

STIMULATING A BIOBASED ECONOMY BY OPTIMISING THE SEAWEED VALUE CHAIN



TNO innovation
for life

WHY SEAWEED?

Growing under the sea and no requiring arable land, seaweed is one of the most promising and sustainable aquaculture crops of the future. Seaweed contains many valuable components such as proteins, bio-stimulants and carbohydrates and is capable to produce essential biocomponents used in the food industry, animal feed, cosmetics, pharmaceuticals, bioplastics and fuels.

Seaweed biorefinery concept can bring a significant contribution to a sustainable development by producing valuable raw materials to can accelerate the transition to a biobased and circular economy.

TAKING SEAWEED APPLICATION TO THE NEXT LEVEL

TNO experts have translated customer needs to potential applications for more than a decade by bringing experimental seaweed research combined with developing techniques to meet the continuous demand for specialized research and processing facilities on this subject.

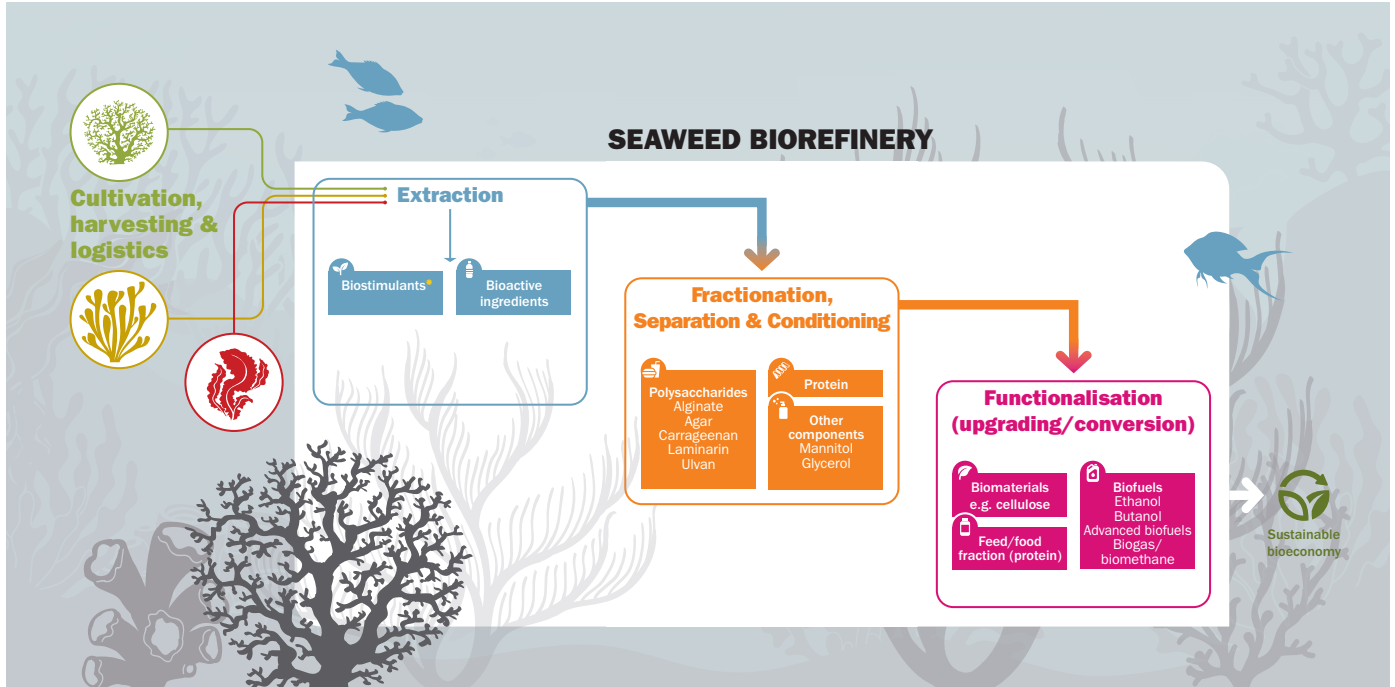
TNO has participated in national and international projects supporting the development and implementation of commercially viable and sustainable processes for the conversion of seaweed into biofuels, biochemicals, and biomaterials.

OUR COMMITMENT

TNO Energy Transition unit aims to accelerate the transition to a sustainable energy and raw materials society together with applied research institutes, industrial companies and governmental organizations.

The biomass expertise group focuses on the thermochemical and biochemical conversion of sustainably grown biomass into sustainable energy, chemicals and materials. Our state of the art and dedicated research facilities enable TNO, to support the research and development of innovative concepts for the production of biofuels and raw materials for the biobased economy.

FROM SEAWEED TO VALUABLE CHEMICALS, FOOD AND FUELS



RENEWABLE MATERIALS

Seaweed is a rich source of fine chemicals and performance polymers as such as well as the raw materials to produce them via environmentally benign processes, Examples are polyphenols, succinic and lactic acid.



AGRICULTURE

In our lab we develop, test and validate extraction methods for (in)organic bio active seaweed substances. The bio-activity of seaweed can be associated to its content of macro- and micro- nutrients, plant-growth regulators, phytohormones, and saccharides.

These compounds improve soil quality, stimulate root and plant growth, and activate defense mechanisms which help to drastically improve plant productivity in the agricultural sector.



FOOD AND FEED

Seaweed's popularity as an alternative and sustainable source of proteins for both food and feed applications is increasing. We are able to develop tailor made processes for the extraction and purification of protein and/or carbohydrate extracts for food and feed applications.



