Policy briefs and strategy papers with recommendations for policy making – Issue 2

MacroFuels Project
H2020-LCE-11-2015

Rita Clancy, EURIDA
Annette Bruhn, AU
Adrian Macleod, SAMS
Deliverable D7.7

Work package 7

Version: Final/ 18th December 2019

Project number: 654010

Deliverable No. 7.7

Dissemination Level		
PU	Public	X

Nature		
R	Report	X

Deliverable Details			
Due date:	30th June 2019		
Submission date:	18th Dec 2019		
Involved participants:	Rita Clancy	EURIDA	
	Annette Bruhn	AU	
	Adrian Macleod	SAMS	
WP no. and title:	WP7 'Dissemination, communication and exploitation'		
WP leader:	Rita Clancy, EURIDA		
Task no. and title:	Task 7.7 Provide a knowledge base for policy makers		
Version/Date	Final/18th December 2019		
Keywords:	Seaweed Cultivation, Sustainable Aquaculture, Environmental Impact, Policy, Sustainability, Decision Making, Policy Brief, Risk Assessment		
Addendum: Justification of deliverable delay and exclusion of techno-economic assessment results.	Originally, deliverable D7.7 was scheduled for M42. The results of the environmental impact assessment of the MacroFuels seaweed cultivation concept were an essential basis for this report around the strategy paper on techno-economic, environmental and social assessment results designed and provided to policy makers on national and EU level. The delay of the environmental data collection and their evaluation did not only delay the delivery of deliverable D6.5, but also delayed this deliverable 7.7. until 18th Dec 2019, the final date of submission. Furthermore, the results of the techno-economic assessment were flagged confidential by the owner TNO and the Exploitation Officer, Bert Groenendaal, respectively due to included details on technology and conversion processes which have been assessed to be Key Exploitable Results, either for follow-up projects or direct commercial exploitation. The techno-economic results were therefore excluded from this public report and the strategy papers (further referred to as Policy Briefs) on environmental and social and regional aspects of the seaweed to fuels value chain.		

Summary

This report represents the Deliverable 7.7 with the core being two enclosed strategy papers (aka Policy Briefs) for national and EU level policy making based on environmental and social assessment results targeted at policy makers on national and EU level.

This deliverable was created in Task 7.7 of MacroFuels and summarizes selected results and knowledge gained from the local environmental and ecosystem as well as the social impact and risk assessments, performed by partners Aarhus University/AU and the Scottish Association for Marine Sciences/SAMS (environmental impacts and risks) and Rita Clancy/EURIDA (social) as part of WP6. It furthermore converts results into conclusions and recommendations for policymakers. Objective is to support the development of sustainable practices in large-scale seaweed aquaculture in Europe by providing knowledge generated during MacroFuels to support future decision making. This is essential for securing a sustainable development of a bioeconomy that is based on seaweed as aquatic biomass.

The conclusions and recommendations have been drawn from the results and data gained during the 48 months of MacroFuels, as well as their expected implications for future European strategies on large-scale seaweed aquaculture and seaweed-to-fuel value chains. They are presented by means of two Policy Briefs, which are included in this deliverable report (as Annex I and II). The briefs shall be used in communication and dissemination to policy makers at European as well as national, regional and global level. The briefs will furthermore be available for download at http://www.macrofuels.eu/results-publications.

The major objectives of the policy briefs are:

(1) To highlight the potential of seaweed as sustainable biomass for advanced fuels, provided it is cultivated, managed, processed and converted in sustainable ways.
(2) To emphasise the possible effects, positive and negative, that large-scale seaweed aquaculture may have on the marine environment.
(3) To give recommendations for policy makers to secure that future activities are based on aquaculture management practices that guarantee the sustainability of seaweed as biomass and mitigate possible unwanted environmental effects, and
(4) To highlight the identified knowledge gaps between research and the sustainable take up of seaweed aquaculture by the private bioeconomy sector and recommend further action needed to improve our understanding of seaweed aquaculture and ocean interactions.
(5) To outline the social implications and regional aspects of large-scale seaweed cultivation, fuel conversion processes and technologies and the usage of seaweed-based fuels as possible solutions to decarbonise the transport and aviation sectors.
(6) To give recommendations on social risk mitigation strategies to promote a socially accepted seaweed-to-fuels value chain in Europe.

Contents

1. INTRODUCTION

Informing stakeholders and policy makers about the latest findings on the sustainability of small- to large-scale seaweed aquaculture, its potential impact on the marine environment and its ecosystem and the social implications, especially for coastal regions and communities is an important aim of MacroFuels.

As part of the overall sustainability assessment of the seaweed-to-fuel value chain, a strong focus has been put on the impacts that especially large-scale seaweed cultivation might have on the marine environment and coastal residents. Besides the potential of a seaweed-to-fuel value chain to create environmental and social benefits the work revealed remaining knowledge gaps, especially for understanding the ecosystem impact of large-scale cultivation systems and social risks that result from the envisaged industrialisation of often remote areas. More research and development as well as cooperation and public dialogues will be needed to close existing knowledge gaps to be able to develop sustainable seaweed-based value chains. This is relevant for a potential future seaweed-based biofuel sector, but also for other fields that could strongly benefit from seaweed as sustainable aquatic biomass, i.e. biomaterials, food and feed, pharmaceuticals and nutraceuticals, and cosmetics. Understanding the environmental impacts of seaweed will also be of relevance for future climate change mitigation and ocean health strategies. To understand and maximise the social benefits while minimising and/or mitigating the social risks will further help to develop a strong seaweed bioeconomy in Europe that is publicly accepted and supported by a wide range of stakeholders.

