

Knowledge and data repository

MacroFuels

H2020-LCE-11-2015

Ilona van Zandvoort, Avantium

Rita Clancy, Eurida

Jan Wilco Dijkstra, TNO

Deliverable 7.4

Work package 7

Version: Revised / 20th February 2020

Project number: 654010

Deliverable No. 7.4

Project Operation Manual

History of Changes		
Version	Version Date	Changes
V1.0 - Final	18 th December 2019	Initial Version
V2.0 – Revised (this version)	20 th February 2020	<p>Page 3, 2nd paragraph, line 6: The previous link to the MacroFuels Fact Sheet website repository has been changed from www.macrofuels.eu/results-publications to www.macrofuels.eu/fact-sheets.</p> <p>Page 5, 1st paragraph, final line: The previous link to the MacroFuels Fact Sheet website repository has been changed from www.macrofuels.eu/results-publications to www.macrofuels.eu/fact-sheets.</p> <p>Page 6, 3rd paragraph, line 4: The previous link to the MacroFuels Fact Sheet website repository has been changed from www.macrofuels.eu/results-publications to www.macrofuels.eu/fact-sheets.</p> <p>All changes were caused by a revised website structure to increase the visibility and accessibility of the fact sheets and to make finding the fact sheets intuitive.</p>

Dissemination Level		
PU	Public	X
PP	Restricted to other program participants (incl. the Commission Services)	
RE	Restricted to a group specified by consortium (incl. the Commission Services)	
CO	Confidential, only for members of the consortium (incl. the Commission Services)	

Nature		
R	Report	
O	Other	X

Deliverable Details		
Due date:	30 November 2019	
Submission date:	18 December 2019	
Involved participants:	Author's Name	Institution
	Ilona van Zandvoort	Avantium
	Rita Clancy	Eurida
	Jan Wilco Dijkstra	TNO

WP no. and title:	WP 7. Dissemination, communication and exploitation		
WP leader:	Eurida		
Task no. and title:	7.5 Knowledge and data transfer		
Version/Date	18 December 2019		
Keywords:	Knowledge, data, stakeholder, communication, dissemination		

Summary

This report represents Deliverable 7.4 and is based on Task 7.5, which aimed to evaluate generated knowledge within MacroFuels for its potential to be shared with the relevant EU knowledge and stakeholder platforms. The report describes how MacroFuels made the generated knowledge and data (in all project areas: algae cultivation, treatment, storage, fuel production, sustainability and impact assessment) available to EU stakeholder platforms and the knowledge community, and shared it by means of a project knowledge repository.

Basis for the repository are selected formats for knowledge transfer, such as summary reports in non-technical language (further referred to as factsheets), strategy papers (by means of Policy Briefs), publications *etc.* All documents were proactively shared with representatives of EU platforms and stakeholder communities (among them DG MARE, EATIP Aquaculture, ETIP Bioenergy, KIC InnoEnergy). In addition, the documents are widely made accessible via in the project knowledge repository via <https://www.macrofuels.eu/fact-sheets>, which is promoted by social media. It should be noted that knowledge and data covered by intellectual property rights were excluded from the public documents and will be used for exploitation purposes.

Analysis of the best approach and suitable target groups/contacts for curation and sharing of knowledge started early in the project (around M12). Direct knowledge exchange additionally was performed during MacroFuels at conferences and via direct communication. These activities are further described in deliverable report D7.6 *Stakeholder engagement events and results' evaluation report – Issue 2*. The specific task of policy input by means of strategy papers and policy briefs is further described in the separate deliverable report 7.7 *Policy briefs and strategy papers with recommendations for policy making – Issue 2*, complementing this report D7.4.

In order to spread the knowledge among the scientific audience, data underlying the scientific papers that were published as part of MacroFuels, for example on seaweed composition, were or will be uploaded in relevant databases.

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1 Introduction

Preservation and transfer of MacroFuels expertise is essential for securing a sustainable development of a bioeconomy that is based on seaweed as aquatic biomass. Knowledge exchange is key for the MacroFuels project as our findings can support different stakeholders over the whole value chain of cultivated seaweed to bio-based fuels. For example: our environmental impact data for seaweed cultivation is relevant for different parties, including seaweed cultivators, environmental NGOs and policy makers. Therefore a project data repository is built, which includes scientific publications, non-technical reports (factsheets), policy briefs, informative video material *etc.* and is accessible via www.macrofuels.eu/fact-sheets.

