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Results of the EnAlgae Stakeholder Workshop on “Benefits and Risks from Biomass Production with Microalgae”

Held at Frankfurt Airport, Germany
On 5th June 2014

Energetic Algae ('EnAlgae')

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Results of the EnAlgae Stakeholder Workshop on "Benefits and Risks from Biomass Production with Microalgae"

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Introduction

The EnAlgae workshop on 5th June was dedicated to discuss benefits as well as critical issues regarding the sustainability of microalgae biomass production with final energy application. It was the objective of the workshop to

- provide new information on the sustainability of microalgae production,
- attract experts, stakeholders and citizens from different countries,
- give insights into the views of the attendees on controversial issues.

The World Café method was applied as a simple, effective, and flexible format for group dialogue of participants with individual perceptions on benefits and risks. Participants were randomly divided into mixed groups à five persons and one person for each group was selected for documentation and presentation of the results of the group discussion. The discussion was structured along the following questions:

- Should microalgae production be placed on non-arable land only?
- Is the application of CO_2 from fossil flue gas emissions desirable?
- Could microalgae production be regarded as conversion technology?
- Are energy saving systems more sustainable than water saving ones?
- What about the use of non-native or genetically modified microalgae?

These questions have been provided before the workshop together with some background information to introduce the participants into the topics for discussion. It was expected to get a broad spectrum of views and opinions, since stakeholders from industry, NGOs as well as from governmental institutions were invited. In the following the results of the group discussions which have been presented and partly discussed in the plenum are summarised.

Should microalgae production be placed on non-arable land only?

There was a broad consensus among the participants that first of all non-arable land should be used for microalgae production and that arable land should just be used in exceptional cases and under certain limitations. With regard to arable land, preferably less fertile land with low biodiversity should be applied for algae production. Doing so, this area would be converted to a much more productive site and thus land use efficiency could be increased without any interference with the natural environment. As knowledge is missing about the impacts of such a land use change on biodiversity it was highly recommended to do research on this issue. It was assumed that in this case land use change could result in an even higher biodiversity due to the lack of cultivation steps which are otherwise associated with traditional agricultural activities such as tillage or fertilization. Consequently, per se negative impacts on biodiversity and the environment should not be expected.

It was stated that generally the location of the algae production should depend on the purpose of application and the final product. For energy production, non-arable land is favorable, however, for large scale production, Europe seems not to be the appropriate terrain. Against the background of the EnAlgae project, which addresses solely North West Europe one has to clearly define the scope question. Considering NW-Europe different categories of non-arable land can be found such as industrial zones, landfills and dump sites, urban areas (cities) and very little sea (water) surfaces and marshes. On these areas, microalgae could be cultivated without any risks of land use competition and consequent restrictions. It was considered that because of the favorable economic features high value products could be produced on fertile arable land. In general, those sites should be preferred where environmental or infrastructural advantages can be captured, such as the supply of nutrients and CO_2 by waste streams as well as waste heat. The availability of these inputs in addition to potential benefits e.g. from bioremediation seem to be far more important for the selection of a microalgae production site for sustainable algae production than just the availability of non-arable land. In this context it was pointed out that microalgae production is currently not a stand-alone technology. It was suggested that a good option to produce algae in a sustainable and efficient way could be in urban areas. Simplified access to the well-known cultivation inputs can influence the efficiency of microalgae production, economically as well as environmentally in a very positive way. Besides, a combination of PV and microalgae to directly use the energy on site is one option to increase areal efficiency and simultaneously reduce the demand for fossil fuels and the production costs.

Is the application of CO_2 from fossil flue gas emissions desirable?

The limitation of CO_2 emissions as carbon source for microalgae cultivation to biogenic sources only – as it was the case to get funding in the FP7 algal biofuel projects – was regarded as not reasonable as long as the majority of energy production is based on fossil fuels. Therefore it was discussed to check the present attitude of the EU in this issue. It was proposed that it should not make a difference whether CO_2 from fossil or non-fossil sources is used for the production of a renewable energy carrier from algal biomass. Instead, more attention should be given to the quality of the CO_2. Higher CO_2 concentrations stimulate microalgal growth whereas flue gas contaminants could inhibit the biomass production. Additionally, flue gas from coal-fired power plants is regarded as a problematic source due to the demand for extensive gas cleaning.

It was stated that by feeding the algae with CO_2 from flue gases, the CCS process could be replaced. The advantage of the algae production over the CCS technology would be that it does not reduce the efficiency of the power plant. Nevertheless this could only be possible if the microalgae can be produced on-site, without any long distance transport of the flue gas. Regarding the transport of CO_2 from the source to an algae production site, only short-distance CO_2 transport was regarded as acceptable because of energy and resource efficiency and the interference in landscape due to the construction of pipelines. Therefore, co-location of the CO_2 source and the algae production site should be aimed for. Apart from the carbon source, the flue gas can also serve as a heat source for drying processes if the algae production plant is co-located to a CO_2 source. However, with the current microalgae technology there is a “scaling” problem. The high amounts of CO_2 in the flue gas emitted by a power plant of up to 1000 MW electric capacity can by far not be taken up by algae cultivated on the available areas in the surrounding of a power plant.