Discussions have been held recently about the potential of seaweeds for climate change mitigation due to their ability to absorb CO2 from the seawater and their potential role in bioremediation based on their levels of nutrient uptake. However, very few systematic insights and verified data are available that underpin the true potential of seaweed in this context. The Policy Brief on environmental impacts of large-scale seaweed cultivation therefore aims to provide evidence to support public discussions based on realistic expectations.

Deliverable 7.7 consists of two policy briefs, which have been created within Task 7.7 ‘Provide a knowledge base for policy makers’. The briefs summarise selected research results from the environmental and social assessments and transfers them into conclusions and recommendations for policymakers. The aim is to help safeguarding a sustainable seaweed aquaculture in Europe as basis for a novel and sustainable field within the bioeconomy.

This Deliverable is the second output of Task 7.7 (Provide a knowledge base for policy makers) in MacroFuels and contributes to the project’s dissemination, communication and impact maximization strategy. All activities are based on the MacroFuels stakeholder engagement and knowledge transfer implementation strategy, which is outlined in detail as part of Deliverable 7.3 (“Stakeholder engagement events and results’ evaluation report – Issue 1”).

2. The Policy Briefs

The first Policy Brief is titled ***'The Environmental Impacts of Large-Scale Seaweed Cultivation'*** and summarises findings and recommendations from the MacroFuels Horizon 2020 research and innovation project.

The brief gives an overview of the challenges and key findings of sustainable seaweed production and the impact of large-scale cultivation on the environment and the ecosystem as they resulted from research and assessment activities within the 48 months of the MacroFuels project. It links the progress made in MacroFuels and results and data from the project's small-scale seaweed test farms towards expected impacts that might results from process upscaling. The brief furthermore incorporates knowledge gained in related projects, e.g. on seaweed, sustainable aquaculture, multi-use of the ocean space and integrated multi-trophic aquaculture (IMTA).

Recommendations are listed for policy makers for future activities, based on identified knowledge gaps in environmental benefits and risks. Recommendations include the need for agreements on acceptable levels of change and environmental impacts and on future monitoring requirements for seaweed farms as part of licensing. Solutions will have to be found that protect the environment and at the same time allow for economic endeavours that are not hampered by data rich, but information poor monitoring needs that do not reflect the actual environmental risks that seaweed cultivation poses on the ecosystem.

The full Policy Brief is enclosed in this deliverable report as Annex I.

The second Policy Brief is titled ***'Future sustainable seaweed industries in Europe - Social and regional aspects'*** and presents the results of a Social Life Cycle Assessment, and the potentially negative as well as positive social and regional effects of the MacroFuels value chain.

Also for the social aspects recommendations are listed for policy makers for future activities, in particular to maximise the social benefits on the one hand and to avoid or mitigate social risks on the other hand. Recommendations include the careful and stepwise upscaling of seaweed industries, the involvement of coastal communities and civil society representatives during the planning and upscaling of seaweed cultivation and related processing industries, the development and/or compliance of and with social and other sustainability standards along the whole value chain and the initiation of systematic dailogues with other ocean users(e.g. fishermen, wind park operators etc.) to create synergies and avoid competition over the ocean space.

3. Conclusions

Key findings of the MacroFuels project have been provided in the policy brief presented in this Deliverable.

MacroFuels, respectively its consortium partners during their research have identified a number of gaps, problems, and potential measures for policy makers to facilitate future activities in supporting large-scale seaweed production for biofuels and other high value products, such as biochemicals, feed, food, pharmaceuticals, cosmetics and fertilizers that maximise the environmental benefits and minimise the risks.

The need for evidence-based policy decision making and sector management is paramount across all the following policy recommendations, which should be acknowledged as essential components of establishing the balance between developing the seaweed-based bioeconomy sectors and the protection of the marine space.

During the MacroFuels project it became evident that sound cultivation site selection is an essential factor in the extent of environmental and ecosystem as well as social and regional impacts of seaweed farms and the processing industries.

As regards environmental sustainability, more research is needed to fully understand the positive as well as negative environmental impacts that large-scale seaweed cultivation might have at local levels as, depending on the geological, geographic and hydrological pre-conditions of a location, the effects of seaweed cultivation could either result in a positive or a negative impact. This improved understanding is essential to be able to maximise environmental benefits and to avoid possible environmental damage when selecting cultivation sites and seaweed production practices.

To promote the establishment of a sustainable seaweed-based industry, the following recommendations have been given to policy makers by means of two Policy Briefs (included in this deliverable report as Annex I and II):

- To establish consent for large-scale cultivation projects, authorities need to implement ‘acceptable’ thresholds of environmental change and aim for social licenses for operations.

- Develop and test coupled hydrological/ecological modelling as site selection tools for predicting yields and impacts and to maximise benefits for coastal residents, for example in areas that are vulnerable to erosion while avoiding negative changes to living environments.

