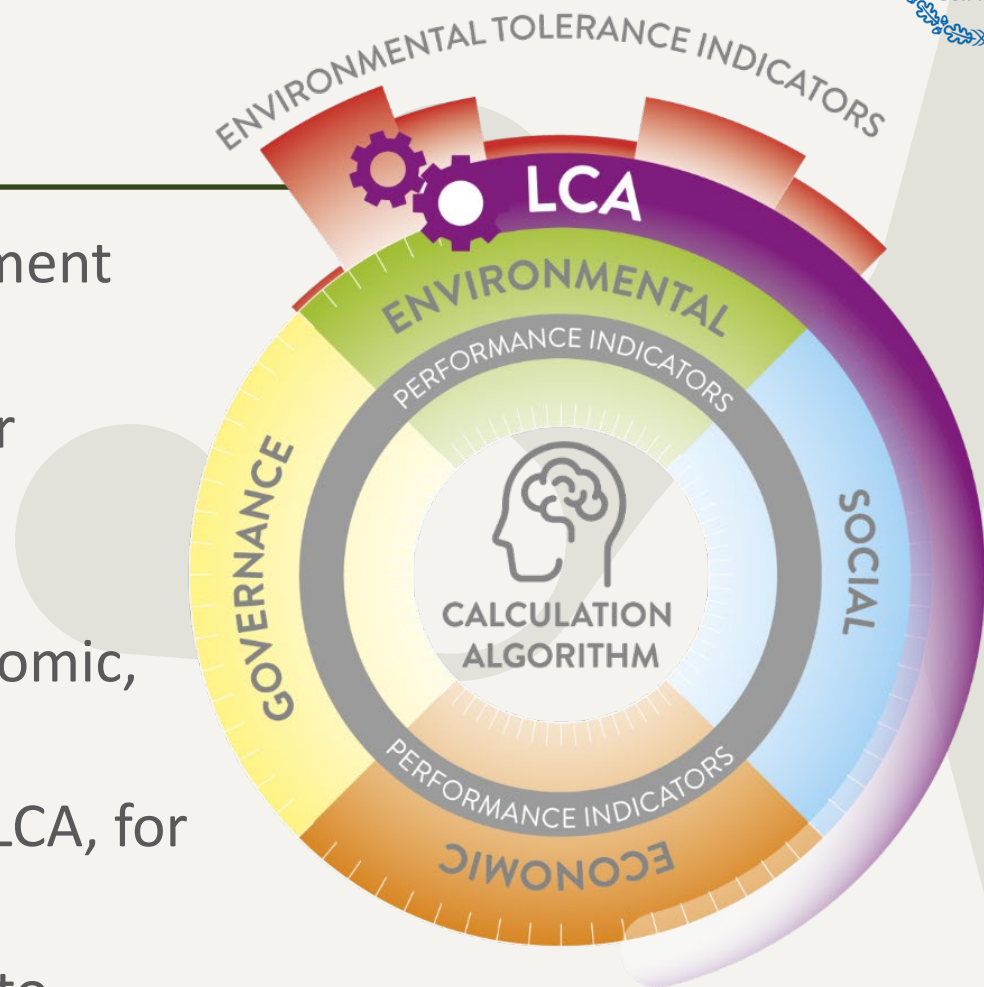


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Assessment Structure

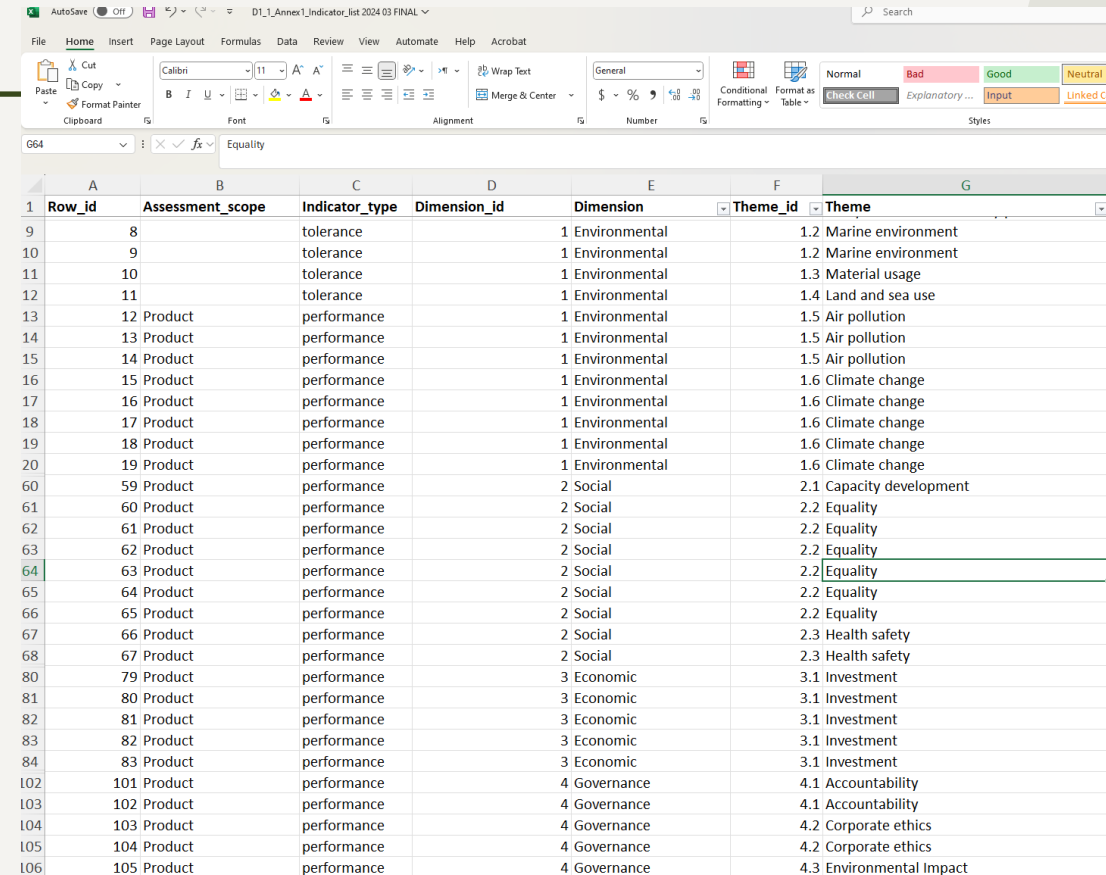
The AlgaePro Banos sustainability assessment framework is built on four key pillars:

- (1)** Environmental Tolerance Indicators for evaluating ecological thresholds,
- (2)** Performance Indicators for assessing sustainability across environmental, economic, social, and governance dimensions,
- (3)** Integrated Assessment Tools, such as LCA, for comprehensive evaluations, and
- (4)** a Sustainability Calculation Algorithm to generate sustainability scores across various dimensions.

