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Stakeholder engagement events and results' evaluation report – Issue 2

MacroFuels – Project
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List of Content

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Executive Summary

This stakeholder engagement events and results' evaluation report, issue 2 includes results from: 1) The Mid-Term MacroFuels Conference (M29) that presented and discussed the first relevant MacroFuels results with key stakeholders; 2) the Final MacroFuels Conference (M48) which presented the project's technical and the LCA results to policy and industrial stakeholders in targeted sessions, and special formats for citizens (incl. a presentation of the social impact assessment results), 3) Focus Group meetings (M24-36): with policy makers, representatives of CSOs and citizens and/or other relevant actors. Detailed results are presented from focus group meetings with the MacroFuels Citizen Panel (focus on meetings between M24 and M48, earlier activities have been described in deliverable report *D.7.3 Stakeholder engagement events and results' evaluation report 1*) with residents from MacroFuels cultivation target areas.

The MacroFuels project over four years (2016-2019) achieved numerous breakthroughs in technologies and processes for producing liquid transportation biofuels from cultivated seaweed or macroalgae. The long-term vision of MacroFuels is to provide a solution for the decarbonization of the transport sector by providing sustainable advanced transportation fuels and fuel additives for heavy road and maritime transport and the aviation sector.

A specific objective in MacroFuels during its entire project term has been to intensify stakeholder dialogues to assure that results and knowledge generated by MacroFuels will be actively used and taken up in future research, development and upscaling activities as well as policies and regulations related to seaweed. Another equally important aim to engage with stakeholders was to gather and understand opinions, expectations and ideas, and to consider these for the critical assessment and improvement of project concepts and activities and for the planning of future upscaling and other follow-up activities.

However, capturing, storing and preserving knowledge and making sure it can and will be discussed and further shared and used by relevant stakeholders has been and still is a major challenge in science and innovation. Common challenges in knowledge exchange and public engagement are the proper identification, evaluation and selection of knowledge that is relevant for specific target groups and finding suitable channels and formats for knowledge transfer and public engagement.

Open engagement in collaborative projects that aim at achieving breakthroughs which allow economic growth in the long term usually is further complicated by the competition between, on the one hand, sharing and discussing knowledge and data openly and, on the other, protecting knowledge and results that are necessary for securing a competitive advantage for the future economic exploitation of results.

To meet those challenges, MacroFuels at the start of the project had established an implementation strategy, which was built on (a) analysing the MacroFuels stakeholder landscape and its knowledge requirements, (b) collecting and understanding knowledge and data generated by MacroFuels, (c) evaluating them for their suitability for knowledge exchange, including their relevance for the protection of intellectual property (d) finding the most effective formats for engaging with each stakeholder group respectively. This strategy provided the basis for all engagement activities within the project and has been described in detail in deliverable report *D7.3 Stakeholder engagement events and results' evaluation report – Issue 1*, together with an overview of activities performed between M1 and M24 of the project.

This deliverable report covers the second half of the project (Years 3 and 4) and the stakeholder engagement activities that were performed during that period.

Basis for the systematic engagement during year 3 and 4 of MacroFuels was an updated stakeholder analysis (the original stakeholder analysis can be equally found in deliverable report *D7.3 Stakeholder engagement events and results' evaluation report – Issue 1*) and a results and knowledge repository that was developed to capture and evaluate the knowledge generated by MacroFuels and to categorise it by specific stakeholder interests.

Key stakeholders that were identified as highest priority group for engagement and knowledge exchange for the second half of MacroFuels were the industry, policy makers, citizens, the scientific community and young researchers and pupils as potential future workforce and innovators in a bioeconomy field that could reach market maturity in 2030 the earliest.

Engaging with industry representatives was assessed to be crucial especially at the later stages of MacroFuels as covered in this report when data and quantified results became available on seaweed cultivation systems and biomass supply, fuel production routes, yields and fuel performance and the overall sustainability of the MacroFuels concept. Key industries that have been identified and targeted in tailored stakeholder engagement formats, such as meetings or conference sessions, included fuel producers, the transport and aviation sectors, seaweed cultivators, the food and chemical industry as well as shipyard, seaport and windfarm operators.

Engaging with the scientific community, especially with other funded projects in the field of seaweed and aquaculture, biofuels and renewable energy was seen as crucial for knowledge exchange and the transfer of know-how on the optimisation of seaweed cultivation, biomass pre-treatment and processing concepts and in particular on co-use scenarios, Integrated Multi-Trophic Aquaculture/IMTA scenarios and the environmental and social effects and public acceptance of a large-scale seaweed industry.

MacroFuels further generated knowledge and results that are highly relevant for future strategies and policies for large-scale seaweed cultivation and advanced biofuels. Therefore it was of utmost important to enter dialogues with policy makers at European, national and regional/local levels, thus working towards a sustainable and publicly endorsed novel field within the bioeconomy.

As MacroFuels matures and promotes concepts that aim at future ocean-based industrial operations, engaging with the public was deemed essential as public acceptance and support will be crucial for the success of seaweed industries in Europe. This is of particular importance as previous efforts in creating biofuels from terrestrial crops have led to controversial discussions, including concerns about the conflict 'Food vs. Fuel'. The upscaling of cultivation methods, the mechanisation of seeding and harvesting and the increasing economic development and resulting industrialisation of rural areas might raise concerns among local communities and/or local authorities who might fear for local and regional acceptance or see a potential threat to living conditions, access to local resources or tourism. Especially fishermen or other users of the ocean space might see a threat in large-scale seaweed cultivation for their livelihood.

Teams that have been involved in activities related to stakeholder engagement and knowledge transfer activities included all consortium partners. TNO supported by Eurida has been responsible for leading those activities and for compiling this report.

Activities targeted at knowledge exchange with EU Stakeholder Platforms and knowledge communities are described in a separate deliverable report, *D7.4 Knowledge and data sharing repositories* and complement the stakeholder engagement activities described in this report.

1. Introduction

Aim of this document is to report on the engagement and exploitation activities towards the diverse groups of MacroFuels stakeholders carried out within the framework of the project in the period M24-M48, and to describe the results that emerged from the activities.

2. Progress towards objectives

The specific objectives of MacroFuels' stakeholder engagement activities during the first half of the project had been to enhance the project visibility at local, national and international levels and to connect with the scientific community to discuss the progress achieved in research and the technological development in the fields of seaweed cultivation, biomass processing and the conversion to fuels. The stakeholder engagement activities performed during that phase and the formats chosen were discussed in deliverable report *D7.3 Stakeholder engagement events and results' evaluation report – Issue 1* and further details can be found therein.

MacroFuels' overall goals and specific objectives during the second half of the project, which is covered in this report, responded to the increasing maturity of concepts, technologies and results and aimed at:

- Demonstrating in more detail how MacroFuels results and outcomes could be relevant to society at large, e.g. by helping to address the challenges of climate change and to decarbonise transport, by maintaining or improving ocean health and by creating jobs and positive environmental impacts.
- Maximising the support and public acceptance and minimising the risks of public resistance towards the upscaling of MacroFuels technologies and concepts.
- Discussing expectations, hopes and concerns of the public and especially of coastal residents towards a future European seaweed industry, especially considering possible scenarios for a seaweed-to-fuel value chain.
- Contributing to the European knowledge base on bioenergy, blue economy and blue carbon and alternative fuels via targeted knowledge and data transfer.
- Ensuring that MacroFuels results are taken up by decision-makers to influence policy-making, by industry to secure market uptake and sustainable growth as a segment of the bioeconomy and the 'blue economy'
- Paving the ground for a successful project follow-up, either via demonstration-level projects or via technology upscaling and investment by the private sector.
- Contributing to skills development via trainings and seminars, especially targeting young scientists and pupils who could become a future workforce and/or innovators in the field of seaweed-based industries.

The multitude of objectives highlights the wide variety of stakeholder groups that needed to be targeted by MacroFuels during the second half of the project to meet the engagement objectives. The stakeholder groups that have been targeted by MacroFuels during year 3 and 4 of the project are listed in table 1.1.

Table 1.1 Stakeholder groups targeted in Year 3 and 4 of MacroFuels

Scientific seaweed community	Scientific biofuels community
Related seaweed projects, incl. IMTA	Related projects on 2nd generation biofuels
Fuel industry	Heavy transport industry
Aviation industry	EU Policy Makers (e.g. Commission Services)

Marine authorities and licensing bodies	Environmental NGOs
Other ocean users, e.g. fishermen, aquaculture etc. (incl. representing associations)	Regional economic authorities
Citizens and coastal residents	Initiatives on ocean energy infrastructures
Maritime spatial planning experts	Commercial enities such as Royal Haskoning DHV and applied research insitutes such as Marin.