- Establish standards for best cultivation practice, including baseline surveys (BACI), monitoring guidelines, material standards, education and social responsibility of cultivators and processing industries

- Establish large-scale test farms in relevant environments, possible as part of multi-use platforms to avoid the social risk of competition over the marine space and to assure access to resources

- Locate future cultivation sites beyond depth limits of natural benthic vegetation

- Protect local biodiversity by cultivating only native species and local genetic cultivars (or apply precautionary approach prior to allowing cultivation of non-native species and non-local cultivars)

- Develop and validate indicators for evaluating impact on biodiversity at the levels of ecosystems, species and genes

- Establish knowledge bases for local genetic variation of crop species and prevalence of seaweed diseases and pests

- Develop and test Marine Strategy Framework Directive indicators for use in evaluating effects of seaweed cultivation om the marine environment

- Engage in continuous dialogues with various stakeholders, including coastal residents, representatives of civil society and local authorities to develop sustainable seaweed industries and create long term benefit for everyone involved

ACKNOWLEDGEMENT

This deliverable is part of the MacroFuels project. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654010.

Annex I

Policy Brief

The Environmental Impacts of Large-Scale Seaweed Cultivation

MacroFuelsProject

POLICYBRIEF

The Environmental Impacts of Large-Scale Seaweed Cultivation

Findings and recommendations from the MacroFuels Horizon 2020 research and innovation project (www.macrofuels.eu)

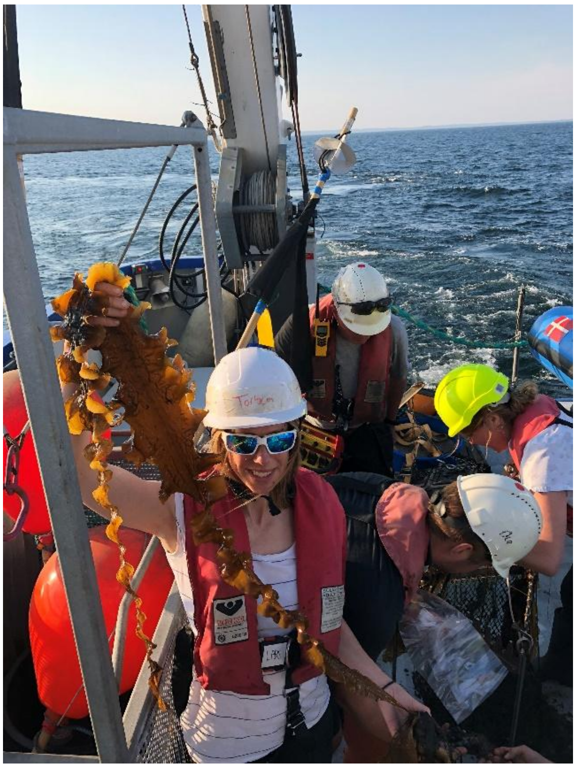
Key Messages

1. Environmental effects of seaweed cultivation are **site and scale dependent**
2. Seaweed production may contribute to **climate change mitigation**
3. Nutrient uptake of seaweed production may **counteract eutrophication**
4. **Site selection and management** are crucial for optimising ecosystem services and minimizing risks
5. **Best practice guidelines** need to be defined
6. **Thresholds of acceptable impacts** need to be defined
7. **Impacts on biodiversity and biosecurity** of large-scale seaweed cultivation needs further investigations, and calls for exercising the precautionary approach

European seaweed cultivation at large scale

Seaweed cultivation if properly managed can provide ecosystem services whilst developing marine resources currently underexploited throughout Europe.

Seaweed for fuels, feed, food and value added products is advancing in Europe. Complementing or substituting land-based crops with seaweeds – in particular for fuels and feed, calls for large-scale* production. Cultivation of seaweeds requires space at sea, but no land-use, no freshwater, no fertilizer and no pesticides. European North Atlantic waters are well suited for cultivation of large brown seaweeds (kelps). Kelps can be seeded onto cultivation substrates, such as ropes or nets, and the kelp grows in the sea from autumn to early summer. Seaweed cultivation is a young technology in Europe, and the processes and materials involved are undergoing rapid development towards higher product yields and quality, and lower costs and impact. Deploying seaweed cultivation systems and cultivating seaweeds in the sea has impact on the local marine environment. With optimal site selection and good management practice, large-scale seaweed cultivation has the potential to deliver important ecosystem services such as climate change mitigation, bioremediation of eutrophication and protection of coastal areas. Potential risks include loss of materials, spreading of non-native species, diseases and pest, and genetic depression of local seaweed populations. The nature and scale of impacts and risks will depend on the cultivation site selected and site management.



*Large-scale seaweed cultivation is presently defined as more than 50 longlines of each 200 m (Marine Scotland, 2017).

Environmental impacts and risks

Lately, many positive environmental impacts of seaweed have been discussed in the general media and by seaweed enthusiasts. While many effects can be verified and quantified, for example the ability of seaweed to capture CO_2 and excess nutrients while growing without any fresh water, arable land or fertilizer, the full environmental impacts of a large-scale seaweed production site are still largely unknown. MacroFuels collected and evaluated environmental data from the project's seaweed test farms, aiming to contribute to the improved understanding of the complex environmental interactions of large-scale seaweed cultivation (see Fig 1).

1. CO_2 uptake – climate change mitigation

Like plants on land, seaweeds live through photosynthesis, using sunlight to convert CO_2 into hydrocarbons (sugars) for growth. The sugars can be used to produce climate-neutral fuels for substituting fossil fuels. The CO_2 uptake of seaweeds is equivalent to approximately 1.3 ton of CO_2 per ton of seaweed dry matter. Only a minor fraction of the CO_2 taken up by seaweeds is sequestered. Two other beneficial consequences of the seaweed photosynthesis is the production of oxygen, which is needed by marine animals and counteracts ocean de-oxygenation, and increase of sea water pH, which counteracts ocean acidification. Seaweeds however also emit other climate active gasses such as halocarbons, dimethylsulphide (DMS) and nitrous oxide. More research is needed to document the scale and consequences.

