

MacroFuels

WP7 – Dissemination and communication

Project Meeting – 29th Nov 2017, DTI



Presentation Overview



- Activities performed during the first project phase
- Results achieved
- Project Phase 2 – Focus on exploitation



Goals 1st Period



- Raise awareness and keep the target community informed
- Implement the general dissemination and press strategy
- Build a basis for policy input
- Prepare stakeholder involvement and public engagement



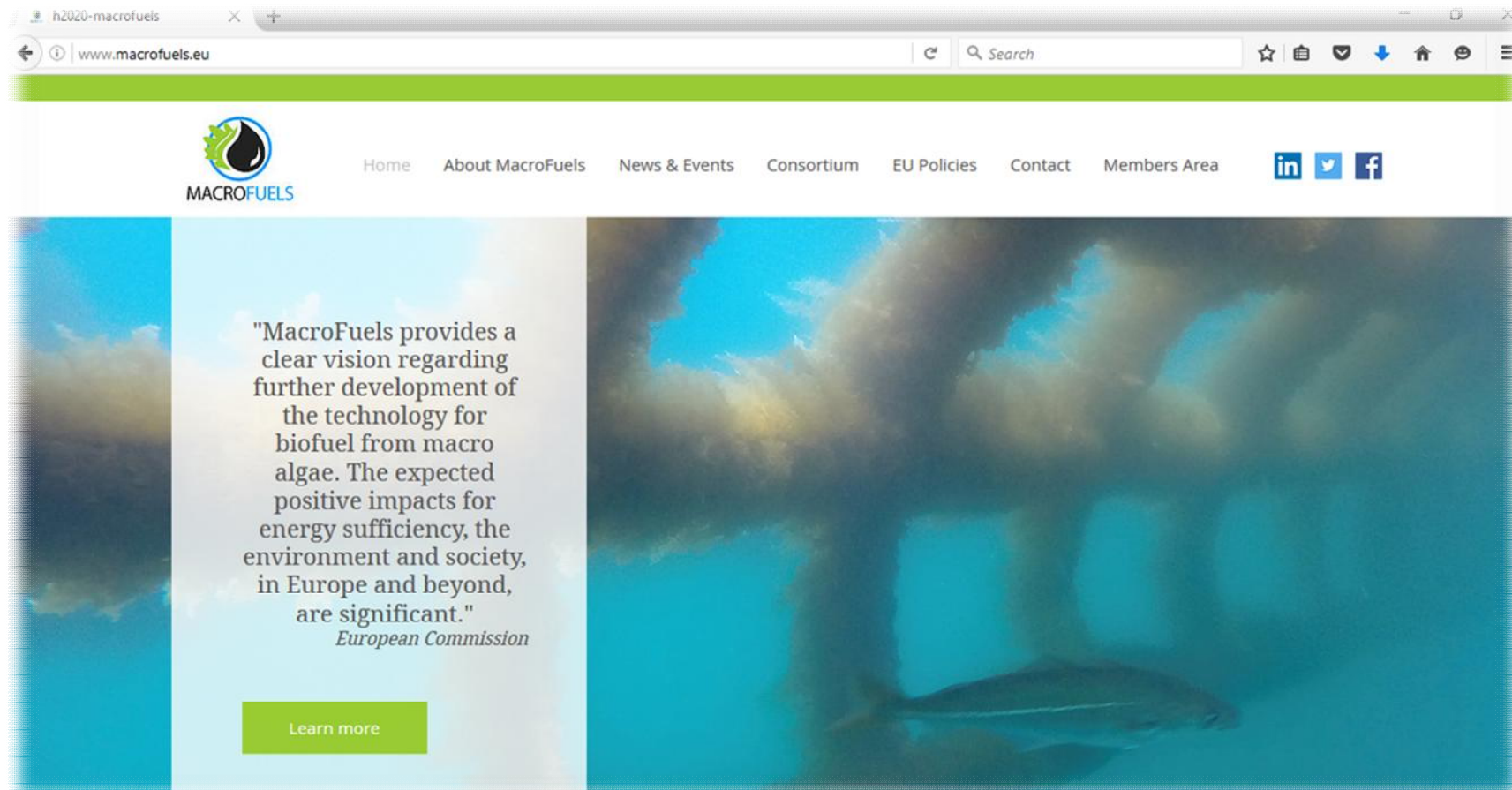
Period M1-M18



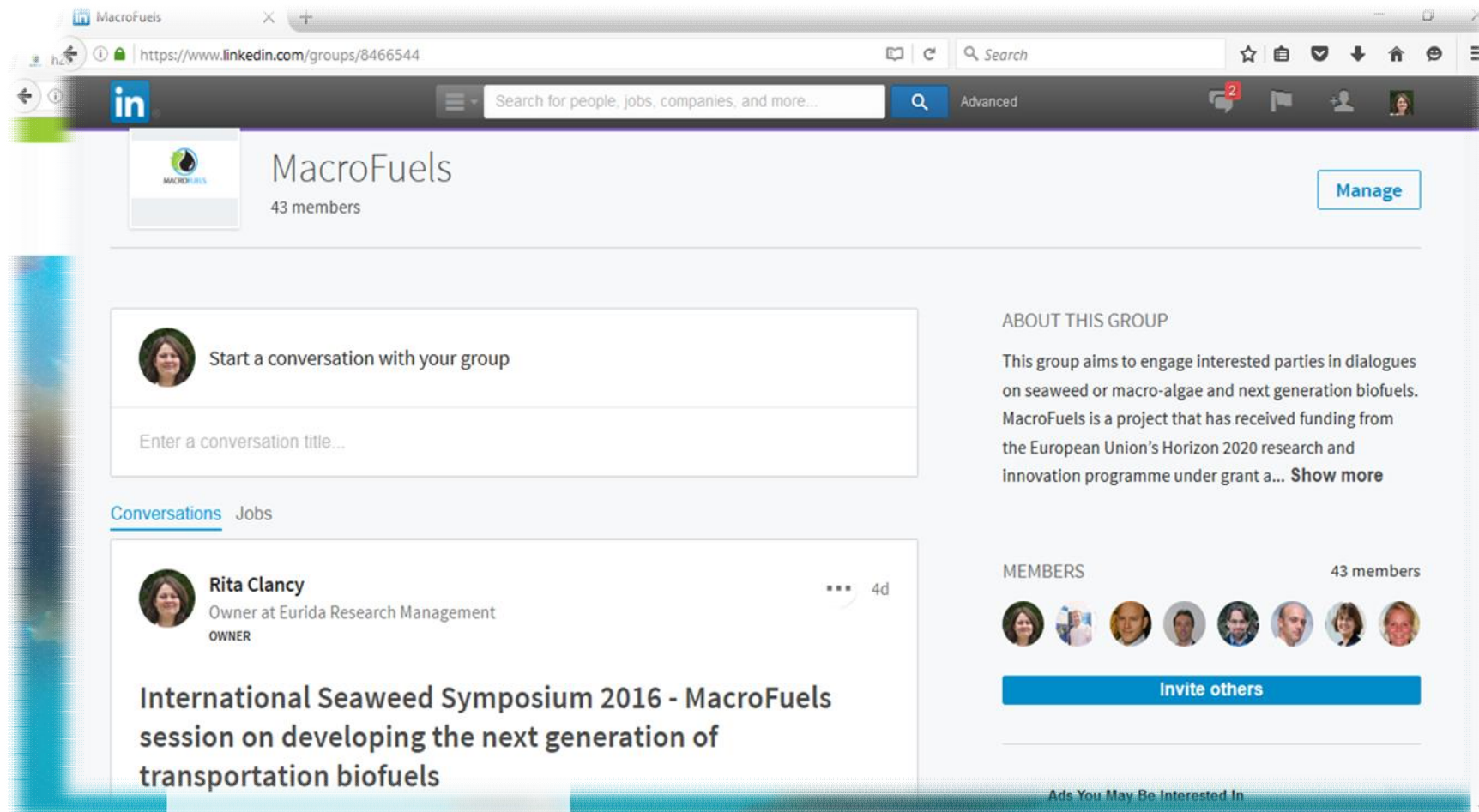
Main results – An Overview



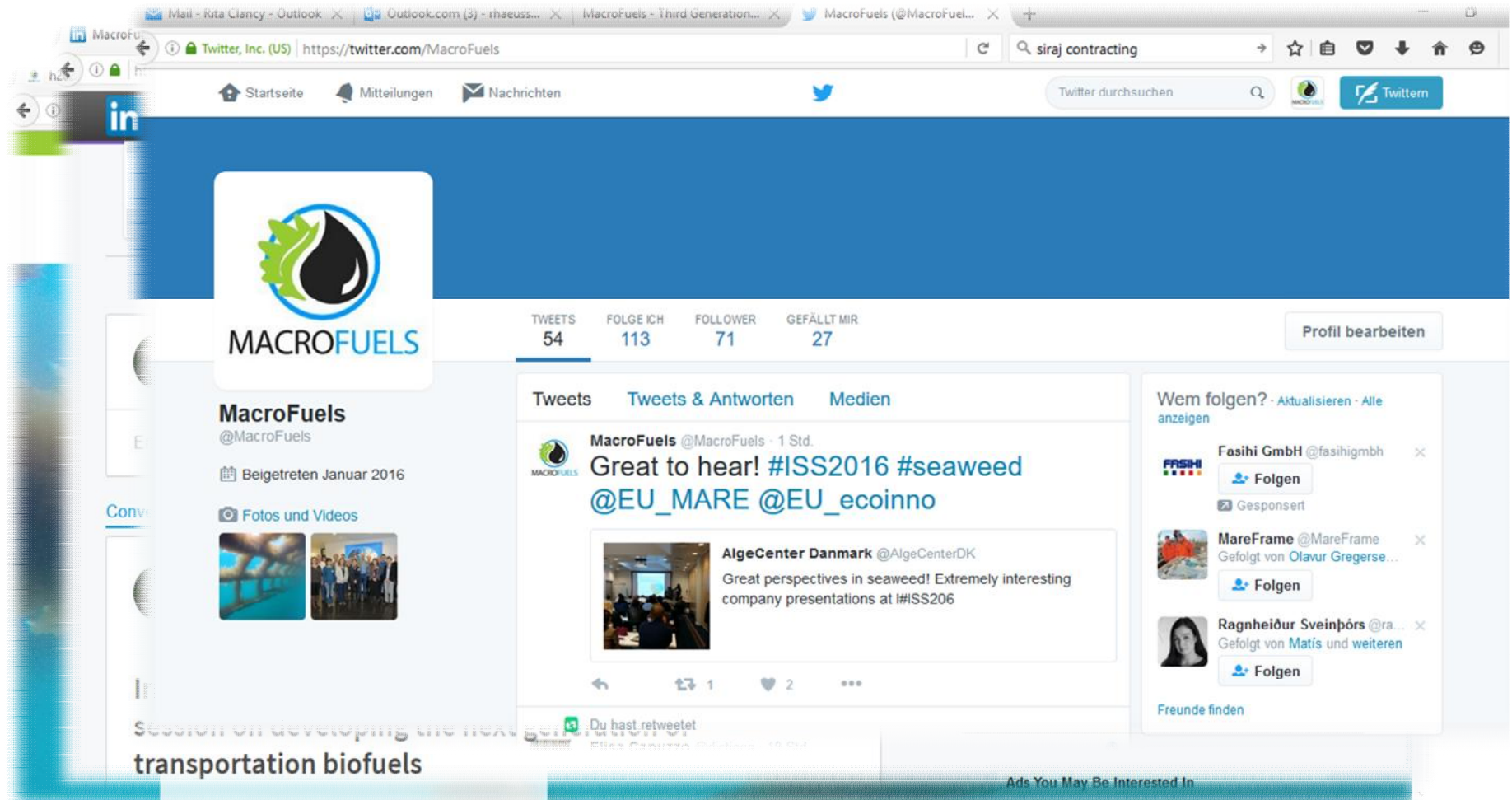
Project Visibility



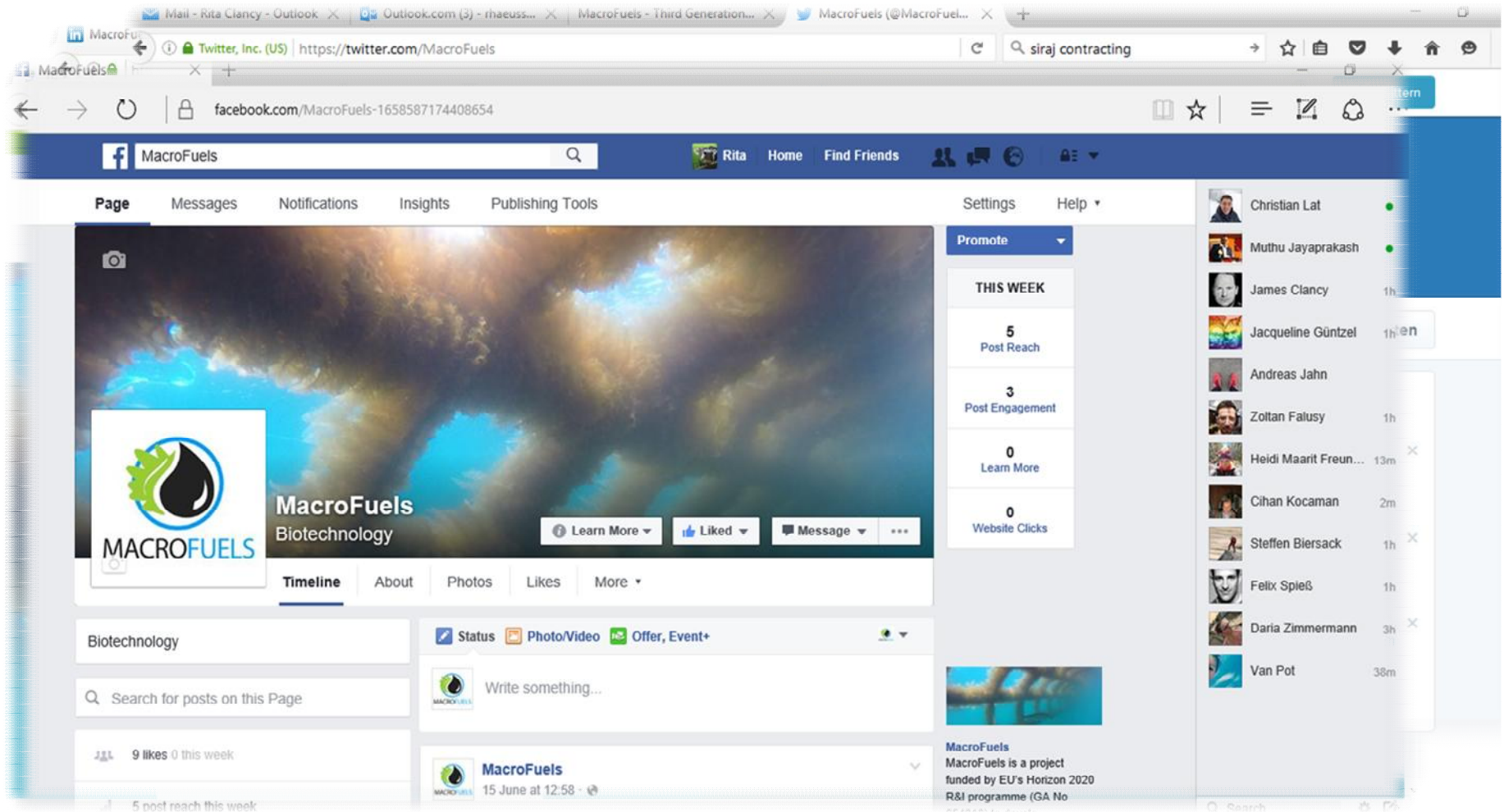
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Third-Generation Biofuels from Seaweed



MacroFuels - Turning a Vision into a Solution



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This flyer 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 n.º 654010.

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MACROFUELS

MacroFuels in a Nutshell

MacroFuels aims to produce advanced biofuels from macroalgae, commonly known as seaweed. The targeted biofuels are ethanol, butanol, furanics and biogas. The project will achieve a breakthrough in biofuel production from macroalgae by:

- Increasing biomass supply by developing a rotating crop scheme for cultivation of seaweed, using native, highly productive brown, red and green seaweeds, in combination with the use of advanced textile substrates resulting in a year round biomass yield.
- Improving the pre-treatment and storage of seaweed and to yield fermentable and convertible sugars at economically relevant concentrations (10-30%)
- Increasing bio-ethanol and bio-butanol production to economically viable concentrations by developing novel fermenting organisms which metabolize all sugars at 90% efficiency
- Increasing biogas yield to convert 90% of the available carbon in residues by adapting the organisms to seaweed
- Developing thermochemical conversion processes of sugars to furan-based fuels