At the moment, large industrial enterprises are not further interested in “greening” their production by cultivating microalgae to use their CO_2 emissions. Consequently, SMEs can be considered as the driver of innovations and improvement in CO_2 supply for algae cultivation and algae biotechnology in general.

Does the energy balance need to be highly positive or can microalgae production be regarded as conversion technology?

Energy balances calculated in the EnAlgae project and published in latest literature show negative results for the production of liquid energy carriers with microalgae. The conversion of electricity and sunlight to a liquid energy carrier with a negative energy balance was hence regarded as status quo. However, whether the energy balance needs to be positive highly depends on the energy carrier that is produced. Looking at jet fuels for instance the only renewable feedstock which produces the required oil content and composition, is microalgae. Consequently, for some participants it was not urgently necessary to achieve a positive energy balance but to gain a renewable kerosene equivalent. On the other hand, the conversion was perceived by other participants as a “dirty trick” to stay at the status quo of algal biotechnology instead of making every effort to reduce the energy demand of algal biomass production by further research activities. To evaluate the efficiency and sustainability of algae as conversion technology a comparison to other systems, like the power to gas technology, is urgently needed. Besides, it has to be considered that for the algae conversion technology significant demands on other renewable and non-renewable resources such as water and nutrients are required.

It was noticed that the idea of transferring renewable electricity into an algal biofuel might predominately reflect the particular setting in Germany where excess electricity form PV and wind is temporarily available and different storage technologies are under investigation. Electricity is a high value and broadly applicable energy carrier. Thus, only in the case of producing excess electricity (like in Germany) it seems to be a way to convert this energy to biomass and “store” it as liquid energy carrier. Moreover, via this conversion technology with microalgae peaks in energy production/supply and also prices can be balanced if the biomass production can be flexibly managed. Nevertheless, it was doubted if enough excess electricity is steadily available for continuous production of algal biofuels and it was not looked at as a feasible system design all over Europe, because electricity prices are too high. It was further pointed out that other storage technologies, like pumped storage hydro power stations, show much higher storage efficiencies than microalgae.

It was stated, that positive energy balances could be achieved by integrated systems which perform very well. The combination of solar energy production (electricity and heat) attached to the microalgae biomass production significantly improves the energy efficiency of the system. Innovative approaches in the field of genetic modification could skip the step of biomass conversion but stimulate the algae to directly produce hydrogen in the future.

Are energy saving microalgae production systems more sustainable than water saving ones?

It was concluded that the water demand for algae production should get more attention and is as important as the energy issue and that therefore production systems should be optimized in both directions since energy and water savings are not contradictory. The paradigm that open systems use less energy but perform worse in water balance was refused. Mixing and CO_2 gassing in open systems consume huge amounts of energy. Additionally the low biomass concentrations e.g. in open ponds result in high energy consumption for harvesting per kilogram algae. High energy requirements lead to higher biomass production costs.