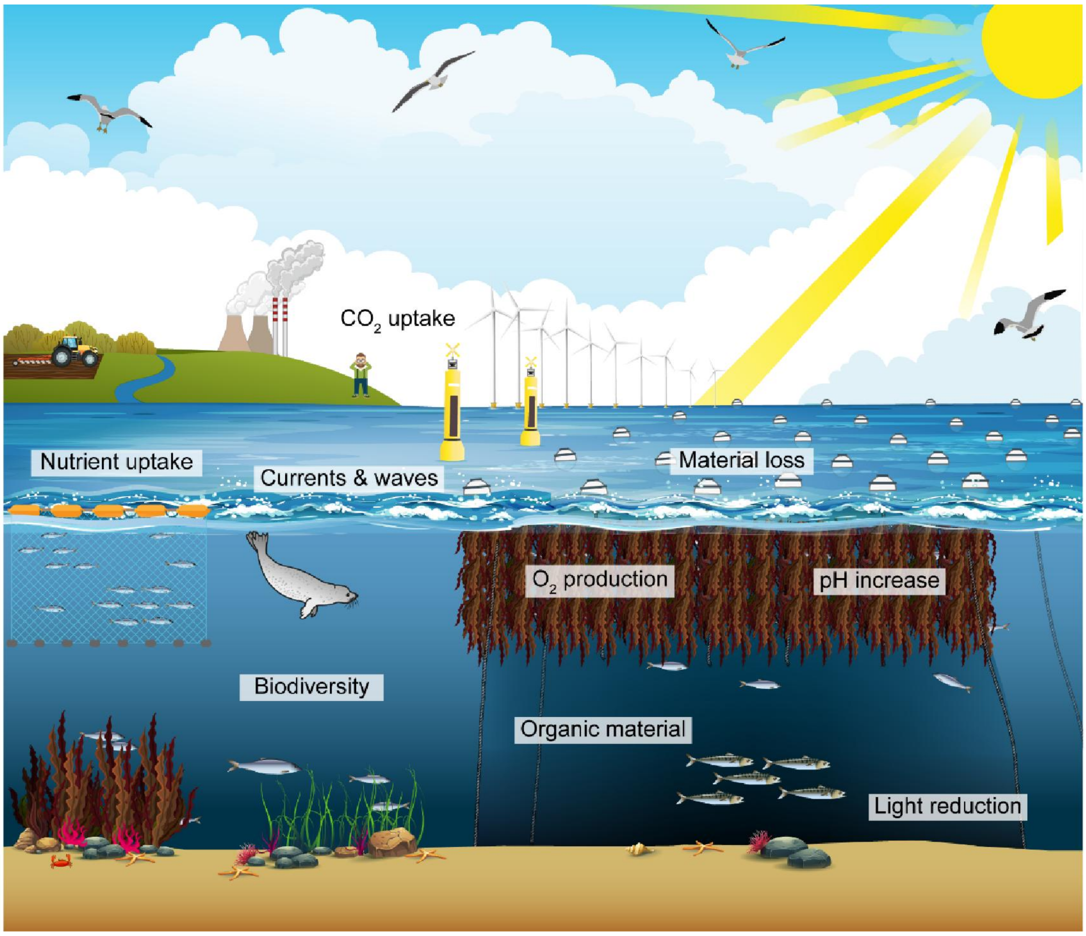


Fig 1 The complex environmental interactions of a large-scale seaweed farm

2. Nutrient uptake – counteracting eutrophication

Seaweeds need nutrients to grow, and efficiently take up nitrogen and phosphorus from the surrounding sea water. When harvesting the seaweeds, nutrients are removed from the marine system and made available for the bio-economical system on land (5-60 kg N per ton of seaweed dry matter). In most European coastal waters, nutrient emissions from human activities on land and aquaculture lead to eutrophication and reduced marine environmental quality. The EU Water Framework Directive demands accelerating the recovery of marine ecosystems from eutrophication. In eutrophic areas, seaweed cultivation could counterbalance the anthropogenic inputs of nutrients. In nutrient-poor marine areas however, competition for nutrients may limit seaweed productivity whilst having a negative impact on natural marine ecosystems. Site selection based on coupled hydrological-ecological modelling is needed to select the best sites for growing seaweed and offer ecosystem services.

3. Biodiversity

Introducing a seaweed cultivation system into the marine environment will increase the habitat complexity. The cultivation structure itself, as well as the seaweeds when growing, will provide feed, shelter and substrate for mobile and sessile marine organisms, increasing the local biodiversity. However, also "unwanted" species – non-native species, diseases and parasites – may use the cultivation systems as stepping stones for further dispersal. Intensive cultivation of a seaweed mono-crop may in itself contribute to spreading of seaweed diseases and pests also to natural seaweed populations. Regarding genetic diversity, caution should be taken not to introduce and cultivate non-local cultivars, as spreading of genes to local populations cannot at present be avoided, and may reduce fitness of the local ecotypes. The industry to date has adopted precautionary practices that mitigate the above risks. Regulators should carefully consider the benefits of seaweed aquaculture and where possible incentivise projects that use cultivation systems and management practices to produce quantifiable benefits to local biodiversity and ecosystem services. This approach also has a vast potential in synergy with other marine activities (e.g. Integrated Multitrophic Aquaculture Approach, multi-use energy/biomass platforms).