- Performing an integral techno-economic, sustainability and risk assessment of the entire seaweed to biofuel chain

MacroFuels will develop technologies for the production of fuels which are suitable as liquid fuels of precursors thereof for the heavy transport sector as well as potentially for the aviation sector. MacroFuels will furthermore expand the biomass available for the production of biomass available for the production of advanced biofuels. Seaweed does not need fresh water, arable land or fertilizers to grow which provides environmental benefits, and, in addition, has a high carbon dioxide reduction potential as well as reduces the demand for natural resources on land. The technology offers many novel opportunities for employment along the entire value chain.



Benefits and Impacts

The progress that will be achieved by MacroFuels will have significant impact on various economic fields, and - most importantly - paves the way towards a sustainable solution that is not competing with arable land or food, in contrast to 1st and 2nd generation biofuels derived from food-based crops and residuals. Thus, MacroFuels aims to make a substantial contribution towards renewable energy from photosynthesis and towards the goal set by the European Union of 10% of the transport fuel of every EU country to come from renewable sources such as biofuels by 2020.

Advanced technologies and decreased production costs for third generation biofuels will offer many novel opportunities for employment along the entire value chain. MacroFuels estimates that about 15.000 jobs can be created based on the EU target of 2.5% biofuels, which corresponds to 5000 km² of cultivated seaweed area.

✓ MacroFuels converts seaweeds more efficiently to biofuels via breakthroughs in pre-treatment (water reduction of more than 50% and total elimination of process steps are among our ambitious goals), via wet, sugar preservative storage methods, and by improving the ethanol and butanol productivity up to economic levels.

✓ MacroFuels enables a favourable energy balance as well as significant potential for cost reduction, which will permit our targeted fuels to eventually compete favourably with fossil or 1st and 2nd generation biofuels.