Selection of suitable target stakeholders for curation and sharing of knowledge started early in the project (around M12). Direct knowledge exchange additionally was performed during MacroFuels at conferences and via direct communication, which is further described in deliverable report D7.6 *Stakeholder engagement events and results' evaluation report – Issue 2*. The specific task of policy input by means of strategy papers and policy briefs is further described in the separate deliverable report 7.7 *Policy briefs and strategy papers with recommendations for policy making – Issue 2*, complementing this report D7.4.

Selected knowledge and data gained in work package 1-6 was summarized and converted into five factsheets, which are an important part of this deliverable as they target a general, non-scientific audience. The factsheets are shared with platforms and stakeholders that are predominantly related to aquaculture, energy, biofuel, bio-economy and transport. Directly targeting European stakeholder groups and established knowledge communities supports spreading of knowledge and data, which is generated in research and innovation initiatives, among various stakeholders and helps to make the MacroFuels data accessible and understandable outside the scientific community. The factsheets are also openly accessible through the MacroFuels website, as part of the project knowledge repository.

Part of the MacroFuels dissemination, communication and exploitation strategy is to promote the data among and beyond the scientific community as openly and widely as possible. Therefore, relevant data will be uploaded in relevant scientific databases, which are related to biomass composition, marine science and biochemistry.

2 Overview of factsheets

TNO, AVT and Eurida evaluated the knowledge generated within 48 months of MacroFuels, also with regard to the protection of intellectual property for exploitation. Eurida analysed the EU stakeholder groups that are key to the integration of newly generated knowledge and data in future concepts and strategies. The selected knowledge was summarized and converted into five fact sheets, which form the core of this deliverable. All fact sheets have been compiled and technical language was translated into non-expert language in collaboration with the project partners that generated the knowledge and data.

The major objectives of the factsheets are:

- (1) Raise awareness of key stakeholders towards the potential of a seaweed-to-fuel chain for the decarbonisation of transport and as a possible area of economic growth with Europe in the lead.
- (2) Provide facts and knowledge and to highlight the potential of seaweed as sustainable biomass, and to support future practices in seaweed cultivation.
- (3) Emphasise the possible effects, positive and negative, that large-scale seaweed aquaculture may have on the marine environment.
- (4) Give insight into fuel production concepts from seaweed.
- (5) Highlight the social and regional aspects of a European seaweed-to-fuel value chain.

Table 1 provides an overview of the fact sheets that have been compiled as part of the MacroFuels knowledge exploitation strategy. Each table entry describes the key topics that are covered in the factsheets and the respective target groups for its distribution. The factsheets were sent directly to members and contacts within these target groups as electronic documents.

The reach of the factsheets is extended by making them openly accessible through the MacroFuels website, which will be promoted via social media. All interested parties can assess this project knowledge repository, which also includes scientific publications, policy briefs, informative video material and infographics, via www.macrofuels.eu/fact-sheets. All important results and knowledge generated by MacroFuels are preserved and made available for scientists, experts and non-experts, covering different backgrounds and fields of activity.

3 Overview of data shared in scientific data bases

Data that has been assessed to be of particular importance for various knowledge communities included the environmental data generated during monitoring activities and cruises to the MacroFuels seaweed farms in Denmark and Scotland. In the future, such data will help to make informed decisions about the climate change mitigation potential of seaweed, which has recently been discussed by various groups, including the Intergovernmental Panel on Climate Change (IPCC)¹ and general media^{2,3,4,5}. Although all data were retrieved from small scale farms, they give an initial idea about relevant potential environmental interactions at larger scales.

¹ <https://www.ipcc.ch/sr15/>

² <https://www.nationalgeographic.com/environment/2019/08/forests-of-seaweed-can-help-climate-change-without-fire/>

³ <https://www.sciencedaily.com/releases/2019/08/190829124250.htm>

⁴ <https://www.theguardian.com/books/2015/nov/20/climate-crisis-future-brighter-tim-flannery>

⁵ <https://www.nytimes.com/2019/04/30/dining/kelp-seaweed-recipes.html>

Other data that have been seen as relevant for wider stakeholder groups are compositions of the seaweed *species* investigated in MacroFuels. Shared data will be important for seaweed cultivators and seaweed-based product developers. Seaweed-based products include more established applications, such as food, nutraceuticals and cosmetics, as well as rather novel products such as feed, fertilisers, bio-based materials, pharmaceuticals and fuel. The range of potential users of the data highlights the importance of making such data accessible.