4. Reduction of light to the seafloor

A "hanging seaweed forest" in the surface waters will absorb a fraction of the incoming light, and hence reduce the input of light to the sea floor for natural populations of seagrass, seaweeds and benthic microalgae. The impact will depend on the scale and density of the cultivation. Good site selection as well as placing of cultivation areas beyond the depth limits of natural benthic vegetation will minimize negative impact.

5. Loss of synthetic materials

Cultivation materials are typically produced from durable synthetic materials such as nylon and polypropylene. Loss of material is difficult to fully prevent, and may cause damage to maritime activities or to marine animals, due to entangling or consumption. Standards and regulations for site management, as for other aquaculture activities, will minimize the risk.

6. Loss of organic material

During growth, the seaweeds will naturally loose dissolved and particulate organic material to the environment. Some of this will stimulate the production of the local food web in the water column and in the sediment beneath the seaweed, and some may be buried in the seabed. If larger amounts of organic material are accumulated in depositional areas, local oxygen deficiency and impoverishment of the benthic biodiversity may occur. Site selection and site management will contribute to minimizing risks of negative impact.

7. Local current and wave patterns

Seaweed cultivation structures will influence the local hydrology (current patterns and wave action). This may affect the water exchange inside the cultivation area, and with this the access of the seaweeds to nutrients, the local patterns of sediment transport, the coastline, as well as the structure and productivity of local marine food webs. Site selection based on hydrological modelling will contribute to minimizing risks of negative impact.

- ✓ Uptake of CO_2 – climate change mitigation
- ✓ Production of oxygen – counteracting ocean de-oxygenation
- ✓ Local increase of pH – counteracting ocean acidification
- ✓ Uptake of nutrients – counteracting eutrophication
- ✓ Increase of species diversity
- – Changing local patterns of currents and waves
- – Increased sedimentation of organic material
- – Reduction of light to the seafloor
- ✗ Risks of spreading of non-native/harmful species
- ✗ Emissions of other greenhouse gasses
- ✗ Loss of synthetic material

Environmental Risk Mitigation and Monitoring Needs

1. Definition of acceptable change

Seaweed cultivation at large-scale will alter many of the physical, biological, chemical characteristics of the environment. With proper site selection, many of these changes could be considered positive. However, as with other types of aquaculture there are risks of negative impacts. Authorities must define the thresholds for acceptable impact to ensure the carrying capacity of the environments suitable for cultivation are not exceeded and natural resources are managed effectively.

2. Site selection

Impacts on the local marine environment of large-scale seaweed cultivation will depend on the local conditions of geology, hydrology and ecology. Development of systematic site selection tools based on hydrological and ecological modelling will be crucial to optimize production and ecosystem services, in order to benefit from positive impacts and minimize negative impacts.

3. Best cultivation practice

Standards and regulations needs to be developed for a 'Best Cultivation Practice' for establishing and operating seaweed cultivation systems. Standards and regulations should include: Site selection, baseline surveys, selection of structure and materials, site management, monitoring practice, education. Monitoring programs should be customized to the scale of cultivation and avoid the costly collection of "data-rich, information-poor" (DRIP) data, while still securing documentation of positive and negative environmental change.

4. Biosecurity programs

The largest potential risk on the local marine environment is the spreading of non-native or harmful species such as seaweed diseases and pests to natural seaweed populations, or the introduction and spreading of genes from non-local cultivars that outperform local genes in the short run, but in the long run cause genetic depression and reduced fitness of local cultivars. Baseline knowledge of local species and genetic diversity needs to be established, including prevalence of non-native species, seaweed diseases and pests. Development of biosecurity programs including rapid diagnostic tools, and quarantine procedures must be included in future standards and regulations.

- ✓ Thresholds for acceptable change
- ✓ Site selection and site selection tools
- ✓ Best cultivation practice (education, standards for material selection, maintenance, timing of processes)
- ✓ Biosecurity: No cultivation of non-native species, only cultivation of local ecotypes

Knowledge gaps

- ✗ Impact dependency on site and scale
- ✗ Validated Marine Strategy Framework Directive indicators for assessing environmental status in cultivated seaweed systems, including biodiversity at the levels of ecosystems, species and genes
- ✗ Physical changes to coastal hydrography
- ✗ Local, regional and global changes to environmental chemistry, including seaweed emissions of greenhouse gasses
- ✗ Biosecurity planning for seaweed, i.e. seaweed diseases and pest – prevalence, diagnostic tools, quarantine procedures

Recommendations for further reading:

Campbell I, Macleod A, Sahlmann C, Neves L, Funderud J, Øverland M, Hughes AD, Stanley M (2019) **The environmental risks associated with the development of seaweed farming in Europe - Prioritizing key knowledge gaps**. Frontiers in Marine Science 6 (107). doi:10.3389/fmars.2019.00107

Barbier B, Charrier B, Araujo R, Holdt SL, Jacquemin B, Rebours C (2019) **PEGASUS - Phycomorph European Guidelines for a SUstainable Aquaculture of Seaweeds**. doi:doi.org/10.21411/2c3w-yc73

Cottier-Cook E, Nagabhatla N, Badis Y, Campbell ML, Chopin T, Dai W, Fang J, He P, Hewitt CL, Kim GH, Huo Y, Jiang Z, Kema G, Li Y, Liu F, Liu H, Liu Y, Lu Q, Luo Q, Mao Y, Msuya FE, Rebours C, Shen H, Stentiford GD, Yarish C, Wu H, Yang X, Zhang J, Zhou Y, Gachon MM (2016) **Safeguarding the future of the global seaweed aquaculture industry**. Institute for Water, Environment and Health