✓ MacroFuels stimulates stakeholder dialogues and international collaboration by bringing together experts that are involved in international activities on seaweed derived biofuels, and by entering dialogues with stakeholders to understand their interests and concerns. Although the objective is unique, MacroFuels will not be an isolated effort. Indeed, the links with other projects and networks ensure that MacroFuels will be up to date on the latest trends and support maximising the project's impacts.

✓ MacroFuels improves innovation capacity by integrating prior state-of-the-art, know-how and experience along the entire seaweed to biofuels chain. Bringing together key players in the seaweed to biofuels area will accelerate innovation and market deployment and broaden the business-case for companies.

Economic viability and sustainability

MacroFuels will determine the economic viability of the seaweed to biofuel production chain by using accurate verified experimental data, obtained under relevant conditions. The data from the assessment will be used in a feedback loop to further inform the experiments, ensuring that the chances of commercial implementation are maximised.

Valorisation of the side- and waste-streams

Side- and waste-streams will be valorised by screening them for high value marketable components and identifying the most viable products. We will further assess the proteins liberated during the entire process for their use to augment feed supply in the EU, as well as the mine streams for use as inorganic fertilizer in terms of primary, secondary and trace elements. This assessment will result in a potential value and market of these streams.



Fuel assessment under realistic conditions

Fuel assessment under operating conditions will be performed by utilising the DTI fuel assessment facilities. Fuel mixtures will be prepared and tested in the relevant engines to assess the suitability of these fuels under different realistic transport conditions.