IMPROVING HEALTH AND BEAUTY

The beneficial effects of seaweed substances have been discovered by the beauty- and pharmaceutical industries and are used in various health improving applications e.g. in the prevention of diabetes, hypertension, cardiovascular diseases and mental degenerative disorders as well as in various cosmetic applications like anti-aging.



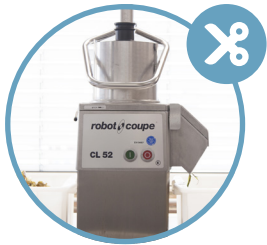
ADVANCED BIOFUELS

Seaweed, unlike terrestrial biomass, does not contain large fractions of recalcitrant non-sugar components. These features make seaweed particularly suitable as feedstock for the biorefining industry in the production of conventional biofuels, such as ethanol and butanol, and advanced fuel boosters, such as furan- based molecules.

OUR SEAWEED PROCESSING FACILITIES

Our seaweed biorefinery lab allows the development entire processing chain for the conversion of (fresh) seaweed into products such as carbohydrates, platform chemicals, plant stimulants or proteins; as well as the characterization and screening of seaweed composition simulating realistic processing conditions for producing samples so users can carry out relevant product tests.

Our lab offers the flexibility to perform processing steps separately as well as in sequence by combining a unique and extensive seaweed biorefinery experience and lab infrastructure.



PRE-CONDITIONING

- **Wet cutter / Wet biomass processor:** Designed for size reduction and homogenization of large seaweed leaves and stems before further processing. Suited for fresh and ensiled seaweed.
- **Freeze dryer:** Reduces the moisture content from more than 80% to less than 10% at room temperature or lower, preserving the cellular structure and purity of seaweed.



SEPARATION AND PURIFICATION

- **Centrifuge:** Designed to separate solids and/or fibers after extraction, as well as carbohydrate fractions.
- **Spray dryer:** Purifies seaweed components e.g. sugars, mannitol, proteins and/or bioactive components.



CONCENTRATION OF ACTIVE COMPONENTS

- **Membrane unit:** Suited for the selective separation of different components e.g. carbohydrates, minerals; and for the increase of concentration of active components in extracts.



- **Rotary evaporator:** concentrates active components and platform chemicals e.g. furanics or bio alcohols in solution.



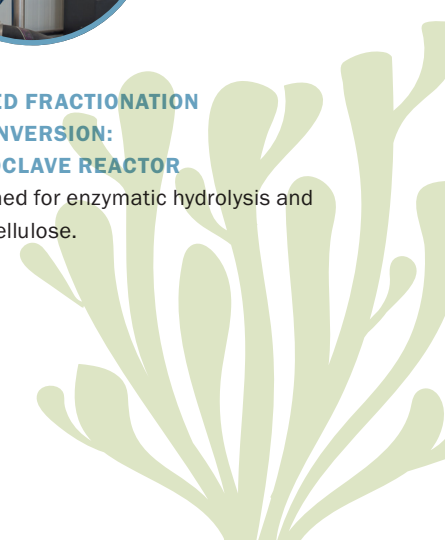
SEAWEED FRACTIONATION AND CONVERSION: 100L AUTOCLAVE REACTOR

- Designed to handle acids and bases, at operating temperatures up to 150°C and pressures up to 3 bar.
- Ideally suited for cold and hot water extraction e.g. for production of mannitol or bio stimulants, acid or enzymatic hydrolysis e.g. for sugar production, sugar fermentation, etc.



SEAWEED FRACTIONATION AND CONVERSION: 4L AUTOCLAVE REACTOR

- Designed for enzymatic hydrolysis and hemicellulose.





READY TO BE PART OF THE ENERGY TRANSITION?

Research lies at the heart of our organization and therefore, we dedicate our international expertise and years of experience to the improvement and optimization of our client's seaweed process development. We ensure our tailor-made solution is suitable to your application.

Please contact us to discuss:

- Scale-up, characterization and sample needs
- Consultancy by specialized experts
- Techno-economic analyses
- Technology development and integration of conversion routes to marketable bio-based products

OUR PROJECTS



MACROFUELS

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(H2020, Grant No. 654010, 2016–2019)

MacroFuels produced the advanced biofuels ethanol, butanol, furanics and biogas, from seaweed or macro-algae. MacroFuels demonstrated the entire production train including road tests with advanced biofuels blends. The seaweed lab produced the sugar syrups from seaweed for the conversion to biofuels.



ZCORE

Seaweed Residues for Superior Bio-Coatings

The ZCORE project will positively contribute to CO₂ reduction goals and help to strengthen the chemical industry as well as the open innovation network in the south of the Netherlands. Fast-growing seaweed is used to produce high-value proteins. A by-product is non-edible sugars streams, a potential valuable raw material for the chemical industry. In this project, these sugars will be converted to biobased aromatics which will be tested in coatings applications.

OUR PARTNERS

We have strong collaborations with institutes and companies in academic, research and industrial sectors of the Netherlands and Europe, including Stichting Noordzeeboerderij, Wageningen University & Research, Deltares, the Maritime Research Institute of the Netherlands (MARIN), the Royal Netherlands Institute for Sea Research (NIOZ), SIOENIndustries, and Avantium.



MACROCASCADE

(BIC JU Grant No. 720755, 2016–2020)

MACRO CASCADE will prove the concept of the cascading marine macroalgal biorefinery i.e. a production platform that covers the whole technological chain for processing sustainable cultivated macro-algae biomass to highly processed value added products. Algae based products for food, feed, cosmetics, pharmaceutical will be tested and documented for their bio-activities and health properties. The lab is used to provide essential feedback for developing realistic process schemes.

CONTACT US

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