POLICY RECOMMENDATIONS

1. To establish consent for large-scale cultivation projects, authorities need to implement ‘acceptable’ thresholds of environmental change
2. Develop and test coupled hydrological/ecological modelling as site selection tools for predicting yields and impacts
3. Establish standards for best cultivation practice, including baseline surveys (BACI), monitoring guidelines, material standards, education
4. Establish large-scale test farms in relevant environments, possibly as part of multi-use platforms
5. Locate future cultivation sites beyond depth limits of natural benthic vegetation
6. Protect local biodiversity by cultivating only native species and local genetic cultivars (**or** apply precautionary approach prior to allowing cultivation of non-native species and non-local cultivars)
7. Develop and validate indicators for evaluating impact on biodiversity at the levels of ecosystems, species and genes
8. Establish knowledge bases for local genetic variation of crop species and prevalence of seaweed diseases and pests
9. Develop and test Marine Strategy Framework Directive indicators for use in evaluating effects of seaweed cultivation om the marine environment

MACROFUELS

www.macrofuels.eu

If you have any further questions and for further discussions, please contact us at:

r.clancy@eurida-research.com

Main contact: Rita Clancy, MacroFuels Communication Officer
Tel.: +43 (0) 663 0324 4114

Horizon 2020
European Union Funding
for Research & Innovation

This policy brief is part of the MacroFuels project. This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 654010.

Project Identity

Coordinators

Prof. Dr. Anne-Belinda Bjerre (Coordinator), anbj@teknologisk.dk
Danish Technological Institute, Denmark www.teknologisk.dk

Dr. Jaap van Hal (Project Executive), jaap.vanhal@tno.nl
ECN part of TNO, The Netherlands
https://www.tno.nl/en/focus-areas/energy/ecn-part-of-tno/

Communication

Rita Clancy (Dissemination Officer), r.clancy@eurida-research.com
EURIDA Research Management, Germany www.eurida-research.com

Dr. Bert Groenendaal (Exploitation Officer), bert.groenendaal@sioen.com
SIOEN Industries, Belgium https://sioen.com/en

European Commission

Agata Przadka, Innovation and Networks Executive Agency (INEA)

Consortium

TEKNOLOGISK INSTITUT · ECN › TNO innovation for life · WAGENINGEN UNIVERSITY & RESEARCH · avantium · SAMS · SIOEN INDUSTRIES · ERM · EURIDA Research Management · AARHUS UNIVERSITY DEPARTMENT OF BIOSCIENCE · matís · FERMENTATIONEXPERTS - for your health

Duration

January 2016 – December 2019

Budget

EU Contribution: 5 999 892,50 €

Website

All MacroFuels Policy Briefs, fact sheets and other publications are available at: https://www.macrofuels.eu/results-publications.

Annex II

Policy Brief

Future sustainable seaweed industries in Europe - Social and regional aspects

MacroFuels Project

POLICYBRIEF

Future sustainable seaweed industries in Europe - Social and regional aspects

Findings and recommendations from the MacroFuels Horizon 2020 research and innovation project (www.macrofuels.eu)

Key Messages

1. Sustainable seaweed industries can have highly positive effects like economic growth and work place creation in rural areas.
2. Positive effects on climate and environment, incl. transport decarbonisation, can result in healthier living environments for coastal communities and society at large.
3. Upscaling and industrialising seaweed cultivation and processing can change the public perception of a seaweed-based bioeconomy and lead to resistance, due to noise and visual pollution, influx of a non-local workforce and unwanted changes to communities.
4. Dialogues with coastal communities provide outside-in perspectives and valuable knowledge on local environments and economic opportunities to maximise social impacts and avoid unnecessary risks for seaweed industries.

The prospect of a seaweed industry in Europe

Seaweed production is undergoing global expansion. With an annual production of 30.4 million tons in 2015 and a predicted growth rate of 8-9% per year[1], cultivated seaweed has been responsible for 29.4 million tons of the overall supply. The large majority of cultivated seaweed is currently being produced outside Europe, *e.g.* in China, Indonesia, Korea and the Philippines. In Europe, seaweed cultivation is in its infancy with the majority of seaweeds cultivated at small scale and mostly for artisan products. Europe, however, faces a growing demand for seaweed, either as "superfood" or as resource for novel animal feed, biomaterials, cosmetics or nutra- and pharmaceuticals, which cannot be met by wild harvest in a sustainable way.

With the urgent need to decarbonise the transport sector the EU recently called for the use of seaweed as a source of renewable energy, stating that: "Advanced biofuels, sourced from seaweed or certain types of waste, should represent at least 2.5% of energy consumption in transport by 2020"[2]. MacroFuels established successful routes for advanced fuels from seaweed and assessed the sustainability of the seaweed-to-fuels value chains with social and regional impacts as one of the sustainability categories.