Techno-economic and sustainability assessment

As part of MacroFuels, a multi-criteria assessment of the sustainability of substituting conventional fossil-based transportation fuels and currently available biofuels with seaweed derived fuels will be performed. The sustainability assessment will take into account economic, environmental, social, health and safety, and risk aspects and will consider the entire value chain of the transportation fuels using a life cycle comparison approach.

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MacroFuels - Third Generation... X

www.besustainablemagazine.com/cms2/macrofuels-third-generation-biofuels-from-seaweed/

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MacroFuels – Third Generation Biofuels from Seaweed

Ashray Udaya Shankar · March 29, 2016

In the last decade, seaweed has received increasing interest worldwide as potential source of advanced biofuels production, which has resulted in a considerable attention from research, industry and policy makers. However, no large-scale, commercial algae-to-biofuels facilities had yet been implemented by the end of 2015. Over the next four years experts from six European countries will concert their efforts to achieve breakthroughs towards the commercially viable production of third-generation biofuels from seaweed or macro-algae. In their efforts they will be financially supported by the European Commission who funds the MacroFuels project with 6 million Euros from their Research and Innovation programme 'Horizon 2020'.

Working methodology: 2D substrates for open sea cultivation

Conference of the European Biogas Association
Sept. 27-29, 2016
Ghent, Belgium
www.biogasconference.eu

REFIP 5.0
5th Annual Renewable Energy Finance in Practice Forum
10-11 October 2016
Austria Trade Hotel Sommer Palace, Austria

7 – 11 November 2016
PARKROYAL on Beach Road Hotel



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Biofuels from seaweed? - Th

MacroFuels - Th

www.theecologist.org/green_green_living/2988214/biofuels_from_seaweed.html

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SETTING THE ENVIRONMENTAL
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RESURGENCE TALKS
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25 October 2017
Save our Soil
Helen Browning OBE

22 November 2017
The Solar Civilization,
renaissance, and new despotism
Dr Jeremy Leggett

31 January 2018
Soil, Soul, Society
Satish Kumar

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SEARCH Go

Biofuels from seaweed?
Laura Briggs
12th October, 2016

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Seaweed is known for its culinary uses and has seen a renaissance in past years thanks to its health claims and a distinctive taste - but there are more ecological benefits to seaweed that currently remain untapped.

More research is needed in the areas of bioactives and conversion technologies linked to developing a seaweed biorefinery

The primary reason for seaweed farming right now is for bioenergy research projects funded by the UK and the EU and although already widely used in food, marine scientists believe this demand will also grow quickly over the next

The Feedme project is investigating the use of seaweed residues after they have been processed for bioenergy for inclusion in animal feeds

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Project Publications



MACROFUELS



PARTICIPATE SEARCH MONITOR SUPPORT OPEN ACCESS



Title	Developing the next generation Macro-Algae based biofuels for transportation via advanced bio-refinery processes
Funding	EC H2020 RIA
Call	H2020-LCE-2015-1-two-stage
Contract (GA) number	654010
Start Date	2016/01/01
End Date	2019/12/31
Open Access mandate	yes
Data Pilot	no
Organizations	MATIS, AU, DLO, Ferm. exp., EURIDA, DTI, SAMS, Sioen, ERM, ECN, AVT
More information	Detailed project information (CORDIS)

Publications (8)

Research Data (0)

Statistics

Can Seaweed Farming Play a Role in Climate Change Mitigation and Adaptation?

Duarte, Carlos M.; Wu, Jiaping; Xiao, Xi; Bruhn, Annette; Krause-Jensen, Dorte (2017)

Projects: EC | MacroFuels (654010)

Seaweed aquaculture, the fastest-growing component of global food production, offers a slate of opportunities to mitigate, and adapt to climate change. Seaweed farms release carbon that maybe buried in sediments or exported to the deep sea, therefore acting as a CO₂ sink.

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- [Dynamically incorporate publications in your site \(HTML\)](#)
- [Dynamically incorporate research data in your site \(HTML\)](#)
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[DEPOSIT PUBLICATIONS](#)

www.macrofuels.eu





ELSEVIER

Contents lists available at ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech



Butanol fermentation of the brown seaweed *Laminaria digitata* by *Clostridium beijerinckii* DSM-6422

Xiaoru Hou ^{a,*,1}, Nikolaj From ^{a,b,1}, Irini Angelidaki ^b, Wouter J.J. Huijgen ^c, Anne-Belinda Bjerre ^a

^aSection of Biomass Technology, Center of Bioresource and Biorefinery, Danish Technological Institute, Gregersensvej, DK-2630 Taastrup, Denmark

^bSection of Residual Resource Engineering, Department of Environmental Engineering, Technical University of Denmark, Møllegaardsvej, DK-2800, Kgs. Lyngby, Denmark

^cBiomass & Energy Efficiency, Energy Research Centre of the Netherlands (ECN), Westerduinweg 3, 1755 LE Petten, The Netherlands

OpenAIRE - Proj

https://



Title

Funding

Call

Contract (GA) num

Start Date

End Date

Open Access mandate

Data Pilot

Organizations

More information

2019/12/31

yes

no

MATIS, AU, DLO, Ferm. exp., EURIDA, DTI, SAMS, Sioen, ERM, ECN, AVT

[Detailed project information \(CORDIS\)](#)

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Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech



Contents lists available at ScienceDirect

Journal of Microbiological Methods

journal homepage: www.elsevier.com/locate/jmicmeth



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gby, Denmark

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report (HTML)

less report (CSV)

SEARCH RESULTS

DEPOSIT PUBLICATIONS

A two-plasmid inducible CRISPR/Cas9 genome editing tool for *Clostridium acetobutylicum*

François Wasels^{a,*}, Jennifer Jean-Marie^a, Florent Collas^b, Ana M. López-Contreras^b,
Nicolas Lopes Ferreira^a

^a IFP Energies nouvelles, Biotechnology Department, 1 et 4 avenue de Bois-Préau, 92852 Rueil-Malmaison, France

^b Wageningen Food and Biobased Research, Bornse Weiland 9, 6709WG Wageningen, The Netherlands

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Contents lists available at ScienceDirect

Bioresource Technology

journal homepage: www.elsevier.com/locate/biortech



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Contents lists available at ScienceDirect

Journal of Microbiological Methods

journal homepage: www.elsevier.com/locate/jmicmeth



Bjerrø^a

gby, Denmark

J Appl Phycol (2016) 28:3511–3525
DOI 10.1007/s10811-016-0842-3



A two-plasmid in *acetobutylicum*

François Wasels^{a,*}, Je
Nicolas Lopes Ferreira

^a IFP Energies nouvelles, Biotechnolog
^b Wageningen Food and Biobased Res

Biorefinery of the green seaweed *Ulva lactuca* to produce animal feed, chemicals and biofuels

