



KEY POINTS

- Algae are promising biofuels feedstocks;
- In addition to fuels, algae can deliver animal feed products, chemicals and nutraceuticals;
- Further research is needed and production processes still need to be optimized at several stages before reaching economic viability;
- Stakeholders should include academia as well as the industry; and
- Funding – from national and supranational organizations – still has a fundamental role to play.

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Special Report

Global: Algae Research and Development Update: Algae Workshop Summary

June 21, 2011

This Special Report summarizes the Workshop on Algae: Technology Status and Prospects for Deployment, co-chaired by the European Commission and Hart Energy, during the 19th European Biomass Conference in Berlin, Germany, on June 8, 2011.

The Workshop consisted of 17 presentations on the status of research and development activities in Europe and Canada, which were followed by seven short presentations on EU research projects.

The Workshop served to highlight the extent and variety of research into algae in Europe, particularly the work focusing on biofuels applications. Additional discussions centered on the sustainability of algae production linked to the origin of the CO₂ used and the amount and source of water used for algae cultivation; the energy consumption of the entire process from algae to fuel; and the benefits of co-products or by-products of algae production.

Background

The 19th European Biomass Conference in Berlin acknowledged the rising interest in the potential of algae as energy crops by not only hosting the Workshop on Algae as a parallel event, but also dedicating several sessions to the topic, including a plenary session on Wednesday, June 8, during which Maëlle Soares Pinto, Hart Energy's Director of Biofuels for Europe, presented on [Algal Biofuels Developments in the EU](#). This presentation focused on three large-scale algae demonstration projects, partly funded

by the EC's 7th Framework Programme (FP7) for research and development and industry-led. Hart Energy will disseminate the findings of the projects (BIOFAT, ALLGAS and INTESUSAL) for the next four years. The presentation also highlighted the links between the requirements under the Fuel Quality Directive (FQD) and Renewable Energy Directive (RED) and the potential and demands they place on algae-to-biofuels processes.

The Workshop addressed the most critical issues faced by the industry, including the range of products which can be obtained from algae, the optimization of separation and extraction technologies, and issues faced during deployment and scale-up. The speakers were from academia, industry, government agencies and an NGO, and from several European countries as well as Canada. Ample time was given for the audience to address questions to the presenters and promote the exchange of ideas during open discussions. In addition to these sessions, the Workshop also presented updates on seven European research initiatives linked to algae.

Session 1: Algae: Can We Domesticate Them So That They Produce What We Need?

The first session highlighted several research projects aimed at presenting decision makers with tools to assess algae projects. Raffaello Garofalo, European Algae Biomass Association (EABA), stressed that the aim should be to promote technological excellence in the production of biomass from algae, rather
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than the transformation into biofuels only. Garofalo also presented some preliminary results of AQUAFUELS, an FP7-funded project that aims to establish a network within the algae community, create a taxonomy library of all algae used for biofuels production, coordinate research into algae, carry out overall sustainability assessments of algae projects and present recommendations to decision makers. Robin Shields, Swansea University, presented the EU regional project ENALGAE, which focuses on the sustainable production of algae for energy in northwestern Europe and seeks to prepare tools for decision makers. Ed Hogan, Natural Resources Canada (NRC), announced that Canada was starting to look into algae as a biofuels feedstock, avoiding both the food vs. fuel issue and allowing for lower CO₂ emissions from road transportation fuels. In particular, NRC sees some potential for algae in biojet applications and in the treatment of wastewater effluents as well as the utilization of flue gas nutrients. Michael Kröger, German Biomass Research Centre (DBFZ), focused on the final biofuels obtained from algae processing. He highlighted issues encountered during the manufacture of FAME from algae when trying to achieve the EN 14214 standard. Kröger mentioned that similar issues could be faced when trying to obtain hydrogenated and hydrotreated vegetable oils from algae.

During the discussion session, the Co-Chair, Kyriakos Maniatis, principal administrator at the directorate general for energy (DG ENER), asked the audience about potential CO₂ sources for algae growth, and whether a source's fossil origin (for example, a power plant's flue gas) could have an impact on the classification of algae as biomass. The audience was generally of the opinion that algae should always be considered

biomass, no matter the source of CO₂ used, but agreed that this could not be considered a form of carbon sequestration. However, legal issues about the definition of what constitutes biomass were not addressed in this forum.

Session 2: Separation and Extraction: Nightmare for Performance and Energy Use?