Social and regional aspects of a seaweed-to fuel value chain in Europe

To establish a sustainable seaweed industry in Europe, a multitude of social impacts, potentially positive and negative, have to be considered. Strategies to maximise societal benefits and to minimise possible social risks are needed. Furthermore wide public acceptance towards a seaweed industry in Europe will be vital. This includes novel seaweed-based products as well as industry-scale production processes. So far both, social impacts and public perception towards seaweed are assumed to be widely positive due to the perceived potential for a sustainable bio-based economy and the 'green', environmentally benign reputation of the biomass. However, very few studies have been conducted to provide systematic insights into the social impacts of large-scale seaweed production and processing. The same applies to public attitudes towards seaweed. MacroFuels assessed a multitude of social and regional aspects and engaged in dialogues with specially set up Citizen Panels, composed by representatives of coastal communities at MacroFuels seaweed test farms (Scotland and Denmark).

Key Findings

Overall, the social impacts of an assumed mature MacroFuels seaweed-to-biofuel value chain are positive, for some impact categories even with the potential for highly positive effects. Assessments consider a value chain built on sound practice and cultivation site

[1] FAO, 2018.
[2] http://www.europarl.europa.eu/pdfs/news/expert/infopress/20130906IPR18831/20130906IPR18831_en.pdf

selection. Nevertheless, even with best practice, a few social risks remain with good mitigation options available for some, others will have to be socially accepted and/or consensus will have to be built.

Positive to highly positive social impacts

- ✓ **Economic growth.** Highly positive impacts can be expected in terms of economic growth, based on a growing seaweed-based industry. This has a particularly high relevance for coastal communities. The overall socio-economic impacts are expected to be more relevant in rather remote and rural areas than in already more industrialised regions. Establishing seaweed as biomass for advanced fuel could support the change towards a market pull for seaweed-based products. However, policies and the public will for seaweed-based fuels are needed to overcome the initial market barrier of fuel price.

- ✓ **Work place creation.** A large number of work places will be created in different work areas, requiring varying levels of qualification and training. With a growing demand of seaweed it is likely that further economic players that deploy seaweed as biomass (e.g. the food, feed, biomaterials, fertiliser and pharmaceutical industry) will settle near seaweed production sites. This will result in an even larger number of work places in the processing industry, including high quality and high salary work places in biotechnology, chemistry, engineering etc.

- ✓ **Fiscal revenues.** In a long term, economic growth and a multitude of opportunities for the bioeconomy could result in an improved economic status of coastal regions, especially through increasing fiscal revenues. However, this depends on local or regional development strategies (e.g. the inclusion of the blue economy in smart specialisation strategies) and policy support.

- ✓ **Decarbonising transport.** An overall positive impact at societal level can be expected from the decarbonisation of transport by advanced and sustainable biofuels. However, this effect depends on the actual sustainability performance of the biofuel in question.

- ✓ **Climate change and healthy living environment.** The effects of seaweeds' CO_2 and nutrient uptake, their ability to release oxygen in the ocean and their effect on biodiversity in large-scale cultivation systems could help to lower the societal burden resulting from climate change, improve the health of the ocean and coastal living environment and benefit coastal communities and other users of the ocean space, *e.g.* fishermen, other aquaculture, tourism.

- ✓ **Coastal protection.** Based on the effects on local wave energy and current patterns, seaweed cultivation structures if located in areas that have proven to be vulnerable towards coastal erosion, may help to dampen the wave energy and that way could help to prevent or decrease the extent of erosion by high wave energy. This could improve the living environment for coastal communities threatened by high erosion rates by the ocean.

- ✓ **Revival of rural areas.** Positive socio-cultural impacts result from an overall revival of rural areas and of regions that lack other economic specialisation opportunities since traditionally, in an economically thriving region infrastructure development follows. This is promoted by the growing need for infrastructures, such as public transport, medical care, schools, kindergartens etc. by a growing workforce (incl. commuters) and the likely influx of non-local workers.

✓ **Access to resources.** Expected impacts are highly positive as the cultivated biomass will for economic reasons not likely to be exclusively used for fuel production, but will represent a novel biomass for local and regional entrepreneurial activity. Existing local entrepreneurs currently self-employed in aquaculture (mussel farmers, seaweed entrepreneurs using wild harvest) could face new sources of income or opportunities for business growth and expansion.

✓ **Regional empowerment.** Highly positive longer-term effects are expected from a good financial status and diversified economic opportunities that often lead to regional empowerment at political levels. Sound regional development strategies could further increase the political influence of regions with a strong seaweed economy.

Social risks and mitigation strategies

A number of socially ambiguous effects and social risks emerge from large-scale seaweed cultivation, even if seaweed farms use best practices and carefully selected cultivation sites:

✗ **Changing public perception and growing resistance towards industrialisation.** Growing industrialisation, the mechanisation of seeding and harvesting and biorefineries/bioethanol plants could lead to public resistance, especially by coastal residents, caused by the fear of visual and noise pollution or the anticipated loss of recreational, touristic and property value in an industrialised area. Although dialogues with Citizen Panels revealed that levels of public acceptance towards seaweed industries rise with the prospects of local economic opportunities, the resistance against perceived negative effect could outweigh local support and pose a significant threat towards upscaling.

Mitigation strategies:

- ✓ Step-wise upscaling concepts and a consensus building process for the industrialisation of coastal communities that includes civil society
- ✓ Involvement of civil society representatives in the planning process as integral part of farming licenses (‘social licenses’; similar to ASC-MSC standards for seaweed farms).
- ✓ Local governance and co-operative business models
- ✓ Careful selection of seaweed cultivation sites, utilising abandoned infrastructure (buildings, processing plants, industrial sites) from fisheries & other forms of aquaculture

✗ **Low wage sectors and seasonal work.** Especially the area of seaweed cultivation and harvesting are traditionally labour intensive and, depending on cultivation practices, might include seasonal work (seeding and harvesting) and work places with low salaries (harvesting). Automated seeding and harvesting concepts could help to avoid those risks, but in itself could pose the risk of labour displacement.