Biochemistry data mainly have relevance for scientific target groups and includes RNA sequence and transcriptomic data of fermentation organisms, which could be of interest beyond seaweed and fuel applications.

Table 2 includes a description of the data, selected repositories and related scientific publications. The data used for peer-reviewed publications can only be uploaded after the respective scientific paper has

been published. Therefore, most data will be uploaded after completion of the MacroFuels project, in this case an estimated time frame is given for data sharing.

Table 1. Overview of fact sheets and target recipient groups

Factsheet	Key topics	Target recipient groups
Overall MacroFuels Concept	<ul style="list-style-type: none"> - Seaweed for sustainable fuel - Seaweed production and supply - Fuel production and performance - Efficient use of the biomass - Sustainability assessment - Technical analysis - Estimated fuel yields - Market potential 	DG RTD EU Parliament DG Transport DG ENER DG CLIMA ETIP Bioenergy EATIP Aquaculture DG MARE DG ENV EIT Climate KIC KIC InnoEnergy EEA European Environment Agency IEA - International Energy Agency JPI Oceans JPI Healthy and Productive Seas and Oceans EERA European Energy Research Alliance JRC EU Joint Research Centre – EU Science Hub EABA – European Algae Biomass Association EU EASME , subgroup EU Eco-Innovation BBI JU & Bio-based Consortium Multi-stakeholder Platforms on Sustainable Development Goals (SDG)
Environmental Impacts of large of scale seaweed cultivation	<ul style="list-style-type: none"> - Environmental impacts and risks of large of scale seaweed cultivation - Environmental risk mitigation and monitoring needs 	EIA Commission Group of Environmental Impact Assessment SEA Strategic Env. Assessment National Experts EATIP Aquaculture - European Aquaculture Technology Platform EEA European Environment Agency DG MARE DG ENV

		<p>DG Clima EIT Climate KIC JPI Oceans - JPI Healthy and Productive Seas and Oceans - IOC-UNESCO Bellona Global Ocean Trust National/local authorities <i>e.g.</i> Marine Scotland VLIZ European Marine Board Nordic Climate Environmental NGOs <i>e.g.</i> Greenpeace WWF Oceana</p>
<p>Seaweed-based fuel for aviation and heavy transport</p>	<ul style="list-style-type: none"> - Seaweed for sustainable fuel - Conversion of seaweed to fuel - Testing of the fuel and road performance - Technical analysis - Estimated fuel yields 	<p>Industry and end-users: IBA – International Biofuel Association ETIP Bioenergy EBAA - European Business Aviation Association EuropaBio – European Association for Bioindustries EUBIA Bioenergy Europe ePURE Neste</p>
<p>Seaweed cultivation and logistics</p>	<ul style="list-style-type: none"> - Expected trends increase in seaweed cultivation in the EU - MacroFuels advances towards large-scale seaweed cultivation - Potential for lowering biomass costs - Benefits related to large scale seaweed cultivation in the EU 	<p>EATIP Aquaculture JPI Healthy and Productive Seas and Oceans - JPI Oceans EU BlueInvest Platform Submariner Network - EU Interreg Platform for the Baltic Sea Region EU MSP European Marine Spatial Planning Platform</p>

	<ul style="list-style-type: none"> - Technical challenges related to large scale seaweed cultivation in the EU 	<p>ASC-MSC IATiP – Irish Aquaculture</p>
Social and regional aspects	<ul style="list-style-type: none"> - Social & regional benefits and risks of the envisioned MacroFuels value chain - Recommendations for maximising impacts and mitigate social risks - Public dialogues: What is needed, who should be involved? - Social licenses for large-scale seaweed farms - Social aspects of seaweed farm standards 	<p>DG Growth RRI Tools Multi-stakeholder Platforms on Sustainable Development Goals (SDG) EESC Rural Development EBRD – European Bank for Reconstruction & Development</p>