The project's updated Advanced Dissemination and Exploitation Plan/DEP (last updated version submitted to the PO: 27th December 2018) during the final two years of the project provided the basis for MacroFuels stakeholder engagement activities by (i) outlining the overall MacroFuels dissemination, exploitation and communication strategy, by (ii) providing the results of an in-depth stakeholder analysis, by (iii) defining the roles and responsibilities and (iv) by providing a work plan at task and stakeholder level, which has been continuously updated during the project course, making it a usable and living working document.

The DEP served as such a working document over the entire term of the project, to apply the strategy and principles outlined in the strategy to verified project results and outputs achieved during the term of MacroFuels. This allowed for the systematic implementation of the MacroFuels stakeholder engagement strategy throughout the project and beyond. The Advanced DEP has been updated regularly and included detailed timelines, dissemination channels, exploitation roadmaps and selected events and networks at work package, deliverable and milestone level.

Based on the work carried out, and as demonstrated by the outputs presented in this document, MacroFuels met the objectives of the stakeholder engagement strategy.

The detailed activities performed by MacroFuels during project years 3 and 4 (2018 and 2019) per target stakeholder group are described in detail in the following chapters.

3. Stakeholder engagement activities – Project Year 3 and 4

Knowledge generated within MacroFuels was screened for the potential to be shared with relevant EU knowledge and stakeholder platforms as well as projects that are related to MacroFuels' topics and planned outputs. Consolidated knowledge that has been generated between M24 and M48 that has been cleared from IP protection and therefore could be shared with a wider community comprised topics in seaweed cultivation and biomass logistics, select results in biomass pre-treatment methods and fuel conversion routes, fuel road test and emission results, the environmental impacts of seaweed cultivation as well as the techno-economics, social and regional aspects and the overall sustainability of the seaweed-to-biofuel value chain.

In parallel to identifying newly generated knowledge that was of interest for sharing with relevant projects and stakeholder groups, knowledge gaps and critical issues that require further knowledge exchange and discussions have been assessed. Here, the need for knowledge exchange was identified especially in the areas of seaweed production and biomass supply, more precisely in maritime spatial planning (MSP) and the eco-system-based management of the marine space for large-scale seaweed cultivation, the integration of seaweed cultivation in Integrated Multi-Trophic Aquaculture (IMTA), national licensing requirements for large-scale seaweed production, the public perception towards seaweed production as well as standards and best practice for seaweed farms to guarantee the sustainability of processes. Furthermore, a need for knowledge exchange has been identified for biofuels and blends derived from different types of biomass as regards logistics and synergies for their future utilisation in the transport and aviation sector. A need for intense knowledge exchange has been identified at scientific, technological and policy level. Knowledge

exchange with policy makers is further explained in chapter 3.3 (p. 16 ff.).

3.1. Scientific Community

During project years 3 and 4 engaging with the scientific community was performed via various channels, the main ones being inter-project meetings, scientific conferences and knowledge exchange via project members who were involved in several projects in the areas of seaweed, biofuels and/or aquaculture.

3.1.1. Scientific conferences

During the second half of MacroFuels project members have participated in several conferences, symposia and meetings, that way discussing relevant content with scientists and professionals outside the consortium and reporting important knowledge back to MacroFuels.

Table 1.2 gives an overview of the events utilised by MacroFuels partners for engaging with stakeholders from the scientific communities relevant for MacroFuels:

Table 1.2 Overview of events MacroFuels visited in year 3 and 4

Conference	Participant(s)
2nd International Conference on Marine Biomass as Renewable Energy 6th-8th March 2018, Glasgow/UK	**Jaap van Hal** (TNO) *Knowledge topic: Direct conversion from seaweed to biofuels.*
EUBCE 2018 14th-17th May 2018, Copenhagen/Denmark	**Jaap van Hal** (TNO) *Knowledge topic: The cost drivers of seaweed based fuel production.*
14th International Conference on Renewable Resources and Biorefineries (RBB) Ghent/Belgium, 30th May-1st June 2018	**Jelle Van Leeuwen** (WUR) *Knowledge topic: Pilot scale biorefinery of brown seaweed; seaweed applications from proteins, sugars and alginate.*
EFIB 2018 30th Sept-2nd October 2018, Toulouse	**Ana Lopez Contreras** (WUR): *Knowledge topics: Conversion routes for seaweed to fuels; butanol production from seaweed sugars; metabolic engineering*
Nordic Seaweed Conference 2018 10th-11th October 2018, Aarhus	**Soren Larsen** (DTI): *Knowledge topic: Ensiling of seaweed as biomass stabilization and pre-treatment method; conservation of sugars for biofuel production* **Adrian Macleod** (SAMS) *Knowledge topic: Environmental impacts of seaweed farming and knowledge gaps*
Rendez-Vous de Concarneau 12th Oct 2018, Concarneau	**Bert Groenendaal** (SIOEN): *Knowledge topic: Innovation in seaweed farming*
7th Flemish Aquaculture Symposium 27th October 2018, Ghent	**Benny Pycke** (SIOEN): *Knowledge topic: Seaweed aquaculture and future scenarios for the Flemish region*
Seagriculture 2018 6th -7th November 2018, Galway	**K. Dussan** (TNO): *Knowledge topic: Macroalgae biorefinery*
PROMAC Conference 8th-9th Nov 2018, Aalesund	**Anne-Belinda Bjerre** (DTI) General discussion of the MacroFuels concept
International Seaweed Symposium	**Jaap van Hal (TNO), Bert Groenendaal (SIOEN)**

(ISS) 2019 **28th Apr-4th May 2019, Jeju, Korea**	*MacroFuels Mini-Symposium (see 3.1.2 MacroFuels scientific events)* **Annette Bruhn (AU), Adrian Macleod (SAMS)** Knowledge topic: Environmental and ecosystem impacts of seaweed farming
27th European Biomass Conference & Exhibition (EUBCE 2019) 27th -30th May 2019, Lisbon	**Karla Dussan Rojas (TNO)** *Knowledge topic: Biorefining of seaweed for producing furanic molecules*
Paving the way towards clean energy and fuels in Europe - Talks with research, industry and EU Member States on bioenergy, advanced biofuels and renewable fuels Side event at EUBCE 2019	**Jaap Kiel (TNO)** *Participation in EC organised policy event, incl. MacroFuels technology concept and impact*
Seagriculture 2019 25th-26th Sept 2019, Ostend, Belgium	**MacroFuels consortium** *MacroFuels Session (see 3.1.2 MacroFuels scientific events)*
Nordic Seaweed Conference 2019 9th-10th Nov 2019, Grenaa, Denmark	**Rita Clancy (EURIDA)** *Knowledge topic: Social and regional aspects of a seaweed-to-fuels value chain*

3.1.2. MacroFuels scientific events

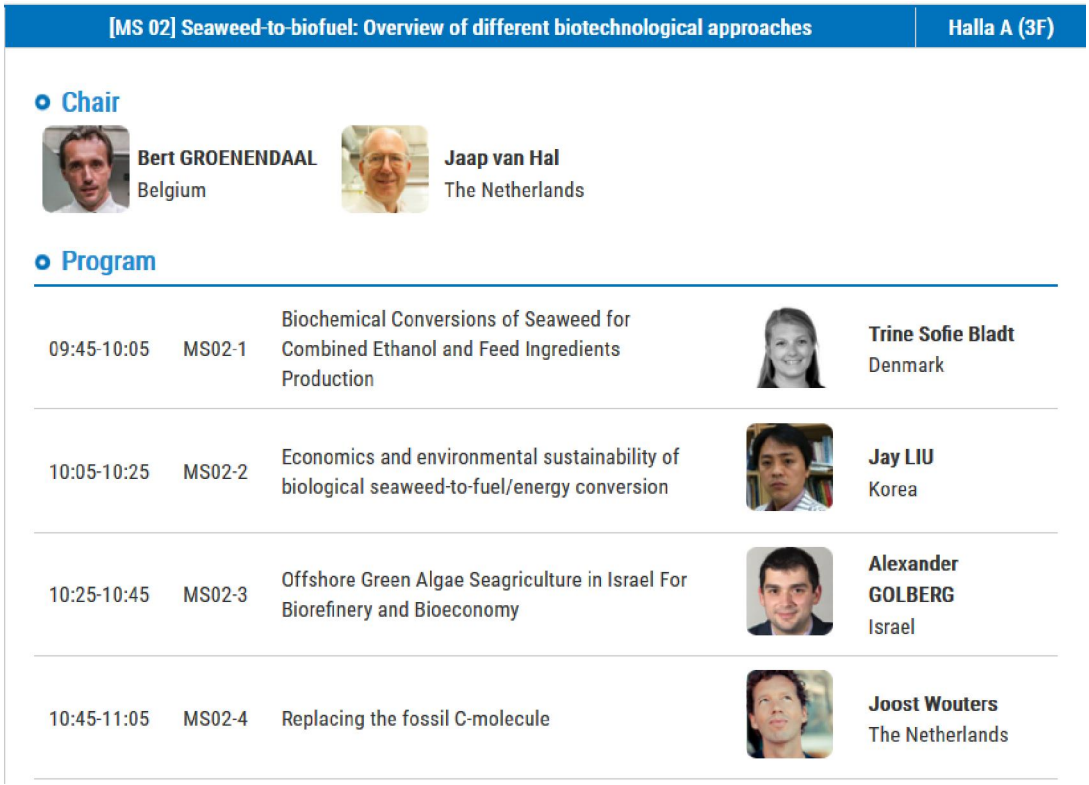
- ***MacroFuels 'Mini-Symposium' at the occasion of the 23rd International Seaweed Symposium 2019 (28th April to 3rd May 2019 in Jeju, South Korea)***

As part of the prestigious triannual International Seaweed Symposium (ISS) which took place in May 2019 in Jeju, South Korea, MacroFuels organized a Mini-Symposium as a format for intense knowledge exchange between the leading scientists in the fields of seaweed and biofuels. The ISS is the largest international forum in which the worldwide leading researchers in the field of seaweed meet and present their concepts and results.