Paul Bikker¹ · Marinus M. van Krimpen¹ · Piet van Wijkelaar¹ ·
Bwee Houweling-Tan² · Nazareno Scaccia² · Jaap W. van Hal³ · Wouter J. J. Huijgen³ ·
John W. Cone⁴ · Ana M. López-Contreras²

Can Seaweed Farming Play a
Duarte, Carlos M.; Wu, Jiaping; Xiao,
Projects: EC | MacroFuels (654010)

Seaweed aquaculture, the fastest
climate change. Seaweed farms re





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J Appl Phycol

DOI: 10.1007/s10811-017-1204-5



Crude fucoidan content in two North Atlantic kelp species, *Saccharina latissima* and *Laminaria digitata*—seasonal variation and impact of environmental factors

Annette Bruhn¹ · Tina Janéček¹ · Dirk Manns² · Mette Møller Nielsen^{1,3} ·
Thorsten Johannes Skovbjerg Balsby¹ · Anne S. Meyer² · Michael Bo Rasmussen¹ ·
Xiaoru Hou⁴ · Bodo Saake⁵ · Cordula Göke⁶ · Anne Belinda Bjerre⁴

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John W. Cone⁴ · Ana M. López-Contreras²

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François Trucillo, et al.
Nicolas Lopes Ferreira

^a IFP Energies nouvelles, Biotechnologie
^b Wageningen Food and Biobased Res

Can Seaweed Farming Play a Role in
Duarte, Carlos M.; Wu, Jiaping; Xiao,
Projects: EC | MacroFuels (654010)

Seaweed aquaculture, the fastest
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J Appl Physiol
DOI: 10.1007/s10811-017-1204-5



Crude fucoidan from *Saccharina latissima* and impact of environment

Annette Bruhn¹ · Tina Janick² ·
Thorsten Johannes Skovbjerg Børsting³ ·
Xiaoru Hou⁴ · Bodo Saake⁵ · Carsten
Bode⁶

Natural Resources, 2016, 7, 157–183
Published Online April 2016 in SciRes. <http://www.scirp.org/journal/nr>
<http://dx.doi.org/10.4236/nr.2016.74016>



Valuable Biomolecules from Nine North Atlantic Red Macroalgae: Amino Acids, Fatty Acids, Carotenoids, Minerals and Metals

Behnaz Razi Parjikolaei^{1*}, Annette Bruhn², Karin Loft Eybye³, Martin Mørk Larsen⁴,
Michael Bo Rasmussen², Knud Villy Christensen¹, Xavier C. Fretté¹

Paul Bikker¹ · Marjolijn
Bwee Houweling-Tan² · Nazareno Scaccia² · Jaap W. van Halbeek³ · Wouter J. J. Huijgen³ ·
John W. Cone⁴ · Ana M. López-Contreras²

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Projects: EC | MacroFuels (654010)

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Project Presentations



Carbohydrate Analysis of Seaweed in the Biorefinery to Chemicals and Fuel Context

J.W. van Hal
A.-B. Bjerre (DTI)
A.M. López Contreras (WUR)
M. Stanley (SAMS)
G.O. Hreggvidsson (Matis)
W.J.J. Huljen

August 2016
ECN-L-16-045

Presented @ the International Seaweed Symposium 2016,
Copenhagen, June 19-24



Project Presentations



Carbohydrate Analysis Seaweed in the Biorefinery to Chemicals and Fuels MacroFuels Context

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W.J.J. Huljgen

August 2016
ECN-L-16-045

Presented @ the International Seaweed Symposium 2016, Copenhagen, June 19-24



Development of Seaweed Biorefineries for Fuels and Chemicals

J.W. van Hal
A.-B. Bjerre (DTI)

August 2016
ECN-L-16-046

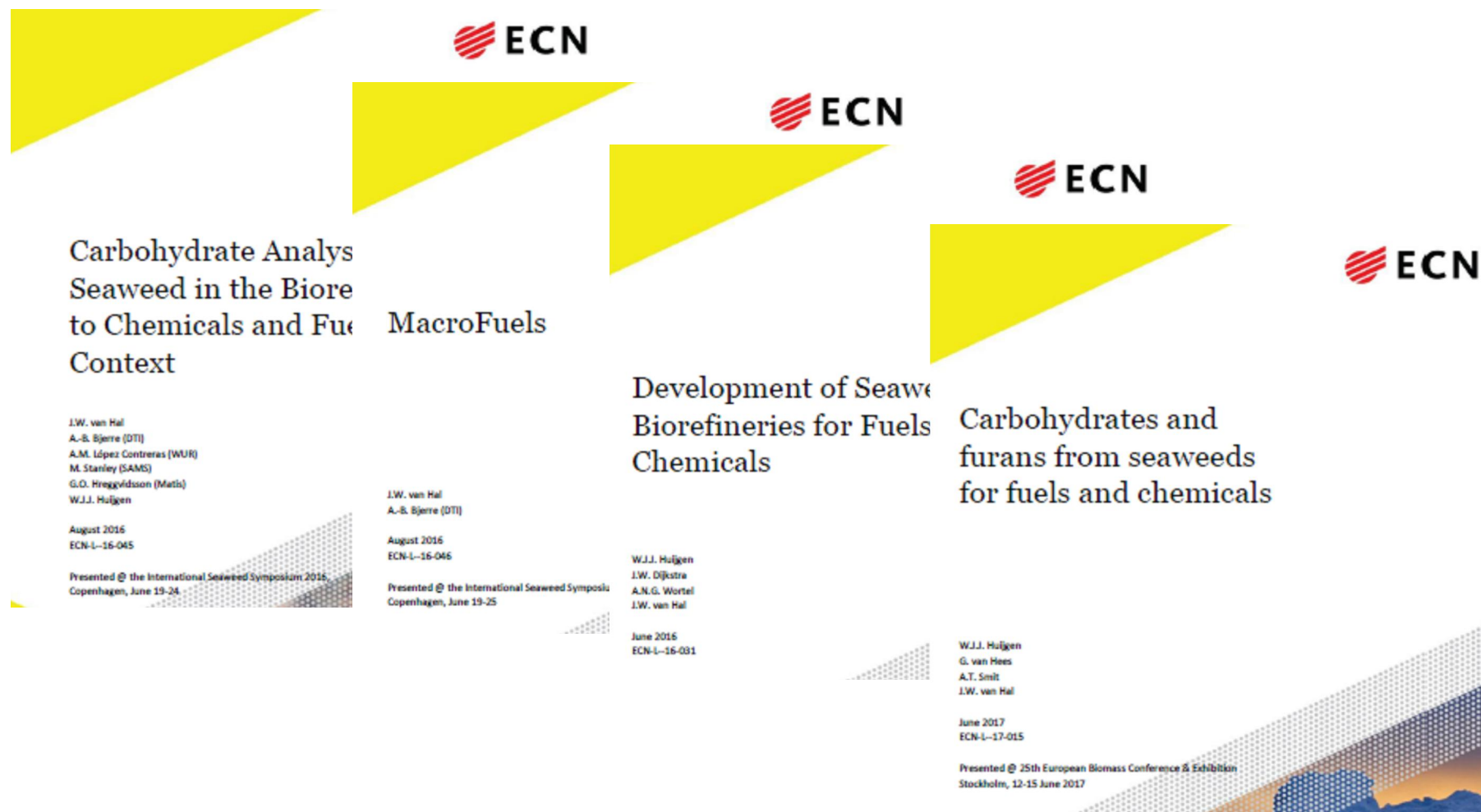
Presented @ the International Seaweed Symposium 2016, Copenhagen, June 19-25