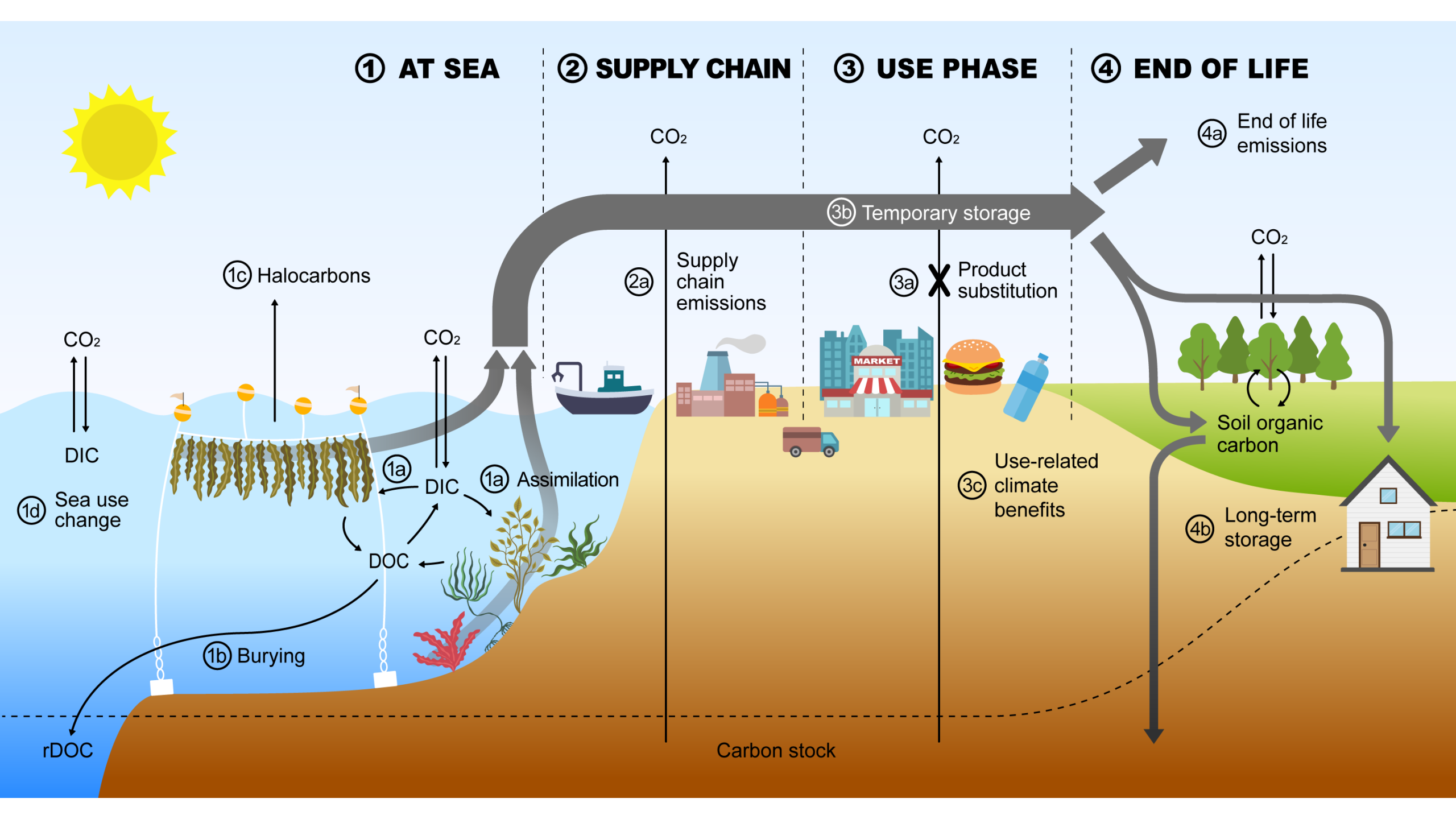


Hierarchy of indicators

The framework's **performance indicators** assess sustainability across environmental, economic, social and governance dimensions, drawing on established frameworks and sources to balance ecological health, economic viability, social well-being and effective governance in the algae sector.



1	A	B	C	D	E	F	G
1	Row_id	Assessment_scope	Indicator_type	Dimension_id	Dimension	Theme_id	Theme
9	8		tolerance		1 Environmental	1.2	Marine environment
10	9		tolerance		1 Environmental	1.2	Marine environment
11	10		tolerance		1 Environmental	1.3	Material usage
12	11		tolerance		1 Environmental	1.4	Land and sea use
13	12	Product	performance		1 Environmental	1.5	Air pollution
14	13	Product	performance		1 Environmental	1.5	Air pollution
15	14	Product	performance		1 Environmental	1.5	Air pollution
16	15	Product	performance		1 Environmental	1.6	Climate change
17	16	Product	performance		1 Environmental	1.6	Climate change
18	17	Product	performance		1 Environmental	1.6	Climate change
19	18	Product	performance		1 Environmental	1.6	Climate change
20	19	Product	performance		1 Environmental	1.6	Climate change
60	59	Product	performance		2 Social	2.1	Capacity development
61	60	Product	performance		2 Social	2.2	Equality
62	61	Product	performance		2 Social	2.2	Equality
63	62	Product	performance		2 Social	2.2	Equality
64	63	Product	performance		2 Social	2.2	Equality
65	64	Product	performance		2 Social	2.2	Equality
66	65	Product	performance		2 Social	2.2	Equality
67	66	Product	performance		2 Social	2.3	Health safety
68	67	Product	performance		2 Social	2.3	Health safety