Several MacroFuels partners had planned their participation in the ISS 2019, so it was decided that applying for a mini-symposium would provide a great additional platform for MacroFuels, as well as being an outstanding networking and knowledge exchange opportunity, especially with international projects.

To allow for an open engagement and foster the discussion about the currently most promising concepts for generating fuel from seaweed, the symposium programme was decided to go beyond MacroFuels and to invite international researchers at the forefront of biofuel research. MacroFuels was presented as one of four leading concepts of the seaweed-to-biofuel value chain.

The mini-symposium took place on the 29th April 2019. The symposium program organised by MacroFuels is outlined in Fig. 1 below:



[MS 02] Seaweed-to-biofuel: Overview of different biotechnological approaches | Halla A (3F)

Chair

Bert GROENENDAAL
Belgium

Jaap van Hal
The Netherlands

Program

09:45-10:05	MS02-1	Biochemical Conversions of Seaweed for Combined Ethanol and Feed Ingredients Production		**Trine Sofie Bladt** Denmark
10:05-10:25	MS02-2	Economics and environmental sustainability of biological seaweed-to-fuel/energy conversion		**Jay LIU** Korea
10:25-10:45	MS02-3	Offshore Green Algae Seagriculture in Israel For Biorefinery and Bioeconomy		**Alexander GOLBERG** Israel
10:45-11:05	MS02-4	Replacing the fossil C-molecule		**Joost Wouters** The Netherlands

Fig. 1 International Seaweed Symposium 2019 MacroFuels Mini-Symposium programme
Source: https://iss2019.org/program/program_03.html?sMenu=02&subMenu=07

- ***MacroFuels Conference Session at the occasion of "Seagriculture 2019", the 8th International Seaweed Conference, 25th-26th September 2019, Ostend, Belgium***

As part of the 8th international "Seagriculture" Conference, MacroFuels organised a special 'MacroFuels Session' that took place on the 26th September 2019. MacroFuels contributed two oral presentations that covered knowledge and results generated by the project in the fields of environmental impacts on the ecosystem by large-scale seaweed cultivation and biorefinery approaches for a seaweed-to-biofuels value chain that includes value added products for further valorisation and improved techno-economics. An additional presentation was invited and held by Philippe Potin, representative of the IDEALG and GENIALG projects with which MacroFuels closely engaged in inter-project communication and knowledge exchange. The session programme is displayed in Fig. 2 below.

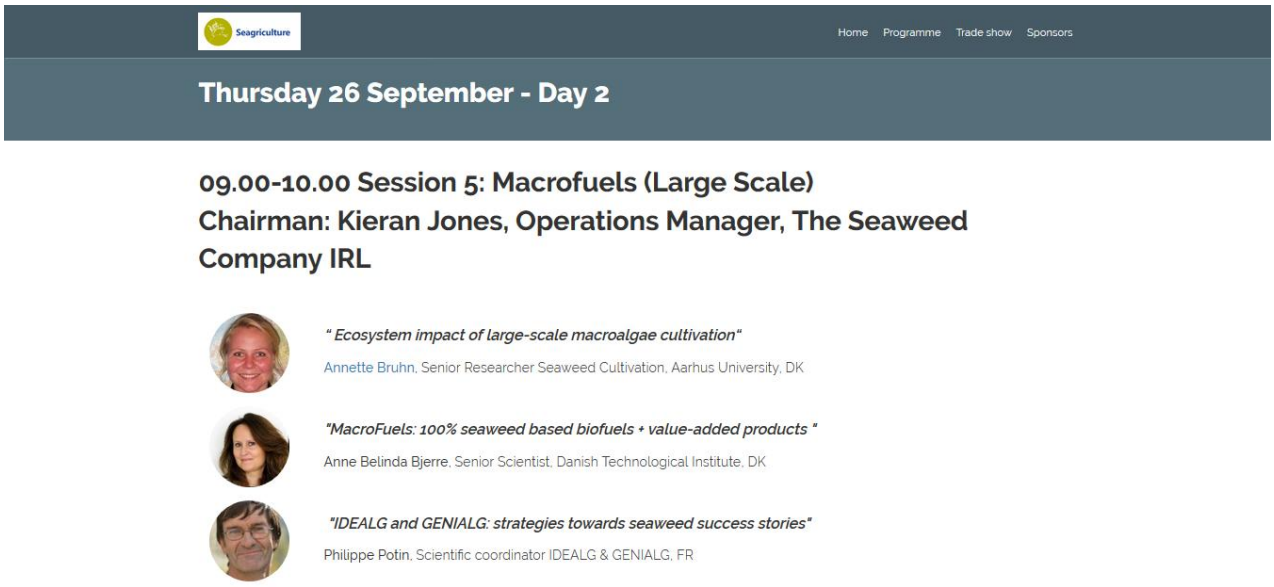


Fig. 2 Seagriculture 2019, MacroFuels Session programme

In addition to the presentations MacroFuels organised close engagement with the scientific community via the MacroFuels project booth. During the two days of the conference the booth provided a meeting place for the interested conference audience to discuss seaweed cultivation, conversion and biorefinery concepts as well as sustainability aspects, such as techno-economics, environmental and social effects. Project knowledge has been presented on roll-ups, posters and brochures and MacroFuels Communication Officer Rita Clancy was available for further explanations and discussions with booth visitors.

Most popular scientific topics for discussion at the MacroFuels booth were (1) yield and seasonality of the seaweed cultivation and the cultivation substrates used, (2) details on the chosen biorefinery concept, (3) sustainability aspects of seaweed cultivation.

Valuable knowledge and insights could be collected by MacroFuels and partially incorporated in MacroFuels concepts, especially for follow-up plans, in the following topics:

- Standardisation and certification schemes and requirements for sustainable seaweed farms (ASC-MSC)
- Possible future seaweed-based applications for compounds extracted and refined during the biorefinery process (food, feed, pharmaceuticals)
- Regional strategies and development plans for seaweed farms (discussions were held with Flemish and Dutch representatives of national/regional authorities)
- Alternative seaweed cultivation scenarios and hatchery concepts (esp. red seaweed *Palmaria palmata*)

Fig. 3 MacroFuels booth at Seagriculture 2019.

3.1.3. Inter-project knowledge exchange

Based on the knowledge identified as relevant for knowledge exchange, communication channels have been established with the projects, groups and initiatives listed below (subdivided by topics). Being leading researchers in their respective areas, many members of the MacroFuels consortium are also partners and even coordinators in relevant other European, national and international projects. Therefore, communication knowledge exchange formats between M24 and M48 included personal conversations with individual MacroFuels members who brought knowledge and progress generated in other projects into MacroFuels for improving concepts and widening perspectives. MacroFuels-external knowledge was captured and preserved in specific templates, so-called 'knowledge sheets', all exchanged knowledge has been kept confidential between the projects involved in the exchange.

Two of the largest meetings for inter-project knowledge exchange were organised by deploying established meeting places for seaweed research, i.e. the International Seaweed Symposium 2019 and Seagriculture 2019, both described in the chapter above. The programmes allowed for maximum synergies and knowledge exchange between projects that were specifically invited based on their concepts and approaches focusing on seaweed cultivation methods and biomass supply, different conversion and valorisation streams and social as well as environmental impacts. Those beforehand had been identified as the main topics for knowledge exchange from the MacroFuels perspective.

Additional formats for knowledge exchange included side-meetings during conferences, virtual meetings and WebEx conferences. In addition, the general exchange of knowledge and project progress has been realised via social media communication, using the established MacroFuels social media accounts on Twitter, LinkedIn and Facebook. Below, all inter-project knowledge exchange activities are listed by knowledge areas.