W.J.J. Huljgen
J.W. Dijkstra
A.N.G. Wortel
J.W. van Hal

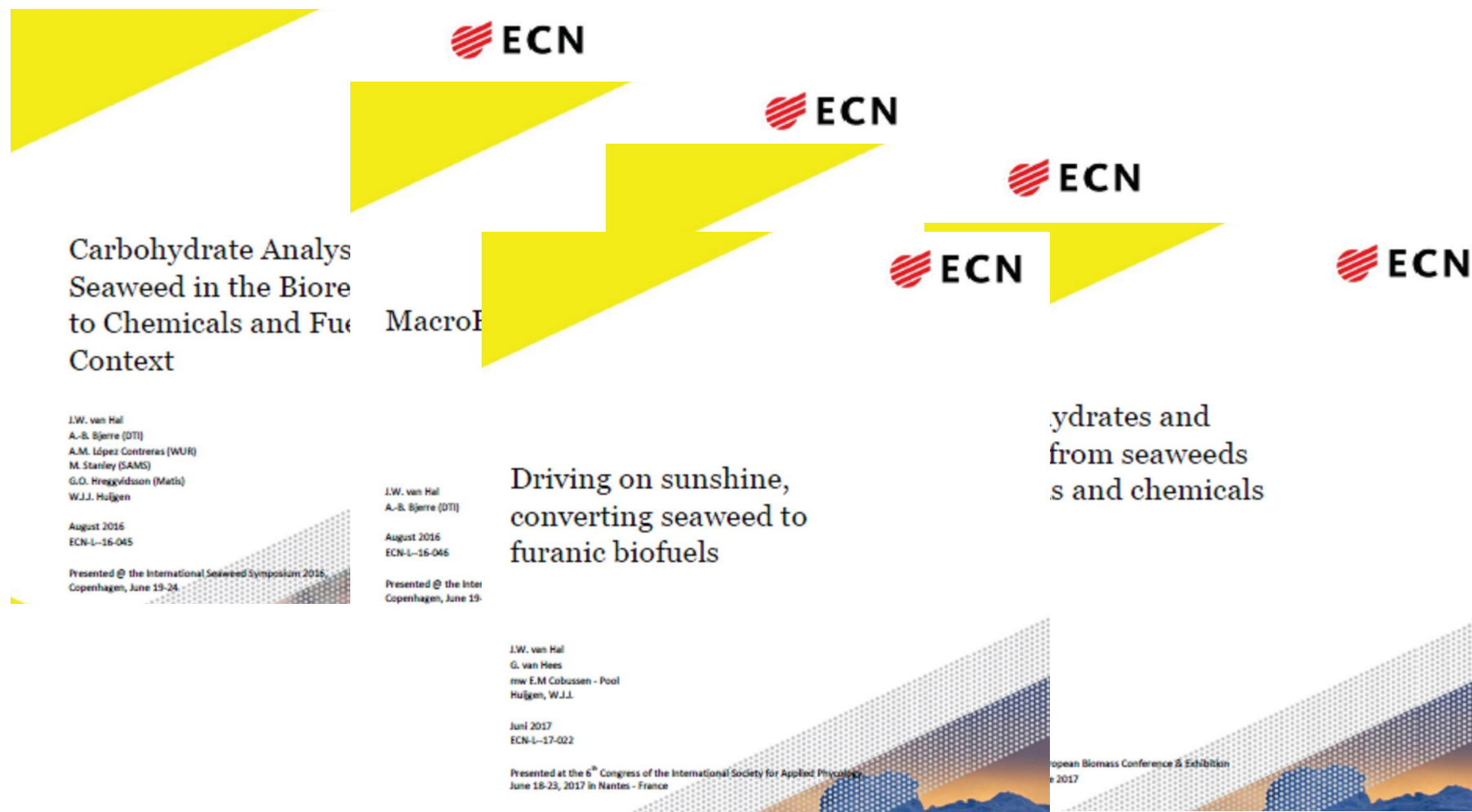
June 2016
ECN-L-16-031



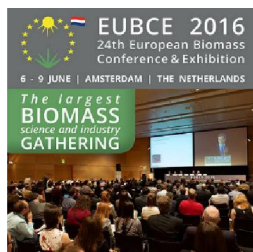
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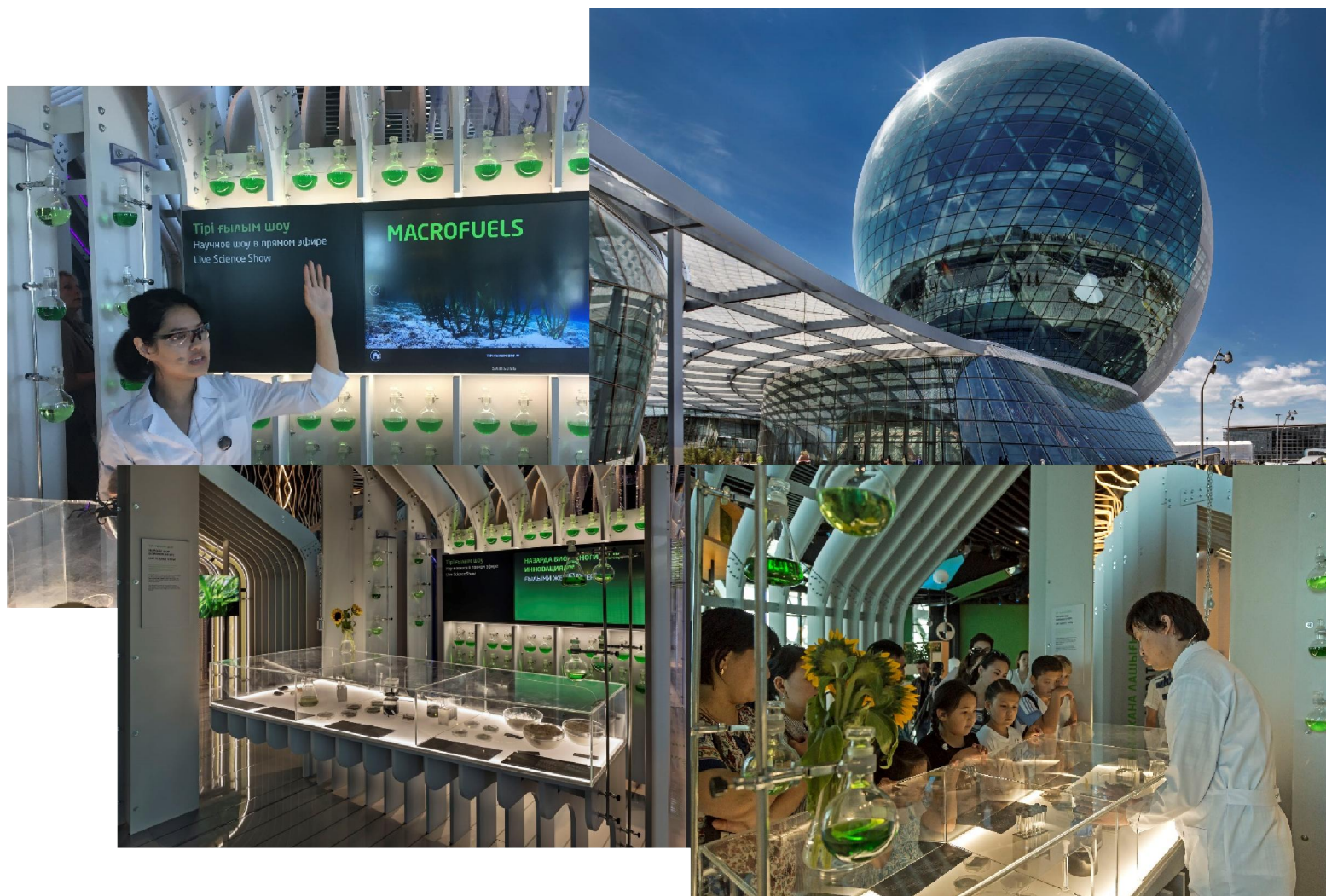
Conference Participations



27-28 September 2016
Portugal
Seagriculture
5th international seaweed conference



MacroFuels @ EXPO 2017



MacroFuels Citizen Events



WP7 – Phase 2: Focus on exploitation

SIOEN, EURIDA

Are we ready to commercially produce seaweed based biofuels
in sufficient quantities today? If not, why?

WP7: Exploitation aspects

Today seaweed based biofuel production in Europe is not possible due to:

- Immature seaweed cultivation in EU
- Immature biorefinery technologies
- Price of seaweed based biofuels
- Lack of cultivation concessions (i.e. km² scale)
- NIMBY
- ..

First initiatives are likely to start in S.E. Asia. Why?

- 1) Maturity of seaweed cultivation in SE Asia
- 2) EU: typically browns => 25 kg ww /m².year
S.E. Asia: typically reds => 6 x 40 = 240 kg ww /m².year
- 3) More space for concessions
- 4) Less NIMBY
- 5) Cheaper labor
- 6) ...

Europe can provide technologies and financing

How much surface area do we need to produce enough seaweed to replace 1% of refined petroleum products by seaweed based biofuels?