Mitigation strategies:

- ✓ Farm licenses that include social standards for work places, collective agreements and minimum salaries.
- ✓ Social monitoring standards for seaweed farms operating at large scales

✘ **Influx of a non-local workforce.** In a growing seaweed industry, especially in regions with a limited local workforce available, the influx of a non-local workforce can be expected. This could pose a threat to the social cohesion and local culture of communities. Risks could be mitigated by sound integration strategies and measures for non-local residents, including living spaces, public meeting places *etc*. Further, the availability of a local workforce could be increased via targeted training and qualification programmes in seaweed cultivation and processing (as in-school programmes, academic courses, vocational training, internships *etc*.).

Mitigation strategies:

- ✓ Sound integration strategies and measures for non-local residents, including living spaces, public meeting places etc.
- ✓ Increase availability of a local workforce via targeted training and qualification programmes in seaweed cultivation and processing (in-school programmes, academic courses, vocational training, internships etc.).

✘ **Competition with fisheries and other users of the ocean.** The competition over the ocean space, e.g. with fisheries, leisure and tourism, wind parks, and other aquaculture represents a negative social impact.

Mitigation strategies:

- ✓ Focusing on co-use scenarios in which different forms of ocean usages are combined.
    1. combination with other forms of aquaculture, *e.g.* fish or mussel farms
    2. energy infrastructures, such as offshore wind parks, with seaweed cultivation.

✘ **Unwanted negative environmental effects.** Poor site selection or insufficient farming standards pose a social risk as this could lead to a negative environmental performance of seaweed farming, unwanted negative effects on hydrodynamics and an overall diminished living environment for coastal communities. This could further result in bad public perception of large-scale seaweed farming.

Mitigation strategies:

- ✓ Good site selection tools and farming standards
- ✓ Site selection for large-scale seaweed cultivation has to be based on smart decision-making systems and coupled hydrological-ecological modelling is needed.
- ✓ Education and training in best practices of seaweed cultivation and site selection

POLICY RECOMMENDATIONS

1. Step-wise upscaling concepts and a consensus building process for the industrialisation of coastal communities that includes civil society to maximise benefits and assure public acceptance towards a large-scale seaweed industry

2. Local governance and co-operative business models to give coastal regions a share in economic growth and to promote tailored development strategies

3. Carefully selected seaweed cultivation sites to maximise socio-economic and -environmental benefits and avoid risks emerging from seaweed farms placed in unsuited locations.

4. Utilising abandoned infrastructure (buildings, processing plants, industrial sites) from fisheries & other forms of aquaculture to avoid unnecessary land-use by the seaweed processing industry and potentially resulting public resistance.

5. Farm licenses that include social standards for work places, collective agreements and minimum salaries.

6. Increase the availability of a local workforce through training and qualification programmes in seaweed cultivation and processing.

7. Sound integration strategies and measures for a non-local workforce , including living spaces, public meeting places etc.

8. Focus on co-use scenarios in which different forms of ocean usages are combined to create synergies and avoid competition, e.g. with local fisheries.

9. Reinforce dialogues with societal stakeholders, such as local residents and fishermen in future seaweed cultivation areas, by making **social licenses** a mandatory part of each seaweed cultivation site license.

MacroFuels Engagement with Coastal Residents

MacroFuels puts strong focus on the social impacts and social acceptance of future seaweed-based industries. Therefore, we organize events that foster open discussions 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.

Our MacroFuels Citizen Event

10. During boat trips residents saw seaweed farms and got an impression about what a farm looks like, what work goes into it and how the seaweed grows on ropes and nets.

11. The MacroFuels vision and ideas for upscaling were openly shared and discussed.

12. Residents' expectations, concerns and hopes were collected during group discussions, compiled in a report which was basis for this Fact Sheet, and considered in MacroFuels concepts.

To find out more about MacroFuels stakeholder engagement, please read our public report available at

www.macrofuels.eu/results-publications

MACROFUELS

www.macrofuels.eu

If you have any further questions and for further discussions, please contact us at:

r.clancy@eurida-research.com

Main contact: Rita Clancy, MacroFuels Communication Officer
Tel.: +43 (0) 663 0324 4114

Horizon 2020
European Union Funding
for Research & Innovation

This policy brief is part of the MacroFuels project. This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654010.

Project Identity

Coordinators Prof. Dr. Anne-Belinda Bjerre (Coordinator), anbj@teknologisk.dk
Danish Technological Institute, Denmark www.teknologisk.dk

Dr. Jaap van Hal (Project Executive), jaap.vanhal@tno.nl
ECN part of TNO, The Netherlands
https://www.tno.nl/en/focus-areas/energy/ecn-part-of-tno/

Communication Rita Clancy (Dissemination Officer), r.clancy@eurida-research.com
EURIDA Research Management, Germany www.eurida-research.com

Dr. Bert Groenendaal (Exploitation Officer), bert.groenendaal@sioen.com
SIOEN Industries, Belgium https://sioen.com/en

European Commission Agata Przadka, Innovation and Networks Executive Agency (INEA)

Consortium

Duration January 2016 – December 2019

Budget EU Contribution: 5 999 892,50 €

Website All MacroFuels Policy Briefs, Fact Sheets and other publications are available at: https://www.macrofuels.eu/results-publications.