A. Inter-project exchange on seaweed cultivation and conversion

➢ **GENIALG**, a Horizon 2020 project that aims to boost the Blue Biotechnology Economy (BBE) by increasing the production and sustainable exploitation of two high-yielding species of the EU seaweed biomass: the brown alga Saccharina latissima and the green algae Ulva spp (SAMS is project partner). https://genialgproject.eu/
Action taken by MacroFuels: EURIDA organised several virtual meetings with GENIALG members. Main topic that has been identified as crucial for knowledge and data exchange was the social impacts that can be expected from large-scale seaweed cultivation and resulting business opportunities. A road map for interaction was jointly developed by MacroFuels Dissemination Officer Rita Clancy and Dr. Suzi Billing, social scientist at SAMS and responsible for the social impact assessment and theories of social licenses in the GENIALG project. As part of the ongoing cooperation, both projects organised a joint conference in May 2018 targeting local stakeholders at Scottish seaweed cultivation sites (further details are described in Chapter X.X MacroFuels Conference below)
Outputs: Stakeholder Conference, 25th May 2018, Oban/UK

➢ **AT~SEA**, a former FP7 project and spin-off company on textile based seaweed cultivation substrates (SIOEN was project partner). http://www.atsea-project.eu/
Action taken by MacroFuels: Coordinated by MacroFuels Exploitation Officer Bert Groenendaal, partner in the At~Sea project, knowledge exchange was mainly performed based on results delivered within WP1 on the performance and results achieved with advanced cultivation substrates developed by At~Sea (now AtSeaNova). Results on biomass yield, binders and the general performance of substrates were shared with AtSeaNova and inputs given on possible improvements.
Outputs: First assessment results on trials with different substrate and binder specifications.

➢ **MAB3 and MAB4**, both national Danish projects on Macroalgae biorefinery for value-added products http://www.mab3.dk/ and http://www.algecenterdanmark.dk (DTI is coordinator, AU, FEX, Bert Groenendaal via AT~SEA are project partners)

Macro Cascade, a project funded by the Horizon 2020 Bio-Based Industries Joint Undertaking on the cascading marine macroalgal biorefinery concept https://www.macrocascade.eu/ (DTI is coordinator, TNO, WFBR, FEX, Matís are project members)

Searefinery, a project financed by funding agencies of Flanders, Denmark, Ireland, Iceland and Norway and the ERA-MBT Joint Call Secretariat on eco-friendly chemical and enzymatic processing technologies to extract and purify high value-added components such as antioxidants, antimicrobial components and hydrocolloids from cultivated seaweed species (e.g. *Saccharina latissima*) in an integrated biorefinery. https://www.searefinery.eu/ (DTI is coordinator, SIOEN is project partner/Bert Groenendaal is Communication Manager)
Action taken by MacroFuels: All above projects are coordinated by Anne-Belinda Bjerre/DTI, also coordinator of MacroFuels and they involve several MacroFuels partners. Knowledge exchange is therefore organised between projects via project staff reporting IP cleared results, achievements and progress from other projects. Content is being communicated towards the MacroFuels consortium in Work Package, WP leader and General Assembly progress meetings.
Outputs: Knowledge generated in above projects was captured in knowledge and results sheets and, where applicable, integrated in MacroFuels activities and concepts and vice versa.

➢ **PROMAC**, a project funded by the Research Council of Norway on seaweeds as novel raw materials for human food and domestic animal feed applications. http://promac.no/ (Matís is project partner).
Action taken by MacroFuels: Tasks and results that are of interest for knowledge exchange between projects include the improved understanding of chemical compositions of seaweed,

ensiling concepts as means of storage and pre-treatment and drying processes as well as economic exploitation and viable business models for seaweed as biomass. MacroFuels participated in the PROMAC final conference, during which progress and results from PROMAC, MacroFuels and other European initiatives were presented. The PROMAC consortium visited the TNO facility on March 20th, 2018 to discuss the projects results.
Outputs: A MacroFuels keynote speech was held by Anne-Belinda Bjerre/DTI on the 8th November 2018 at the final PROMAC Conference in Ålesund/Norway. Knowledge was exchanged in follow-up discussions on different seaweed applications, economic viability and sustainability, and concepts on biomass supply, pre-treatment and conversion methods.

B. Biofuels from various feedstocks

➢ **BRISK2**, a large Horizon 2020 funded biofuel research infrastructure providing access and funding to biofuel researchers and boosting knowledge sharing, incl. activities on seaweed round robin and analytical techniques (TNO is partner) http://www.brisk2.eu
Action taken by MacroFuels: Data generated by MacroFuels was screened for the suitability for integration into the Brisk/Brisk 2 funded 'Phyllis' database (https://phyllis.nl/) . This task is ongoing and selected data is currently being collated and checked for IP protection. Once the work is completed, data will be integrated into the Phyllis database.
Outputs: Preliminary data of relevance for the Phyllis database has been identified and collated. Selected data will be uploaded to the BRISK2 Phyllis database by the end of the project.

➢ **ADVANCEFUEL**, a Horizon 2020 project that aims to facilitate the commercialisation of advanced renewable transport fuels from renewable resources (TNO is consortium partner). http://www.advancefuel.eu/


GLOBAL TRANSPORT

RENEWABLE FUELS

Renewable Fuels

Advancing European Market Uptake

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Discovering the world, working with people across the globe, commuting to work everyday or consuming exotic fruits imported to Europe – nearly every European is used to at least one of these habits producing a significant amount of carbon emissions. On the road to decarbonizing transport and reaching climate targets, the market uptake of renewable fuels is essential.

1. By 2050 global aviation emissions should be at least 41 percent lower than in 2005. Photo: Jasper

The European transport sector is the only major sector where greenhouse gas (GHG) emissions are continuously increasing. According to the European Environment Agency, in 2016 the transport sector contributed 27 percent of total EU greenhouse gas emissions and they were 26.1 percent higher compared to 1990. While road transport has contributed the most to the transport sector's GHG emissions, the largest increase in final energy consumption has occurred in the aviation sector between 1990 and 2016, and this sector is expected to continue growing rapidly. International shipping activity is also expected to increase as it is driven by increasing globalization and trade.

In response to increasing emissions, the EU has set several targets to mitigate and limit GHG emissions from transport. An overall target of a 60 percent reduction in GHG emission within the transport sector by 2050 was set in 2011 (compared to 1990) – still too low to reach the 2015 Paris Agreement aspiring to limit global warming to less than 1.5°C. In 2015, the study "Emission reduction targets for international aviation and shipping" conducted for the European Parliament suggests that by 2050 global aviation emissions should be at least 41 percent lower than in 2005, and the global emissions of the shipping sector to be at least 63 percent lower.

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Action taken by MacroFuels: MacroFuels, with ADVANCEFUEL media partner REVOLVE (contact: Vanessa Wabitsch) as the leading organisation co-developed a media article about renewable fuels and advancing the European market uptake.

MacroFuels' Communication Officer Rita Clancy provided content and insight in seaweed-based fuels, the current state of advanced fuels in the European market, existing market barriers and possible future applications for fuel from macroalgae. ADVANCEFUEL further organised a press briefing based on the media article. The briefing took place at the occasion of the ETIP Bioenergy Stakeholder Event in Brussels on the 21st November 2019. MacroFuels was invited by ADVANCEFUEL to join the press briefing.

Outputs: Media article "Renewable Fuels - Advancing European Market Uptake", published in "REVOLVE - QUARTERLY INSIGHTS INTO A CHANGING WORLD N° 33 | Fall 2019" in September 2019; Press briefing, 21st November 2019, Press Club Brussels

C. Maritime Spatial Planning, IMTA and the co-use of the ocean space

- **Pilot Project by Noordzee Boerderij Netherlands**, a Dutch governmental organisation. The North Sea Farm Foundation is a non-profit organisation aimed at realising a sustainable seaweed industry in the Netherlands and surrounding EU countries, including the promotion of co-use of the ocean space. https://www.noordzeeboerderij.nl/ . TNO coordinates this cooperation.

Action taken by MacroFuels: Knowledge exchange in particular focuses on a pilot site project, coordinated by Noordzee Boerderij, that combines offshore wind parks and seaweed cultivation. Several meetings have been held in which knowledge has been exchanged on the expected specifications of an industrial, large-scale seaweed farm, spatial requirements and farm logistics as well as expected impacts of large-scale cultivation.

Outputs: Several meetings were held and ideas for future cooperation mapped.

- **SOMOS:** Technical Standards for Safe Production of Food and Feed from marine plants and Safe Use of Ocean Space, a study into safety at sea funded by Lloyd's Register Foundation, to investigate safety aspects of combined activities at sea. The focus in SOMOS is on renewable energy production in combination with seaweed, used as biomass for food, feed, bio-chemicals, energy and other valuable products. https://www.wur.nl/en/project/SOMOS.htm

Actions taken by MacroFuels: EURIDA initiated contacts with SOMOS to exchange knowledge on quality standards for seaweed as biomass for food and feed applications and, in this context, safety standards for ocean-based operations, especially in the light of multi-use concepts and shared ocean infrastructures and how they could relate to large-scale seaweed cultivation in the future. This is of particular importance for seaweed used in a biorefinery concept, which is a very likely scenario of the future to assure the economic viability of the seaweed-to-biofuel value chain. Two virtual meetings were held with members of the SOMOS project (Sander van den Burg and Christine Rockmann, both WUR) in which opportunities for a joint workshop for project members have been discussed.