WP7: Exploitation aspects

Some calculations ...

Worldwide consumption of refined petroleum products (2016) = 94 million barrels per day
= 5 billion tons per year

Global biofuel production (2016, ethanol and biodiesel) = 82 million tons per year

If we replace **appr. 1%** of this land-based biofuel production by seaweed based biofuel
⇒ 1 million ton per year

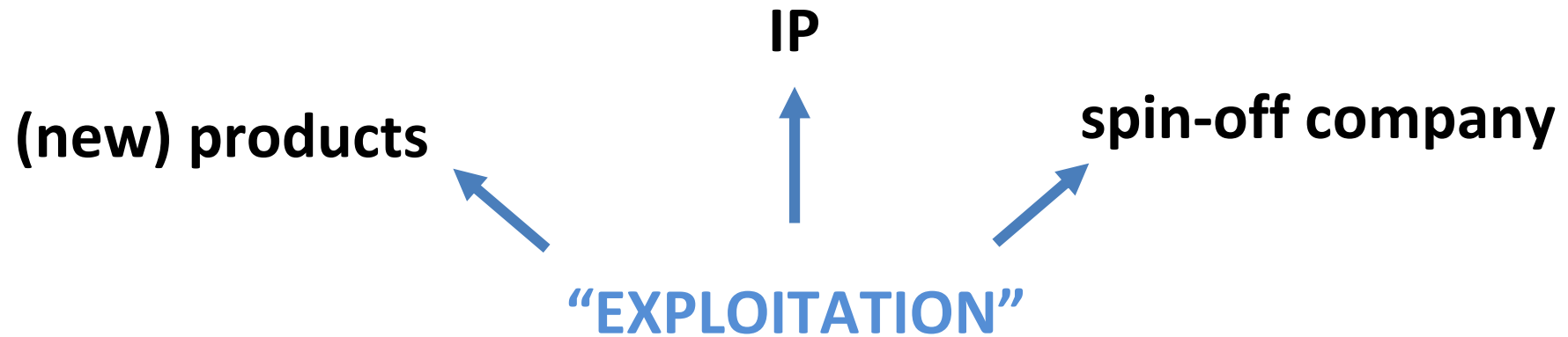
⇒ 27 mio tons ww of seaweed (is exactly the annual seaweed production in 2016)
(assuming 2kg sugar for 1 kg of biofuel and 60% sugar content in seaweeds)

⇒ 1100 km² of cultivation space required (assuming 25 kg/m²), or

⇒ 113 km² of cultivation space required (assuming 240 kg/m²)

(If we want to replace all 94 million barrels per day by seaweed based biofuels we need
565,000 km² (assuming 240 kg/m²) = 750 km x 750 km)

WP7: Exploitation aspects



WP7: Exploitation aspects



New IP/products developed during first 2 years of MacroFuels:

WP1:

WP2:

WP3:

WP4:

WP5:



WP7: Exploitation aspects



Is there an interest for an **Exploitation Strategy Seminar (ESS)**?

An ESS seminar takes 1 day and is typically organized during a GA meeting

During this day an exploitation expert (typically a professor) supports the consortium in identifying exploitable results by means of highly interactive exercises.

