trans algae

INFOSHEET

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Biogas from Algae in Nordic Countries

Anaerobic digestion of algae has gained high attention recently, both as a renewable energy source and for wastewater treatment. The biodegradability of algae, based on methane yield and biomethane potential (BMP), varies significantly depending on the species. These properties are key parameters to be considered for economy, design, and operation of a full-scale biogas plant that wants to use algal biomass as substrates for biogas production. However, there are still some issues remaining that need research before it can be implemented.

BIOGAS

Biogas, which is produced through anaerobic digestion (without oxygen), consists mainly of methane (CH_4) and carbon dioxide (CO_2). It can be used for heating and production of electricity or upgraded into biomethane and used as transport fuel. Usually it is made from organic waste, but could also be produced from algae. This could help to reduce the use of fossil fuel and steer the economy to more sustainable resources.

ALGAE

Algae is a 3rd generation biofuel that in theory can be grown cost effectively in waste streams and ponds with sustainable means. The 1st generation of biofuels is made from food crops and the 2nd generally from waste products. Algae can also be seen as carbon capturer since algae use CO_2, light and nutrients to produce biomass. This can help with environmental issues, such as global warming and eutrophication.

MICRO- AND MACROALGAE

Both micro- and macroalgae can be utilized for many different applications; for biogas as well. In TransAlgae thus far, different consortia of microalgae, such as *Scenedesmus spp*., and one macroalgae, kelp (*Laminaria Digitata*), have been anaerobically digested.

However, it has previously been shown that especially microalgae are difficult to completely digest, which also has been shown in experiments in TransAlgae. Therefore, pretreatment methods have to be investigated next. Another issue is the nutrient composition of microalgae. This can be improved by co-digestion, which is to combine two or more substrates for anaerobic digestion. By doing this, a better balance between carbon and nitrogen can be achieved. Thus far, a small synergistic effect from co-digestion has been observed in biogas trials at Novia UAS.

METHODS

The main device used in the laboratory work by Novia UAS in TransAlgae is the Automated Methane Potential Test System II (AMPTS II) by Bioprocess Control. This allows for a convenient way of finding out the biomethane potential (BMP). Its application in TransAlgae is further explained in infosheet #4.

Ongoing BMP-tests at Novia UAS

System analysis is primarily done by calculating a preliminary energy balance, which summarizes the input and output energy flows of the processes.

BIOMETHANE POTENTIAL

The assays to find out BMP of algae mixed with locally available substrates are still being conducted, however, a couple of findings can be mentioned. Since the nutrient composition of microalgae is imbalanced, with too much nitrogen in relation to carbon, straw was mixed with untreated microalgae. A small synergistic effect could be observed. It can be expected that if both straw and microalgae would be pretreated, so that more of their components are available for digestion, the effect of co-digestion would increase. Wild *Laminaria Digitata* has initially proved to be an interesting substrate. Organic waste, which already has a high BMP, can be mixed with both micro- and macroalgae. Even though anaerobic digestion does not generally require drying, the low concentration of digestible material from harvested microalgae showed that some dewatering is needed for biogas production.

ENERGY BALANCE

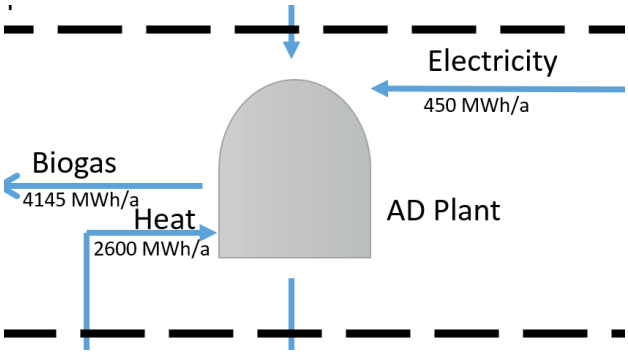
The energy balance of algae cultivation coupled to anaerobic digestion is necessary for checking the feasibility of the concept. Due to some intense process costs, such as harvest of algae, it has been difficult to achieve a net gain by only producing microalgae for energy. However, the Nordic climate, with its low temperature and seasonally limited sunlight, provides an additional challenge for using algae. Since anaerobic digestion takes place at either 37°C or 55°C, the latter in this project, the process itself needs a considerable amount of energy. The heating of the reactor will always consume some of the produced energy, but for the systems investigated in TransAlgae, many more processes will have to be included in the energy balance.

At the time of this report, no actual data from investigations in TransAlgae was available. A preliminary energy balance served mostly as a way to identify knowledge gaps and possible issues with analysing the system as early as possible. It was shown that by using a real and relatively high BMP-value (of *Laminaria Digitata*), and only for the biogas reactor itself, a net gain can be achieved, but likely not if other processes such as cultivation is included. A more detailed and inclusive study is under way. This also shows the need for the biorefinery concept, where several functions take place simultaneously, such as wastewater treatment and valuable products. While energy balance is important, other values can be included, such as contributing to usage of renewable biofuels.

CONCLUSION

While biogas from both micro- and macroalgae seems to be a promising 3rd generation biofuel, several issues remain. These are further complicated in a Nordic climate, where both temperature and light is limited. There is still development needed to establish anaerobic digestion of algae as a technique. Preliminary investigations show that it is unlikely that production of only energy is feasible. Combining several processes and products can improve this. The feasibility of these systems, so called biorefineries, are currently being analysed.

Further experiments with co-digestion, as well as pretreatment, will be conducted by Novia UAS. An initial, full, energy balance will be available by summer 2017, which would show the feasibility. The full report serves as a good source for general knowledge about algae cultivation for biogas production.



Analysed part extracted from the system.

AUTHORS AND REFERENCE

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Full report: Shiva Sharma, 2017, Algae Energy: A Perspective on Algae as a Biogas Source in Nordic Climate, TransAlgae Research report