Outputs: A concept note for a joint workshop has been drafted. Currently, both projects are assessing timelines, roles and responsibilities and the best occasion for organising a workshop (e.g. of integrating it into the 'Seaweed Success Stories' Conference planned in 2019 (see above under Task 7.4, 'MacroFuels Conference').

- **IMPAQT**, a Horizon 2020 project that aims to promote and support the eco-intensification of aquaculture production systems, including inland, coastal zone, and offshore. To that respect, IMPAQT proposes an intelligent management platform for IMTA. https://impaqtproject.eu/ (SAMS is project partner).

Action taken by MacroFuels: Based on a meeting held with SAMS responsible within the IMPAQT project for seaweed aquaculture in the context of IMTA, it was decided that IMPAQT will participate in the 'Seaweed Success Stories' Conference and introduce their IMTA concepts, initial results and progress.

Outputs: Two meetings held and agreement on the participation in the 'Seaweed Success Story' Conference made.

Additional projects with who MacroFuels partners liaised at several occasions included:

- **Port4Innovation**, a national project in the Netherlands, focusing on innovation, valorisation and support of start-ups and cooperation initiatives in the fields of maritime maintenance, seaweed, business support and strengthening of the eco-system (TNO is partner).
- **European MSP Platform**, an information and communication gateway designed to offer

support to all EU Member States in their efforts to implement Maritime Spatial Planning (MSP) in the years to come. https://www.msp-platform.eu/

➢ **MUSES**, The Multi-Use in European Seas (MUSES) project is a Horizon 2020 funded project that is exploring the opportunities for Multi-Use in European Seas across five EU sea basins (Baltic Sea, North Sea, Mediterranean Sea, Black Sea and Eastern Atlantic).

3.1.4. Young scientists and students

Workshop with high school students from Helmond

On the 1th of October 2019, a group of students visited Avantium for a general introduction to the company as well the theory of seaweed production and processing into fuel. Part of the workshop were to prepare experiments by studying literature and gather different types of edible, non-edible and waste biomass.

On the 6th of November 2019, the students visited Avantium for a second time. After the safety instruction, they hydrolyzed different types of biomass: including wood, fruit, vegetables, stalks, grasses and seaweed (provided by SAMS), using Avantium's equipment. All samples were analyzed for released sugars and formed fuel compounds. The students used literature research to understand fermentation and chemo-catalytic routes to produce biofuels. They submitted reports at school and for the contest of "Imagination at work". Additionally, the work was presented to other participants and teachers. It was the second workshop for students organized by MacroFuels partner Avantium, the first event took part during the first half of the project.

More information can be found in the links below:

https://www.c3.nl/
http://imaginationatwork.nl/

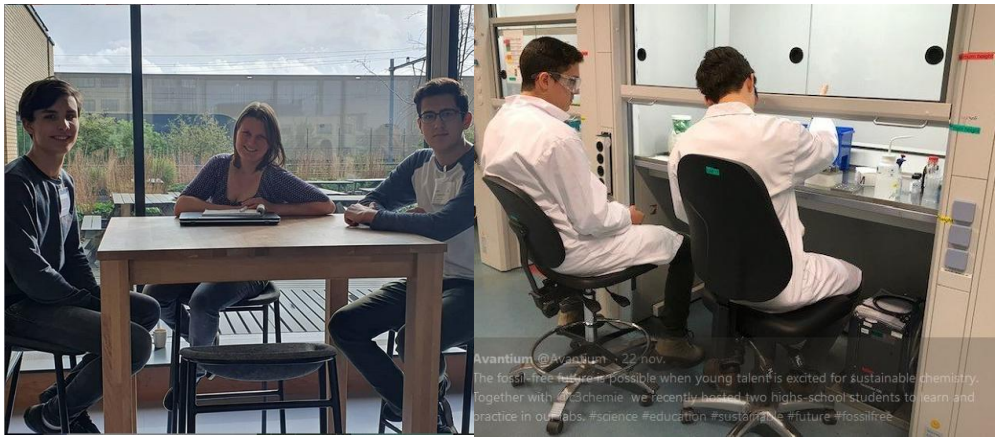

Fig. 4 Student workshop at Avantium

3.2. Engagement with industrial stakeholders and end-user representatives

Direct knowledge exchange and engagement with industrial stakeholders and future end users via meetings was performed via the MacroFuels Advisory Board (AB), which includes selected representatives from the transport sector, and representatives of selected industry sectors outside the AB.

3.2.1. Industrial Advisory Board

The MacroFuels Advisory Board comprises representatives of the fuel and aviation industry, both important end users of MacroFuels. Members, contacts and strategic goals for involvement are outlined in Table 1.3 :

Table 1.3 Members of the MacroFuels Advisory Board

AB Member	Contact	Strategic cooperation goal
Shell Biodomain	Jeremy Shears	Discuss and collect end user input on fuel specifications, industry standards, upscaling and market entry strategies and future partnerships.
SINTEF/EERA SET	Berta Matas Guëll	Discuss and collect input on technology barriers for renewable fuels and biorefinery, European strategies and requirements (RED II, SET, Horizon Europe), upscaling strategies and financing.
SkyNRG	Renco Beunis	Discuss and collect input on needs of the aviation industry for renewable fuels and market entry strategies.
TOTAL	Olivier Vidalin	Discuss and collect end user input on fuel specifications, industry standards, upscaling and market entry strategies and future partnerships.

The Advisory Board members were invited to all MacroFuels internal project meetings in the final year of the project since during the final phase of the project relevant results on fuel conversion routes, specifications and performance were available. Discussions were organised on the different types of MacroFuels target fuels, e.g. ethanol, butanol (ABE mix) and furanics and their specifics. Further discussion were held about the mixing of seaweed-based fuels with transport fuels as required by industry standards. That way, needs and requirements can be taken into account at early Technology Readiness Levels of seaweed-based fuels, which will assure the market relevance and feasibility of MacroFuels' products and results.

First fuel test results were presented and discussed during a MacroFuels project meeting at TNO in June 2019 with all members of the Advisory Board. The test results had become available for seaweed-based ethanol shortly before the meeting based on first engine tests in a test bench. Details were further presented about the thermo- and biochemical conversion steps to produce the different fuel types.

Discussion revealed strong interest of both fuel producers, Shell Biodomain and TOTAL in both, ethanol and butanol derived from seaweed for future advanced biofuel solutions. TOTAL emphasised their interest in advanced fuel based on cultured biomass over fuels derived from waste, despite the initially large investments that will be necessary for upscaling biomass production and the biorefinery for seaweed processing.

Advisory Board member SkyNRG expressed the aviation industry's great interest in furfural molecules and furanic fuels, which can act as fuel boosters. Red seaweed (Palmaria palmata) was found to be a good source for furanic fuel production by MacroFuels and conversion routes were successfully demonstrated at litre scale. Based on the input from the aviation industry, which is a

key stakeholder of MacroFuels, follow-up plans will include the upscaling of the furanic fuel value chain with special emphasis on the aviation sector.

Further input was collected on future European strategies in the field of sustainable fuels, sustainability requirements, financing schemes and plans within the SET Plan. Input was mainly provided by Advisory Board member Berta Matas Guëll, member of the bioenergy group at EERA SET.

3.2.2. Other industrial Stakeholders

Meetings have been organized with representatives of industries that are relevant stakeholders besides the fuel industry. Target groups included the transport sector, potential end users for seaweed-based compounds that are relevant for high-value product valorisation as part of improved techno-economics and other ocean users that could become relevant partners for promoting ocean co-use scenarios. Main cooperation goals were to present MacroFuels concepts, to develop a common understanding about each other's practices, needs and currently limiting factors for cooperation and to develop initial road-maps for future joint activities.

Table 1.4 lists the stakeholders meetings that were organised, subdivided by type of industrial sector.