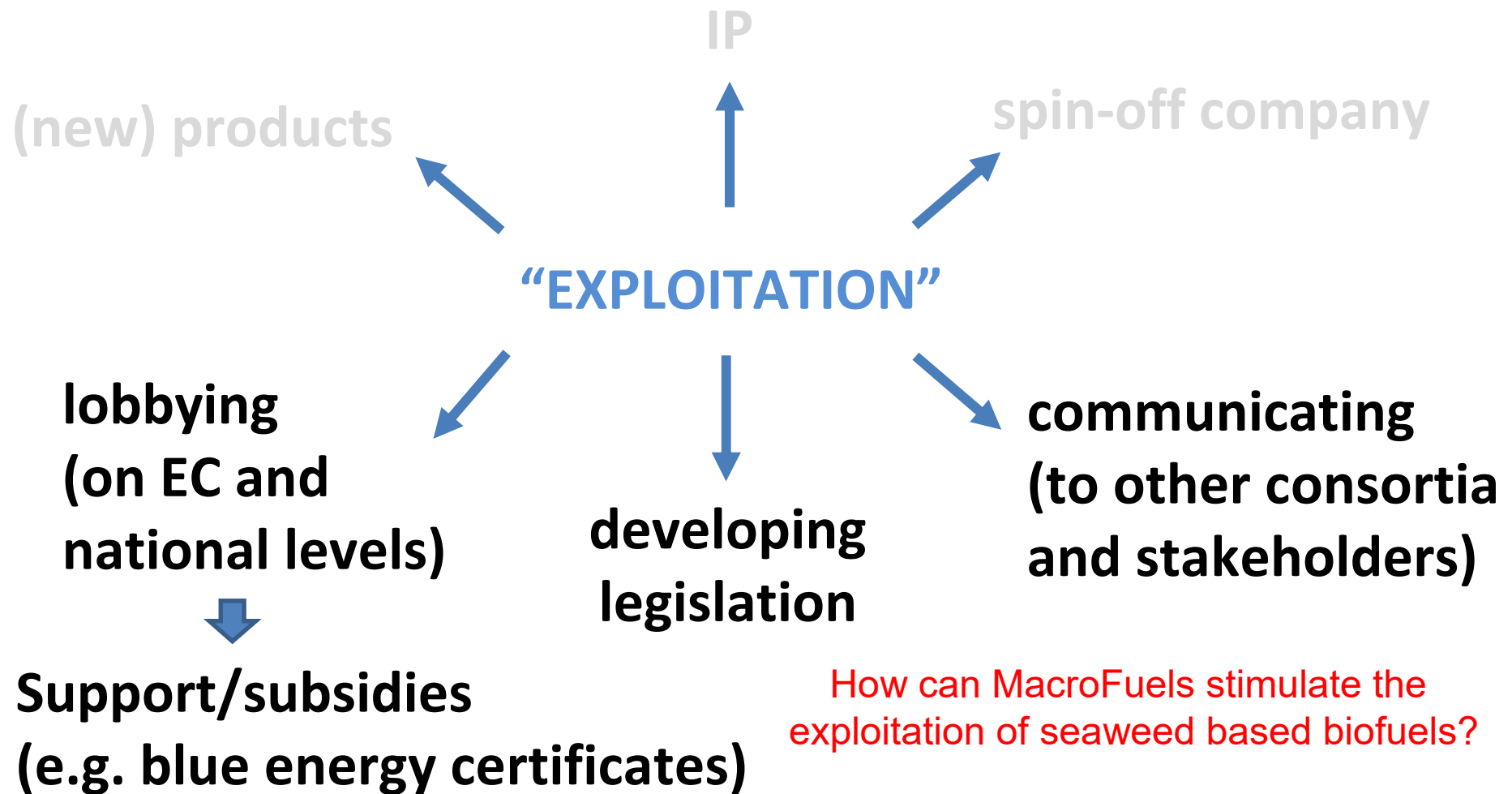
For more info see:

<http://sserr.meta-group.com/Services/Pagine/Exploitation-Strategy-Seminars.aspx>



Who are our stakeholders?

WP7: Exploitation aspects



WP7: Exploitation aspects

How can MacroFuels stimulate exploitation in these areas:

1) Contribute to Legislation and future strategies/policies:

- Direct interaction with EC and other legislation bodies
- Knowledge exchange with multipliers (associations and existing initiatives)
- Pre-legislative participation and input most promising

What has MacroFuels done so far or what partner activities can we build upon?

- Personal communication with MEP Nils Torvalds
- Contact established with Thomas Schleker, DG RTD, Policy Officer 'Renewable Energy Sources'
- Contacts established with Dutch policy making bodies for targeted input on future policies (Jaap van Hal, ECN)
- Contribution to Scottish 'Seaweed Cultivation Policy Statement' (Michele Stanley, SAMS)

WP7: Exploitation aspects

How can MacroFuels stimulate exploitation:

2) Networking & Lobbying

- Direct interaction and intensified knowledge exchange with national and international stakeholders
- Propose ideas how to stimulate seaweed based fuels (e.g. via blue energy certificates)
- Interaction with related EU projects (seaweed, ocean safety, multi-use of the marine space, etc.)

What MacroFuels has done so far:

- Organise a stakeholder round table on multi-use approaches of the ocean space (e.g. integrated solutions seaweed farm-wind park) – Early 2018 in cooperation with Noordzee Borderij, Grow Project on Offshore Wind Energy)
- Initiate dialogues with SOMOS project and Maritime Spatial Planning EU Platform about future joint activities on safety and licensing issues

WP7: Exploitation aspects

How can MacroFuels stimulate exploitation:

3) Communication via exploiting 'MacroFuels' knowledge

- White papers, fact sheets and/or policy briefs on:
 - Sustainable seaweed farming and its potential for other marine sectors
 - Integrated solutions leading to 'Offshore Energy Platforms (based on results from stakeholder round tables)
 - Social impacts from large-scale seaweed farms (building on WP6)
 - Ecological impacts of large-scale seaweed farming
 - Boosting the blue economy via realising the seaweed-to-biofuels value chain (building on results from WP6)
 - Seaweed based biofuels vs terrestrial plants biofuels
- Intensify knowledge transfer to relevant national and EU stakeholder platforms

WP7: Exploitation aspects

Next Steps (input and actions from all partners needed)

In progress:

- MacroFuels Conference as event for multiple stakeholders planned for May 2018 @ SAMS, a.o. with
 - ✓ Boat trips to the seaweed farm
 - ✓ Harvesting demonstration
 - ✓ Meeting with policy makers and local communities

Needed:

- Make contacts with national/regional/local bodies and policy makers
- Provide info on (inter)national legislation and policies
- Identify stakeholders for cooperation and involvement
- Look out for existing initiatives that we can create synergies with
- Use own events and initiatives for liaising with stakeholders
- Suggest topics for White Papers and Knowledge Sheets

Roadmap for technical and non-technical activities



Exploitation = YOU !

**If we will successfully perform the actions mentioned,
MacroFuels will be a BIG success !**

- New papers
- New patents/licenses
- New products/applications
- New projects (MF II)
- New processes to be adopted
- ...

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