ALLGAS - LARGE SCALE PRODUCTION OF BIOFUELS FROM WASTEWATER ALGAE

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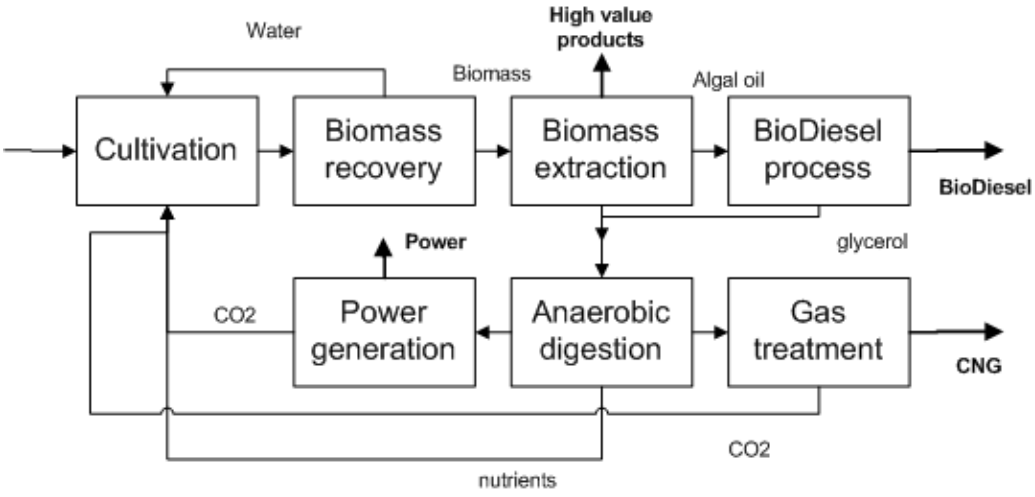
The objective of this project is to demonstrate on an industrial scale the feasibility of the sustainable production of bio-fuels based on low cost microalgae cultures. The full chain of processes from algae ponds, to biomass separation and processing for oil and other chemicals, extraction, downstream processing for biofuel production, as well as the demonstration of vehicle use, will be implemented on a 10 ha facility. The process scheme is shown in Picture 1.

To minimize financial and environmental impacts, the approach is based on the recycle of organic matter from agricultural residues and wastewater to produce CO2 and biogas, as well as the recovery of nutrients and water, in order to encourage the growth of algae under favourable conditions and extract oils and chemical byproducts from the algae biomass.

Our consortium has developed an innovative approach to reach these targets, and provide a cost effective and sustainable biofuel production.



Picture 1: Flow scheme for the process

Instead of only recovering algal lipids for oil extraction, the whole algal biomass is transformed into a variety of products such as LPG, biogas and biodiesel. In addition, wastewater solids and algae residue are anaerobically digested to biogas.

To confirm these estimates, and to limit the risk of scale-up, the main process components are first designed, built and operated in a prototype plant comprising their largest unitary sizes, based on a 5000 m^2 pond system, to be operated and optimised during a 2 year period. Simultaneously, certain critical parameters and complementary technologies are investigated in parallel at lab and pilot scale, to maximise the biofuel production and minimize cost and environmental impacts before building the full facility.

Only once the whole process and the main components have been confirmed by more than a year of operation on a scale 1 to 1, the gathered knowledge and experience will be integrated into the design,

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construction and operation of a 10 ha facility, to reach the total algae production close to 1000 tonnes/ha/yr. This farm will comprise up to 20 ponds systems of 5000 m^2 each, located at Chiclana, Spain, close to the Mediterranean sea.

In order to address the technical challenges as well as large scale project management, our consortium encompasses leading companies in each project component. It is coordinated by Aqualia of Spain, a leading builder and manager of large public infrastructure projects, employing 6000 people,

To grow the algae target of 100 t/ha/yr, a theoretical minimum CO_2 quantity of at least twice the biomass is needed. Only about half of the minimum CO_2 nrequirement can be recovered from the biogas produced by anaerobic digestion of wastewater solids and algae residuals. Because of system losses, most high rate algae growth system inject about twice the minimum amount.

In this project, the main know-how on algae growth is provided by CleanAlgae, a SME with head offices in Las Palmas, Gran Canaria, where currently 1000 m^2 of algae ponds are being operated and a 1 ha facility is under construction. Clean Algae has developed a specific device, the Light Enhancement Factor (LEF), to enhance the light penetration in ponds and at least double their productivity, which will allow reaching the specified algae yield even using low cost and simple pond systems. This technology will be validated and upscaled to the 10 ha scale to demonstrate the required algae production targets.

Algae harvesting and processing is provided by AlgaeBiotech, a sister-SME also located in Gran Canaria, and dedicated to creating new innovative products and processes in the field of product extraction from algae

The main testing and development of biodiesel production is carried out by BDI – BioEnergy International AG, from Graz, Austria, one of the world's leading suppliers of complete BioDiesel production plants with in-depth experience with the processing of various and difficult raw materials. In collaboration with the Fraunhofer Umsicht Institute in Oberhausen, Germany, BDI performs the transesterification and purification of the algae oils in its existing pilot plant at the in-house research and development facilities.

In the second step of the project, once the algae oil product meets the given fuel quality standards, BDI will modify one of the existing 30 BDI-Biodiesel plants it has designed to process the oil from the expected yield algae biomass.

Once algae oils and related sub-products have been extracted, the remaining biomass is incorporated in the biomass recovery plant for conversion into biogas. After digestion, the residues are dewatered, in order to recover the nutrients, while the solids are thermally treated for conversion into heat and CO_2. In the preliminary phase of this project, Soton optimises the net energy yield of the biomass recovery plant, by enhancing the anaerobic digestion of residues to produce biogas and a carbon-rich exhaust gas, as well as to recover mineral elements and nutrients to be re-utilised in the algal production process.

Biogas from the anaerobic fermentation of the residual biomass and wastewater solids are a complementary biofuel provided by the project. Hygear, an SME based in Arnhem, the Netherlands, focusing on development and manufacturing of gas generation products for fuelling stations, provides the engineering of gas separation and conditioning, in order to produce vehicle-grade biomethane, equivalent to compressed natural gas (CNG), as well as CO_2 for the algae cultures.

To evaluate the overall sustainability of the project, and identify the critical parameters that will allow extrapolating the project to other sites, the Fraunhofer Institute from Oberhausen, Germany, analyzes the environmental and social impacts of the production of biofuels from algae and their by-products.

The whole process chains (necessary inputs, algae cultivation, harvesting, transport, algae oil extraction and transformation, residue fermentation and combustion, plus by-products utilisation) will be assessed based on their effect on sustainable development and greenhouse gas balance. Closely linked to the technical activities, environmental, economic and social criteria will be developed and applied to rate and to rank the influence on sustainable development, and to recommend optimisations of the processes to maximize sustainability.