Table 1.4 Stakeholder meetings held during year 3 and 4 of MacroFuels

Name	Industry	Date
Ports and shipyards		
Port of Den Helder	Seaport	2019-06-03 (TNO
IHC	Ship Yard	
Port of Amsterdam	Seaport	2019-04-23 (TNO)
Offshore contractors and cultivators		
SEAMAR	Off-shore	2019-10-22 (TNO)
Van Ooord	Off-shore contractor wind	2019-11-14 (TNO)
Transport		
Maersk	Heavy Transport, shipping	2019 09-12 (DTI)
Eco-Services		
Royal Haskoning DHV	Eco Services	2018-02-12 (TNO)
Brightlands	Large Chemical Industry	2018-10-01 (TNO)
Food industry		
Cargill	Food	Several meetings between 2017 and 2019 (DTI, TNO)
Cosun	Food	Several meetings between 2017 and 2019 (TNO)
Think Tanks		
PBL	Think Tank for the Dutch Government	2019-02-22 (TNO)

3.3. Policy and multi-stakeholder engagement

3.3.1. Community of Practice (COP) North Sea

The Dutch government aims to set aside 14,000 km^2 of the Dutch part of the North-Sea for the generation of energy, materials, food and recreation. This corresponds to roughly 25% of the Dutch part of the North Sea. This policy has been adapted to reach the 2050 Paris agreement climate goals. This ambition envisions the intense multi-use of the area of the North sea. Concurrent co-users are expected to be:

- Energy producers: Wind energy, tidal energy, wave energy
- Floating solar arrays
- Food producers
- Seaweed cultivators
- Fisheries: Fish farming, passive and active fishing
- Crustacean cultivation
- Shell fish cultivation
- Recreation

As part of the mid to long term strategy, the Community of Practice (COP) for the North Sea 2030 was established to engage all parties to facilitate a common ground to accelerate the development of this vision. The Community is organised by four departments (Economic Affairs, Agriculture, Environment and the State Department), the Dutch permitting agency Rijkswaterstaat and the Dutch funding agency The Netherlands Enterprise Agency (RVO).

Format chosen for the COP is regular one day meetings that include oral presentations, workshops and networking sessions. MacroFuels participated in several COP meetings, represented by partner TNO. Table 1.5 shows a list of all meetings TNO took part in.

Table 1.5 COP North Sea Events with participation of TNO

Location/date	Agenda
COP 20th Sept 2018, Scheveningen	Information about the COP
	Multi-Use in the existing park from the developers perspective
	Semi-open cultivation
	Lessons learned from NSEL
Ark & WWF Netherlands 22nd Nov 2018, Delft	Pilots crustacean cultivation in Wind Parks, what is necessary for pilots
	Source materials
	What does the North Sea look like in 2030
RVO 18th Dec 2018, Den Haag	Taylor made: Blue Growth
COP 7th Feb 2019, Scheveningen	Inspiration
	The new innovation agenda of the Netherlands (MMIP in Dutch)
	Cockle cultivation
	Circular fishing
COP 14th May 2019, Hoek van Holland	North Sea permitting process (2 parts, the permitting and the regulatory framework)
	North Sea Agreement
Noordzeedagen 4th Oct 2019, IJmuiden	Inspiration
	Multi-Use procedures
	Start of the win wind project
	European funding
Campus@Sea 26th Nov 2019, Scheveningen	SME pitches North Sea Project (o.a. seaweed)
	Funding opportunities
	Developing R&D projects
	Sailing innovation

A large cross-section of these subjects is relevant for the MacroFuels vision. Ocean multi-use

scenarios will be essential for large scale seaweed cultivation for reasons of economics and to avoid the socio-economic risk of competition over the ocean space which could threaten other coastal livelihoods.

Indicative experiments on Integrated Multi-Trophic Aquaculture (IMTA) further suggest that there is a positive synergetic effect of co-locating crustaceans with seaweed on the growth of both. The permitting procedure for multi-use is still embryonic, and this platform facilitates the stakeholders' interests as well as setting an initial framework on how to coordinate this novel and challenging field. Further R&D programmes are also essential for the development of this vision. In summary, the first steps of integrating large scale seaweed cultivation in future usage of the North Sea were set in the COP meetings and related strategies (among other places in the world). For this reason, TNO has participated in the majority of these meetings.

A large variety of stakeholders were present at the meetings, including off-shore contractors, wind turbine park owners, NGO's, permitting agencies, fishermen, entrepreneurs, RTOs, etc. This variety of target groups provided a unique platform for MacroFuels for national, regional and local stakeholder engagement.

The meeting minutes and summaries are part of the public record (available in Dutch). Meetings were public, seating was limited, but meetings also provided video summaries. Sample videos can be found at:

https://www.rvo.nl/onderwerpen/duurzaam-ondernemen/energie-en-milieu-innovaties/noordzee
https://www.youtube.com/watch?v=kknwISNJs9Q
https://www.youtube.com/watch?v=3RXjo-QUETU
https://www.youtube.com/watch?v=q1Ud6c2br7A

All COP meetings and the very existence of the Community show there is a general consensus towards multi-use of the North Sea and the inclusion of a comprehensive range of stakeholders in the Netherlands. This is further evidenced by the multitude of pilot activities on multi-use scenarios that are currently under development with many having been discussed during the COP meetings.

Lessons learnt from meetings and further ideas on multi-use scenarios, integrating MacroFuels concept for large-scale seaweed cultivation have been presented by TNO to the MacroFuels GA, the project Advisory Board and the Advisory Board of the TNO Wind Programme (November 7th, 2019).

3.3.2. Stakeholder Workshop "Multifunctional use of the North Sea"

MacroFuels partner TNO organised a multiuse workshop with a variety of stakeholders. The workshop was organised as a first step to introduce North Sea multi-use stakeholders to each other. Furthermore, an essential first step in evaluating technical boundaries for multi-use of the sea is to learn to speak each other's language. The work-shop was therefore organised to give the stakeholders the opportunity to present the basics of their technology. The workshop agenda, participant lists and minutes are included as Annex I in this deliverable report.

3.3.3. EUSEW 2019

MacroFuels partner EURIDA organised a MacroFuels Energy Talk and a stand at the Energy Fair at the European Sustainable Energy Week that took place on the 19th and 20th June 2019 in Brussels. Objective for the participation in EUSEW was to highlight MacroFuels' advances and innovation along all segments of the seaweed-to-biofuels value chain, from novel concepts for the

sustainable year-round large-scale seaweed cultivation in Europe via a novel and economically viable seaweed biorefinery through to seaweed-based fuel (additive) performances under real road conditions and in novel engine concepts that allow to use advanced biofuels more effectively. Test results from the first litres of biofuel from seaweed produced by MacroFuels were shown.

With the help of MacroFuels visual material, including a MacroFuels film that was prepared for the occasion by EURIDA, the audience got a real impression of what a seaweed farm looks like, how seaweed is processed and treated and eventually converted to a liquid fuel. The audience also

learnt about the great environmental potential of this, for Europe rather novel, biomass, but also existing knowledge gaps were openly discussed. It was clarified that indeed, seaweed represents a highly promising feedstock for sustainable biofuels regarding the great potential for CO_2 absorption and the fast growth rates of seaweed (e.g. compared to trees) that result in a much faster reabsorption of CO_2 released from its combustion. However, not all potential environmental impacts, especially those of large-scale seaweed cultivation, are known yet, so at the occasion of this policy event that focuses on sustainable energy scenarios necessary future work was highlighted during the Talk and policy recommendations given.

Following the presentation, the aspects of the seaweed-to-biofuel value chain – technological, economic and environmental – were vividly debated with members of the audience and expectations and concerns discussed. Participants in the open discussions included members of other EU projects, among them ADVANCEFUEL, HyFlexFuel and a selection of ocean energy initiatives, researchers from the area of Energy Islands, members of the European Institute of Innovation and Technology (Sven Aerts). Further in-depth discussion were held at the MacroFuels Energy Fair stand, topics that were in the spotlight were:

- Opportunities for European islands emerging from seaweed cultivation as regards economic growth and energy-independence
- Environmental impacts and prospects for climate change mitigation and bioremediation (e.g in estuaries) with seaweed
- Synergies between seaweed farms and ocean energy infrastructures. First ideas for cooperation have been discussed and will be further developed as possible follow-up

activity due to their potentially high innovation potential.

Fig. 5 MacroFuels Energy Talk and Energy Fair at the EUSEW 2019

3.3.4. Final MacroFuels Conference

MacroFuels took the opportunity of the final project meeting in Brussels to organise a one-day conference with contributions from EU level policy experts that complemented MacroFuels presentations. The final public event was held on the 13th November with the following external participants:

Thomas Schleker	DG RTD
Andrea Weber	DG MARE
Iain Shepherd	DG MARE
Ewan Geffroy	DG MARE
Alexandra Neyts	EATIP Aquaculture
Sven Aerts	ERFC Brussels Office, EIT
Berta Matas Guëll	SINTEF, EERA SET
Agata Przadka	INEA
Karen Mooney	Queens University

During the meeting a number of topics were covered, among them technical and sustainability aspects, economic and social impacts and the need for public dialogues as well as policies and regulatory frameworks in Europe that will be relevant for seaweed producers and seaweed-based fuels. The event also featured a short film of the first ever test drive of a passenger car powered with seaweed fuel.

Part of the event has been an open discussion round, which provided an opportunity to discuss most promising future strategies, barriers, requirements and remaining knowledge gaps on the way to sustainable and economically viable seaweed-based aviation and transport fuels.