80	79	Product	performance		3 Economic	3.1	Investment
81	80	Product	performance		3 Economic	3.1	Investment
82	81	Product	performance		3 Economic	3.1	Investment
83	82	Product	performance		3 Economic	3.1	Investment
84	83	Product	performance		3 Economic	3.1	Investment
L02	101	Product	performance		4 Governance	4.1	Accountability
L03	102	Product	performance		4 Governance	4.1	Accountability
L04	103	Product	performance		4 Governance	4.2	Corporate ethics
L05	104	Product	performance		4 Governance	4.2	Corporate ethics
L06	105	Product	performance		4 Governance	4.3	Environmental Impact



Sustainability claims: do:s and don't:s

DON'T

- Don't cherry-pick the good bits
- Don't use vague buzzwords
- Don't hide the data (or lack of it)

DO

- Think in systems, not silos
- Back every claim with solid proof
- Be transparent and comparable



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Q&A

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Conclusion Workshop #4



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MAJOR EVENTS FROM APRIL 2026 TO SEPTEMBER 2026

EMD

- European Maritime Day 2026
- 21st and 22nd of may 2026
- Limassol, Cyprus
- Sister projects conference – Joint workshop on “Blue economy sectors : Algae Solutions for a Thriving Blue Economy” (21st of may 2026 – 1:50PM – 3:05PM)

RRB

- International Conference on Renewable Resources & Biorefineries (21st edition)
- 2nd June 2026 – 4th June 2026
- Turku/Åbo, Finland

Seagriculture

- International Seaweed Conference EU (15th edition)
- 16th-18th of June 2026
- Gothenburg, Sweden
- Exclusive site visit to Nordic SeaFarm on 16th June