Table 2. Overview of fact sheets and target recipient groups

Knowledge Topic 1: Seaweed and environment				
Specific information and data on environmental impacts				
Partners	Description of the data	Databases	Related publication	Data uploaded*
Aarhus U. SAMS	Environmental data from the cruises to and monitoring of the seaweed cultivation sites. <ul style="list-style-type: none"> ○ Nutrients, ○ Salinity, ○ Temperature ○ Dissolved organic matter ○ Dissolved organic carbon ○ Light 	EMODNet http://www.emodnet.eu/	Bruhn <i>et al.</i> , <i>in preparation</i>	30 June 2020
			Boderskov <i>et al.</i> , <i>in preparation</i>	30 June 2020
Knowledge Topic 2: Seaweed as cultivated biomass for various industries				
Compositions of seaweed as cultivated biomass for various industrial applications				
Partners	Description of the data	Databases	Related publication	Data uploaded*
SAMS Aarhus U. WR DTI TNO	Composition of different seaweed <i>species</i> <ul style="list-style-type: none"> ○ Elemental analysis ○ % Dry matter ○ Sugar analysis ○ Protein content ○ Metals/minerals ○ Fatty acids 	Phyllis Database (part of BRISK2) https://phyllis.nl/	Boderskov <i>et al.</i> , <i>in preparation</i> X.C. Frette <i>et al.</i> , Valuable Biomolecules from Nine North Atlantic Red Macroalgae: Amino Acids, Fatty Acids, Carotenoids, Minerals and Metals, <i>Natural resources</i> 2016 , 7, 157-183 A.-B. Bjerre <i>et al.</i> , Crude fucoidan content in two North	30 June 2020 15 January 2020

			Atlantic kelp <i>species</i> , <i>Saccharina latissima</i> and <i>Laminaria digitata</i> - seasonal variation and impact of environmental factors, <i>Biorescience technology</i> 2017 , 238, 16-21	15 January 2020
Knowledge Topic 3: Conversion of seaweed to biofuels and fuel additives				
Biochemistry of the seaweed-to-biofuels process and scientific data				
Partners	Description of the data	Databases	Related publications	Data uploaded*
WR	RNA sequence and transcriptomic data of <i>Clostridium</i> DSM6423	<i>EBI data submitted to:</i> https://www.ebi.ac.uk/s/ubmission ArrayExpress https://www.ebi.ac.uk/arrayexpress under E-MTAB-7487	A.M. López-Contreras <i>et al</i> , L-Rhamnose Metabolism in <i>Clostridium beijerinckii</i> Strain DSM 6423, <i>Applied and environmental microbiology</i> 2019 , 85, 5, e02656-18	November 2018
WR	Fermentation of <i>Saccharina latissima</i>	Phyllis Database (part of BRISK2) https://phyllis.nl/	Manuscript <i>in preparation</i>	30 June 2020

WR	DNA and RNA sequence of <i>C beijerinckii</i> DSM6423.	<p>EBI https://www.ebi.ac.uk/submit/</p> <p>European Nucleotide Archive https://www.ebi.ac.uk/ena/data/view/PRJEB11626 under PRJEB11626</p> <p>NCBI BioProject Database https://www.ncbi.nlm.nih.gov/geo/query/acc.cgi?acc=GSE10002 Under GSE100024</p>	<p>Wasels, François, <i>et al.</i>, A two-plasmid inducible CRISPR/Cas9 genome editing tool for <i>Clostridium acetobutylicum</i>, <i>Journal of microbiological methods</i> 2017 1405-11.</p> <p>Diallo, Mamou, <i>et al.</i>, Adaptation and application of a two-plasmid inducible CRISPR-Cas9 system in <i>Clostridium beijerinckii</i>, <i>Methods</i> 2019</p>	5 January 2018
* Dates in <i>Italics</i> are expected dates for uploading of the data.				

4 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

Factsheet: Driving on Seaweed: Towards a production chain for sustainable transportation fuels from cultivated seaweed

Fact sheet on the overall MacroFuels concept

Partners: Eurida, Avantium, TNO, ERM, DTI, Aarhus University, SAMS, Sioen, WFBR

Factsheet: The Environmental Impacts of Large-Scale Seaweed Cultivation

Fact sheet on the environmental and eco-system impacts of seaweed cultivation

Partners: Aarhus University, SAMS

Factsheet: Fuel production and road performance

Fact sheet on seaweed-based fuel for aviation and heavy transport, MacroFuels production routes and engine performance and emission tests

Partners: TNO, DTI, WFBR, Avantium

Factsheet: Towards sustainable, industrial scale cultivation of seaweeds in Europe

Fact sheet on biomass cultivation and logistics

Partners: Sioen, DTI, SAMS, Aarhus University

Factsheet: Future sustainable seaweed industries in Europe - Social and regional aspects

Fact sheet on social and regional implications and impacts resulting from large-scale seaweed cultivation

Partners: Eurida