Fig. 6 MacroFuels Final Conference.

The full conference programme is available as Annex II.

3.4. Citizen stakeholder engagement

A one-day Stakeholder Conference was organized on the 25th May 2018 in cooperation with the Horizon 2020 GENIALG project at MacroFuels partner Scottish Association for Marine Sciences/SAMS in Oban. SAMS is also partner in the H2020 GENIALG project which, similar to MacroFuels, puts strong focus on the social impacts and social acceptance of future seaweed-based industries. Therefore, it was decided to organize a joint stakeholder conference with representatives from coastal communities to learn about expectations, hopes and concerns towards a potentially growing economic field that is expected to have significant impacts on the living environments of coastal residents. The conference was mutually beneficial to both projects.
Conference participation was based on invitations, which were sent out to a limited number of people to allow for active discussions instead of presentations only.

The conference was attended by 24 participants, among them representatives of the regional Councils of Argyll and Bute, the Highlands and Islands Enterprise/HEI, the Scottish Seaweed Industries Association/SSI, local entrepreneurs from the aquaculture sector (incl. mussel farmers, micro and small seaweed enterprises), and active citizens interested in environmental as well as regional development issues. All participants were residents of the Argyll and Bute region. Furthermore, the local press was present to report about the work performed in MacroFuels and GENIALG and about the conference. The conference programme can be found in Annex III in this report.

As part of the event boat trips were organised for all participants to showcase the SAMS seaweed farm and to allow a hands-on impression on seaweed cultivation operations, materials used for cultivations, visual impacts that can be expected once seaweed cultivation is practiced at larger scales and other components of this rather novel type of aquaculture for Europe.

From the 24 participants 13 agreed to contribute to MacroFuels as members of a Citizen Panel, acting as a consultative body to social and regional aspects of the seaweed-to-fuels value chain by participating in surveys and focus group meetings. An open discussion was organised at the end of the Stakeholder Conference with the Citizen Panel members for MacroFuels to collect input on the general acceptance level of seaweed cultivation and seaweed-based fuels, on expectations and concerns for the region and on ideas for increasing the sustainability of operations at local levels.

The majority of Citizen Panel members (21 out of 24) rated their previous knowledge levels on seaweed as minimal to moderate. One member had no previous knowledge, two rated their knowledge as mature.
The Panel showed a satisfying balance in the capacity with which Panel members participated in discussions and surveys: five members acted as general public, three represented local business owners (one small seaweed entrepreneur), three represented local authorities, two represented trade associations.
Before the meeting the majority of participants had a rather positive to neutral perception of seaweed and related economic activities. Reasons for positive expectations towards seaweed and seaweed-based products could be categorised as twofold: The expectations were either targeted at potentially positive effects on the local economy or at environmental benefits coming from seaweed cultivation helping to improve the local ecological status of the coastal and marine areas.

After the boat trip which included explanations by MacroFuels researchers, short presentations were held on the MacroFuels vision on large-scale seaweed cultivation and on what so far is known about environmental impacts and existing knowledge gaps in that area. The Scottish Seaweed Industries Association (Walter Spiers) contributed a short talk about the status of seaweed industries in Scotland.

After boat trip and presentations an open discussion was organised with the Citizen Panel in four small focus groups, moderated but not steered by one MacroFuels member each. Key topics were the impressions from the seaweed farm, possibly changed perceptions based on upscaling scenarios, hopes and concerns for local and regional development and other opportunities and risks perceived by stakeholders.

The outcomes of the open discussions can be summarised as follows:

- Visual impacts of the seaweed farm were predominantly seen as low to acceptable, at least based on small scale operations. All groups rated visual impacts as lower and preferable over fish and salmon farms.
  For larger scales visual impacts are expected, but for a majority of citizens stay at acceptable levels. However, acceptance levels depend on actual operations, distance from the coastline and additional visual impacts that might be added by harvesting machines or boats for maintenance.
- A good site selection was emphasized by all participants unison with operations further offshore being clearly favoured. Needed additional infrastructure on land (piers, harbor expansion etc.) were seen as challenging by all, but not as high risk. Additional land-based operations were seen as critical, also here good site selection was given high priority during the planning stages. All groups preferred co-use scenarios to avoid competition, especially with fisheries and tourism and favoured Integrated Multi-Trophic Aquaculture (this topic had been introduced in one of the presentations) especially in the context with local fish and salmon farming.
- Concerns were expressed by a majority of citizens (esp. general public) over the sustainability of cultivation materials used and the possibility of material loss, for example in storm events or due to wear and tear. Suggestions for improvement included the use of sustainable and environmental-friendly or recycled material, e.g. from fisheries, to allow for second lives of materials instead of newly produced ones. Questions were asked about who will take responsibility in cases of material loss, for example for necessary beach clean-ups.
- Opportunities were mainly perceived for local and regional employment, the onset of entire supply chains and the chance of second income for local entrepreneurs in aquaculture or fisheries. Investments should be encouraged by local authorities and decision makers and businesses (supermarkets etc.) should stock seaweed-based products, so the full value chain is present in seaweed locations.
- Opportunities were seen by most groups in the influx of new workers and their families, so rural and more remote areas could be revived and reinvigorated. This could have positive effects on local schools, shops, public transport etc.
- Chances were seen in the potential for replacing land-based operations, where growing land use was perceived as an issue by a majority of participants.
- Potential clashes with tourism were not seen as high risk as the main times of seeding and harvesting activities in the seaweed farm with higher work intensities and boat trips based on the MacroFuels concept will not fall into main tourism season.
- Concerns were expressed mainly by local business owners that at the beginning seaweed farms might be small to medium size and, with growing market demand and expansion, might be bought up by large industry. However, if employment is created and if farms are managed in a sustainable way this will not result in a negative perception or a significant risk. Uncertainties remained for return on investment (ROI) and for finding customers for seaweed as biomass.
  However, none of the groups was aware of the multitude of possible products or of the price of seaweed, which was perceived as cheaper than the current and prospected market

price (approx. 8€/kg)

- Involved regulations for seaweed farms should in agreement by all participants be proactively organised with the help of environmental experts and based on existing knowledge. It should not present a hurdle for economic development, but environmental harm has to be prevented by all means in agreement by all four discussion groups independent from each other.
- All four groups emphasized that local residents should be well informed about plans and ideally be educated about seaweed and its opportunities, incl. farming methods and product development. One group suggested to, if possible, use the seaweed farm for educational purposes, e.g. by organizing diving trips in the seaweed farm or by organizing (environmental-friendly) glass bottom boat tours.

Additional 12 members for the Citizen Panel were added from coastal areas near the MacroFuels seaweed test farm in Denmark with further surveys and consultations organized via the AlgeCentre and Kattegatcentret in Grenaa/Denmark and with comparable results. However, a slightly stronger skepticism was assessed for the Danish results. This could be in collection to previous bad conduct by fish farms and stricter laws for aquaculture licenses that had been implemented by the government as a consequence.

It is planned to keep engaged with the Citizen Panel after the MacroFuels project has ended, for example by utilising Open Days at partner organisations SAMS and AlgeCentre which are organised annually for continuing discussions and consultations.

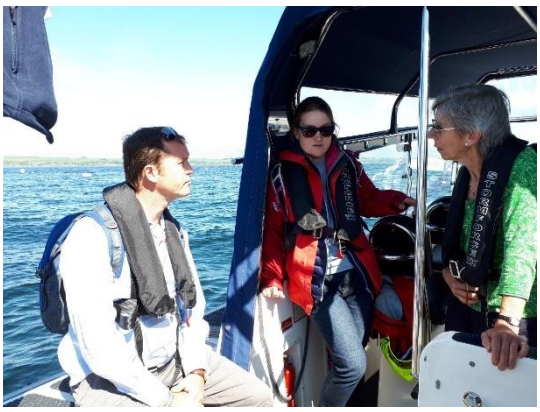

Fig. 7 The 'Citizen Panel' at the MacroFuels Stakeholder Conference, SAMS, Oban, 29th May 2018

Key results and outcomes of the dialogues with In the case of follow-up activities and further projects, the members of the Citizen Panel will be contacted and consulted on relevant topics in seaweed cultivation, upscaling and further aspects of social relevance.

The input collected from the Citizen Panel and surveys so far has been evaluated and ranked as part of the social impact assessment (sLCA) and further details can be found in the public report on social and regional aspects (D6.3, publicly accessible via the MacroFuels project website at https://www.macrofuels.eu/results-publications).

4. CONCLUSIONS

The stakeholder engagement activities carried out within the MacroFuels project were designed to maximise the project's impact and to facilitate the uptake of results and newly generated knowledge by all stakeholder groups.

The ground for intense engagement with wider stakeholder groups also in the future has been paved with a comprehensive set of events tested, performed and evaluated during the project. Newly generated knowledge and results with relevance for policy makers, industrial stakeholders and citizens was shared and discussed.