Workshops with Nausicaa

- Workshop co-design and feedback meeting
- Survey-premarket study
- Sensory workshop + cosmetic testing : in the Blue Living Lab
- In preparation : may happen in june/july

Project finale conference

- September 2026
- Gothenburg, Sweden
- In preparation

Delivrables on Zenodo

D1.1 – Report of the current algae industry in Europe

GRANT AGREEMENT: 101060607
PROJECT START DATE: 01/10/2022
DURATION: 48 MONTHS

Co-funded by the European Union

CEVA

<https://doi.org/10.5281/zenodo.13375431>

D3.1 – Report of the Definition of Requirements and Specifications for Final Products

GRANT AGREEMENT: 101060607
PROJECT START DATE: 01/10/2022
DURATION: 48 MONTHS

Co-funded by the European Union

CEAMSA

<https://doi.org/10.5281/zenodo.13375558>

D6.2 Project Web page and communication tools

GRANT AGREEMENT: 101060607
PROJECT START DATE: 01/10/2022
DURATION: 48 MONTHS

Co-funded by the European Union

AQUIMER

<https://doi.org/10.5281/zenodo.13375636>

D5.1 – Report of the algae derived product market in Europe

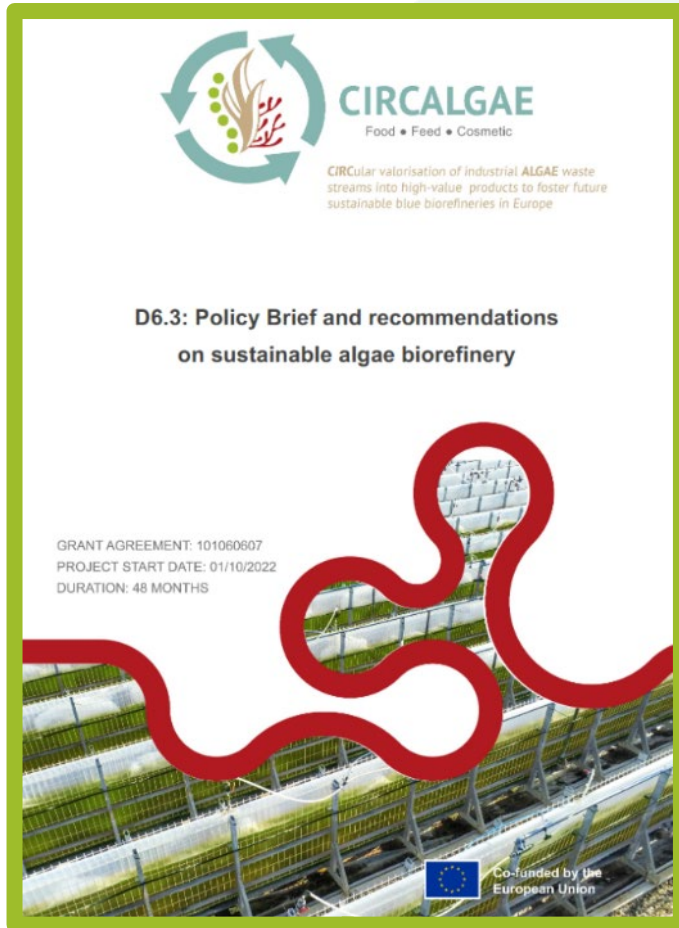
GRANT AGREEMENT: 101060607
PROJECT START DATE: 01/10/2022
DURATION: 48 MONTHS


Co-funded by the European Union

CIVITTA

<https://doi.org/10.5281/zenodo.13375608>

New deliverables on Zenodo




 **CIRCALGAE**
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CIRCular valorisation of industrial ALGAE waste streams into high-value products to foster future sustainable blue biorefineries in Europe

D6.3: Policy Brief and recommendations on sustainable algae biorefinery

GRANT AGREEMENT: 101060607
PROJECT START DATE: 01/10/2022
DURATION: 48 MONTHS

 Co-funded by the European Union

<https://doi.org/10.5281/zenodo.14975133>



 **CIRCALGAE**
Food • Feed • Cosmetic

CIRCular valorisation of industrial ALGAE waste streams into high-value products to foster future sustainable blue biorefineries in Europe

D4.1 – European regulatory compendium for new algae products

GRANT AGREEMENT: 101060607
PROJECT START DATE: 01/10/2022
DURATION: 48 MONTHS

 Co-funded by the European Union

<https://doi.org/10.5281/zenodo.19367606>

Webinars replays



Replay - Workshop on algae Harvesting and Cultivation in Europe - 10-26-2023



Replay Workshop "Best practices on the production and sustainability of microalgae in Europe"



Replay Hybrid Workshop - Developing novel Blue biorefineries from aquatic resources



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THANK YOU !

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