This session focused on separation and extraction methods that may improve the value of algae by increasing the concentration of proteins or nutrients or oil, while keeping the energy consumption as low as possible to deliver good GHG savings. Jonas H gh Hansen, Danish Technological institute (DTI), presented on separation and concentration methods that allow the concentration of proteins in algae, thus increasing their value as a food product. The wide variety of algae application was further emphasized by Michele Aresta, Bari University, who stated that the only way to make algae economical was within the concept of a biorefinery, where "chemicals paid for fuels." Laura Garcia Alba, Twente University, presented on a method of controlling the operational conditions during the algae conversion step so as to control the concentration of nutrients and other compounds in the oil obtained from algae. Hen Boele, Evodos, presented the company's harvesting system, which is a separation technology with low energy consumption. It has been selected by one of the large-scale demonstration projects sponsored by FP7 as well as by a large-scale algae plant in Australia.

The discussion which followed this session focused on the issue of water consumption and algae cultivation and whether a water consumption standard might be an effective tool to ensure sustainable water consumption. This issue does not affect marine algae, which

require seawater, or algae grown using wastewater or industrial water. However, it affects algae grown using freshwater because of the potential competition with other uses, such as agricultural or human consumption. Technology developments can improve the overall water consumption of algae cultivation as well as careful geographical positioning of algae production sites. The audience felt that this topic should be discussed among all stakeholders and that a water consumption standard might be too strong an instrument at this stage to tackle this issue.

Session 3: Deployment: Case Studies and Current Issues

This session presented the research carried out in several pilot projects throughout the EU, focusing on lipid extraction, light penetration in reactors, process improvements to increase productivity while reducing investment and operating costs, methane production, climate change, and renewable energy production from algae in the biorefinery concept.

Christine Rösch, Karlsruhe Institute of Technology (KIT), highlighted the research activity of KIT in microalgae and, in particular, algae nutrient content as well as sustainability. Wolfgang Frey, KIT, presented on an extraction method which could improve the downstream process and increase the overall life-cycle analysis of the process. Claire Remacle, University of Liege, presented the SUNBIOPATH project and the impact of light capture on biomass synthesis, with a special emphasis on methane production. Enrique Espí, Repsol, listed several algae projects that the Spanish oil company had already carried out in-house or with national research partners. Repsol's research focuses on the quality of the oil obtained from algae as it will affect the

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fuels which could be derived from it. He also spoke about the overall productivity and costs of the biofuels production process. Frédéric Vogel, Paul Scherrer Institute, presented the SUNCHEM project, which aims at producing methane from algae economically. The process, based on gasification, is also efficient at CO₂ recycling to optimize CO₂ mitigation. Tone Knudsen, the Bellona Foundation, reminded the audience that the whole purpose of considering algae as biofuels feedstock was to limit emissions and help fight climate change. Knudsen briefed the audience about the work that the NGO is doing with the European Biofuels Technology Platform to include algae and aviation biofuels in their areas of study. Gerfried Jungmeier, Joanneum Research, outlined how algae could play a greater role in the renewable energy outlook of Austria between now and 2050. For that to happen, though, he said that the biorefinery concept needed to be further developed and that siting issues needed to be resolved in Austria. He concluded that there might still be a long way to go before algae processes are ready for commercialization.

Session 4: Short Presentations and Rapporteur

This session consisted of seven short presentations and was summarized by Charles Banks, University of Southampton, who acted as rapporteur for the session.

His views were that current research on algae follows in the steps of the research started in the 1970s in the U.S. but which was discontinued when funding stopped. Current work focuses on different algae strains but the outcomes will depend on what product, or products, are sought. Research should now focus on identifying the best co-products, whether they are animal feed or nutraceuticals.

Some challenges remain to be solved:

- Can algae survive in mass culture and produce a lot of what we want? In other words, is a scale-up from pilot plant to commercial exploitation possible?
- Can we provide algae with what they need to grow and deliver those products? And then, can we get these products out of the algae?
- Should we consider more carefully the sustainability of the CO₂ used for algae growth?
- Can we design reactors that allow for good mixing and high productivity?
- Can we improve extraction techniques to increase yields while keeping energy consumption low? Have we carried out all the process integration studies that would minimize energy consumption?

These steps are all necessary to obtain fuels that must compete with very cheap fossil fuels.

Conclusion

The Workshop on Algae succeeded in bringing together scientists and stakeholders from several research institutes around Europe and beyond, as well as people from industry, NGOs and government bodies allowing a transfer of information on the status of research in the algae field and reasonable expectations for algae. In addition, the questions and discussions allowed the stakeholders from academia to listen to the concerns of other stakeholders, helping them to focus on delivering results that are compatible with market demand in terms of quantity, quality, sustainability and price. The Workshop also highlighted the importance of the first demonstration projects, now in their early stages, because the results they deliver will be crucial in establishing whether commercial operations can be economically viable in the longer term.

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