Especially the intense forms of stakeholder dialogues, such as the Citizen Panel, focus group meetings and the open engagement with multi-stakeholder groups, incl. policy aspects (e.g. COP, EUSEW etc.) have been seen as endeavours that add high value to research and innovation initiatives like MacroFuels. Although such formats are rather time intensive, the results clearly justify the effort as perspectives were added that expanded the horizons of all project participants.

Based on the stakeholder engagement activities performed during MacroFuels and based on the evaluation of results, derived from the input from various stakeholders we have come to the conclusion that multi-use approaches of the sea, i.e. eco-systems concepts or Integrated Multi-Trophic Aquaculture/IMTA as well as smart Maritime Spatial Planning considering ocean co-use scenarios is one of the most important areas for future stakeholder engagement beyond the term of MacroFuels.

For increasing the public acceptance towards seaweed-based industries, especially among coastal residents, and for maximising economic and environmental benefits, intense and open forms of dialogue, for example via Citizen Panels and focus groups are necessary and can be highly recommended based on the very positive and constructive debates MacroFuels experienced during these events.

Traction for large scale seaweed is increasing, thus further emphasising the need for proper stakeholder engagement across disciplines. MacroFuels has laid the foundation over the last four years to properly engage with the key stakeholders and potential facilitators who are necessary to bring this technology and its spin-offs forward towards a sustainable field of the bioeconomy.

Annex I

North Sea Multi Use Meeting March 28th, 2018

Workshop Agenda

Workshop multifunctional use of the North Sea 28th of March 2018, ECN, Amsterdam

Time	Description
09.30-10.00	Walk in with coffee and tea
10.00-10.30	Introduction Welcome by ECN + goal of the meeting (5 min.) by Jaap van Hal, ECN Biomass Round the table (oral introduction of all participants, expectations of the meeting) (25 min)
10.30-10.45	Introduction to the sessions Introduction of the sessions on the multifunctional use of space in offshore wind farms. Group will be divided in two separate groups. One group will focus on limitations and opportunities when working together in Offshore Wind Energy and Food (Seaweed). The other group will focus on limitations and opportunities when working together in fish and fish/shellfish farming)
10.45-11.45	Sessions round 1 Group 1.1: Offshore Wind Energy, Food (seaweed) and Stranded assets Chair: Jaap van Hal, ECN Biomass Notes: Harald van der Mijle Meijer, ECN Wind Energy
	Sessions round 1 Group 1.2: Offshore Wind Energy and Fish and fish/shellfish farming Chair: Peter Eecen, ECN Wind Energy Notes: Lesly Barton-Stam, ECN Wind Energy
11.45-12.15	Plenary reporting by Group 1.1: Jaap van Hal, ECN Biomass Group 1.2: Peter Eecen, ECN Wind Energy
12.15-13.00	Lunch
13.00-14.00	Sessions round 2 Group 2.1: Offshore Wind Energy, Nature building and Stranded assets Chair: Jaap van Hal, ECN Biomass Notes: Lesly Barton-Stam, ECN Wind Energy
	Sessions round 2 Group 2.2: Offshore Wind Energy , Floating Solar Power and additional synergies food Chair: Hans Verhoef, ECN Wind Energy Notes: Harald van der Mijle Meijer, ECN Wind Energy
14.00-14.30	Plenary reporting by Group 2.1: Jaap van Hal, ECN Biomass Group 2.2: Hans Verhoef, ECN Wind Energy
14.30-15.00	Break
15.00-16.30	Wrap-up and sharing ideas which support multifunctional use of the North Sea (with the possibility for short presentations)

	Presentation by Saskia Jaarsma, Tennet Presentation by Joost Wouter, Inrada Group/Seatech Energy Presentation by Harald van der Mijle Meijer, ECN Wind Energy

Participants

Voornaam	Achternaam	Bedrijf/Instituut
Lesly	Barton-Stam	ECN wind energy
Eef	Brouwers	Stichting Noordzeeboerderij
Bernadette	Castro	Algaemech
Anouk	Dijkman	ECN Wind Energy
Pepijn	Docter	Siemens Gamesa Renewable Energy B.V.
Peter	Eecen	ECN Wind Energy
Anouk	Florentinus	Nuon/Vattenfall
Tijmen	Gombert	Temporary Works Design
Wesley	de Groot	Temporary Works Design
Susanne	Hagen	Natuur & Milieu
Jaap	van Hal	ECN Biomassa
Guido	Hommel	Nederlandse WindEnergie Associatie
Saskia	Jaarsma	Tennet
Robbert	Jak	Wageningen Marine Research
Lasse Fast	Jensen	Vattenvall
Josine	Kelling	Oceans of Energy
Tim	Van Keulen	Boskalis
Wouter	Knap	KNMI
Bob	Meijer	TKI Wind op Zee
Harald	Van der Mijle Meijerr	ECN Wind Energy
Saskia	Mulder	Royal Haskoning
Hans	Verhoef	ECN Wind Energy
Noor	Visser	VisNed
Pim	Visser	VisNed
Desirée	van der Vliet	Rijkswaterstaat, afdeling vergunningverlening Zee en Delta
Marije	Wassink	Rijkswaterstaat
Ine	Wijnant	KNMI
Joost	Wouters	Inrada Group/SeatechEnergy
George	Wurpel	MSG Sustainable Strategies

Annex II

MacroFuels Final Conference – Brussels

Location: EURATEX, Rue Montoyer 24, 1000 Bruxelles, Belgium

Programme

Wednesday, 13th November 2019, Euratex, Brussels	
09:00-09:30	**Welcome & Coffee**
09:30-09:45	**Welcome by Anne-Belinda Bjerre (DTI), Coordinator 'MacroFuels'**
09:45-10:15	**Goals of bioenergy and biofuels R&I funding: The European viewpoint – Thomas Schleker, European Commission DG RTD**
10:15-10:45	**MacroFuels – A Success Story 'Made in Europe'** Project coordinator Anne-Belinda Bjerre will give an overview over the MacroFuels concept for a seaweed-to-biofuels value chain and the innovation highlights achieved during the project.
10:45-11:00 Coffee	
11:00-11:30	**MacroFuels for decarbonizing transport - Fuel performance and engine tests – Jaap van Hal, TNO & Sten Frandsen, DTI**
11:30-12:15	**Sustainability aspects of large-scale seaweed cultivation – Part 1** - Environment / Annette Bruhn, AU - Social & regional aspects / Rita Clancy, Eurida
12:15-13:15 Lunch	
13:15-13:45	**Oceans 2050 - Strategies for healthy oceans – Iain Shepherd, DG MARE**
13:45-14:30	**Sustainability aspects of the MacroFuels concept – Part 2** Techno-economics, environmental life cycle impacts and overall sustainability – Jan Wilco Dijkstra, TNO & Jamal Miah, ERM
14:30-15:00 Coffee	
15:00-16:15	**Panel discussion: The role of seaweed and seaweed-based fuels for a sustainable bioeconomy and a cleaner planet** Panelists: Thomas Schleker (DG RTD), Iain Shepherd (DG MARE), Alexandra Neyts (EATIP Aquaculture), Berta Matas Güell (SINTEF), Anne Belinda Bjerre (DTI), Jaap van Hal (TNO), Annette Bruhn (AU) Discussion lead: Bert Groenendaal & Rita Clancy
16:15	**Conclusions by Jaap van Hal (TNO)**
16:30-17:00	**Press Conference** *Afterwards: Wine & Talk*

Annex III

MacroFuels Stakeholder Conference
25th May 2018 at SAMS, Oban, Scotland/UK

Programme

10 am - Boat Trip to the SAMS Seaweed Farm and a nearby salmon farm (about 2 hrs)
In a boat trip, MacroFuels scientists show the SAMS seaweed farm and a nearby salmon farm and will explain the principles of seaweed cultivation. They answer questions around seaweed, its usage for everyday products and opportunities for the bioeconomy and the marine environment.

12.30 pm *Lunch at the SAMS premises*

13.15 pm **The State of the Seaweed Industry in Scotland**
Walter Spiers, Scottish Seaweed Industry Association

13.30 pm **The future of seaweed farming in Scotland - The MacroFuels Vision**
Bert Groenendaal, SIOEN Industries

13.45 pm **Environmental and Sustainability Aspects in Seaweed Cultivation**
Dr. Adrian Macleod, SAMS

14.00 pm **Focus groups discussions about the future of seaweed in Argyll and Bute**

Conference participants share their views with scientists from GENIALG and MacroFuels and their perspectives on the future of seaweed industries in Scotland.
Aim is to learn about stakeholders' expectations, hopes and concerns and provide a forum in which researchers can directly answer the questions non-scientists have about the future of seaweed farming in Argyll and Bute and Scotland in general.

16.30 pm **End of the Conference**