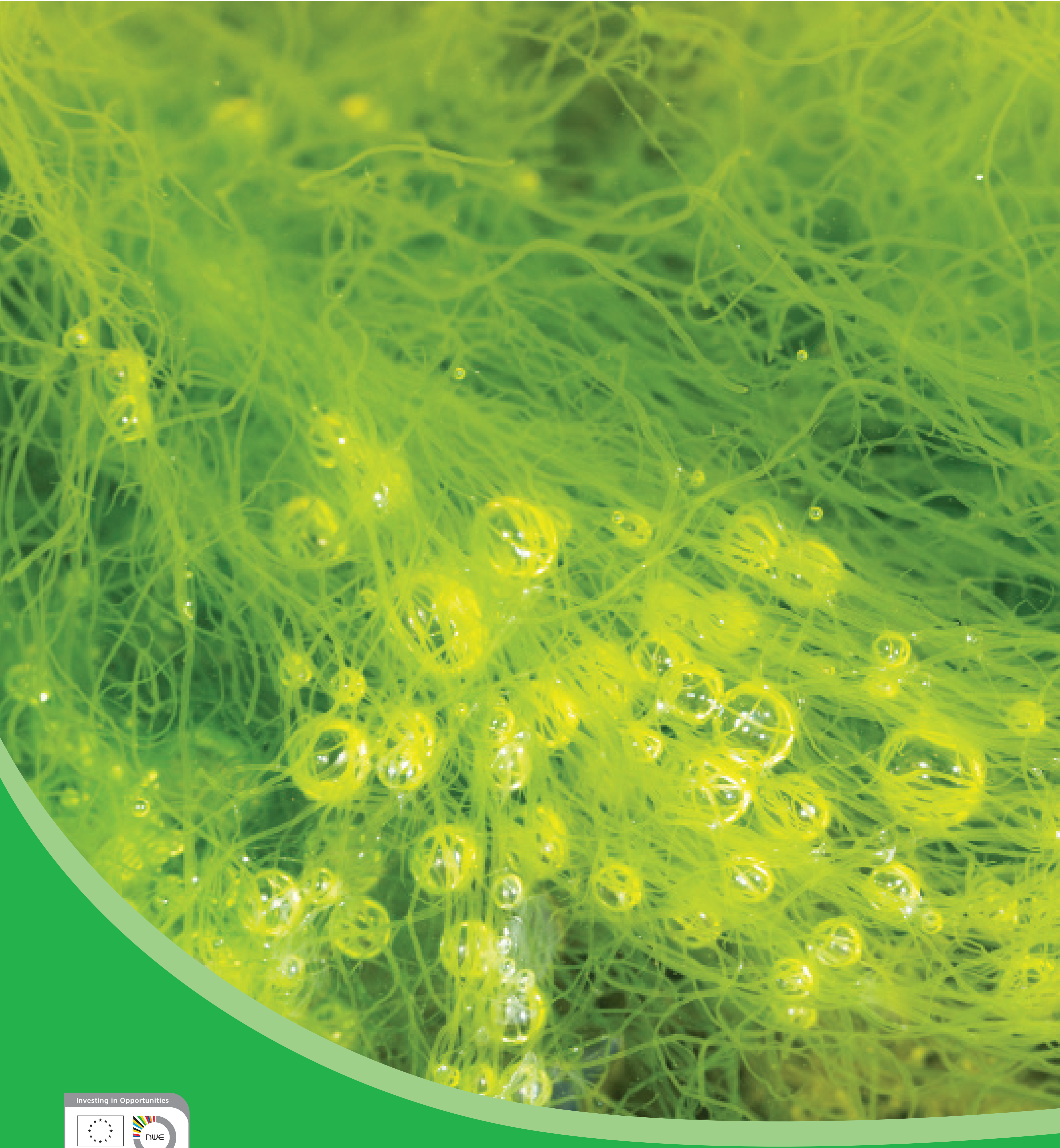
Generally the whole production chain should be considered and embodied use of energy and water should be detected. In particular, water recycling systems with low energy demand should be investigated because large-scale algae biomass production plants won’t get permits to discharge excess process water from harvesting. Also water requirements were considered as an important issue. Especially in upscaling scenarios savings should be achieved. Like in the energy topic, first expectations are misleading. Due to evaporation in open systems huge amounts of water are needed but cooling of closed systems with spray water must not be neglected in calculating water balances. For sustainability evaluation in the water context, the type of the water source is crucial. Process water (technical media) seems to be economically preferable, because certain parameters can be adjusted. Therefore the use of waste water, which is often variable in quality, does not seem realistic, especially for algal energy production.

What are the perceptions of the use of non-native or genetically modified microalgae?

The participants made clear that genetically modified algae should not be used because of the inherent risks associated with their cultivation and the difficulty to avoid leakages. One exception of GMO application could be for closely specified pharmaceutical purposes under controlled conditions. GMO-algae can have the advantage of producing pyrogen-free compounds (in contrast to GMO bacteria) that can be used in the pharmaceutical industry. The costly pyrogen removal could be avoided.

Many mutations can be achieved through classical breeding and positive qualities like fast cell divisions can be observed. Besides, it is regarded as a great challenge to stabilize and maintain the genetic modification during large scale operation because offspring can lose the engineered part which is dedicated to store energy in the algal cell. The offspring can then use sun energy for growth and fast reproduction only and suppresses the growth of the original GMO algae.

In the US, GMO microalgae are already cultivated but it is questionable whether there exist reliable technological processes that prevent the GMO algae to spread. Although they might only survive in selective artificial environments within the cultivation system and not under outdoor conditions there was consensus that native species should be preferred. Besides GMO algae, non-native species should be avoided despite the finding that microalgae occur everywhere and drifts via the air and adaptations in the past lead to higher biodiversity and “nativeness” in a certain area. Against this ubiquitous existence of algae species around the world the question arose on the definition of native and non-native algae.



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EnAlgae is a four-year Strategic Initiative of the INTERREG IVB North West Europe programme. It brings together 19 partners and 14 observers across 7 EU Member States with the aim of developing sustainable technologies for algal biomass production.

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This report has been published by Swansea University, lead partner of the EnAlgae project.
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