

SUSTAINABILITY OF ALGAE ENERGY SYSTEMS – MODELING AND CASE STUDIES

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Content

Within the finalized project “Algae&Energy:Austria – Algae - A Future Renewable Energy Source? - Current Status and Future Perspectives for the Austrian Energy System” basic knowledge about algal energy systems and their environmental performance (analyzed with a life-cycle analysis) has been gained. This basic knowledge is used to develop a standard methodology for sustainability assessment for microalgal biomass and the whole energy production system involved. The developed methodology for sustainability assessment contains the methodologies for the assessment of economic, environmental and social aspects and reflects the current status on knowledge of assessing the sustainability of algal energy systems. The key elements to measure the sustainability are identified (e.g. global warming potential, water demand, investment cost, market aspects, employment, regional cooperations). The methodology will be used to assess the sustainability of two case studies in comparison to a substituted reference system. A modeling of the process of the two case studies, including e.g. the definition of system boundaries, allocation issues, has been done.

The two case studies are the integrated process of the European project FUEL4ME and the ecoduna production plant in Bruck an der Leitha. The project “FUEL4ME - Future European League 4 Microalgal Energy” - is driven by the urgent need of transforming the current energy system into a sustainable one, which pursues the European and global energy goals reducing GHG emissions, finding alternatives to fossil fuels and fostering the renewable energies. Microalgae are one of the most attractive sources of liquid transportation biofuels (e.g. biodiesel, hydrotreated vegetable oils (HVO)), since they can produce energy-rich molecules. FUEL4ME aims at developing and demonstrating an integrated and sustainable process for continuous biofuel production from microalgae, and thereby making the second generation of biofuels (HVO) competitive alternatives to fossil fuels. The ecoduna production plant aims at producing omega-3 fatty acids for human nutrition. This plant is a demo plant using flat-plate photobioreactors for microalgae cultivation. An environmental assessment is done to provide information about the greenhouse gas emissions and the fossil primary energy demand of this facility.

Methodology

Starting with the existing methodologies of sustainability assessment and the knowledge gained within the Austrian project Algae&Energy:Austria the methodologies of sustainability assessment are modified for the application to energy systems with microalgae. For the development of the methodology ongoing international developments are considered to work towards a standard and harmonized methodology for algal energy systems, e.g. ILCD-Handbook (International Reference Life Cycle Data System) and methodology for LCA, methodology of the sustainability assessment of further FP7 funded biorefinery projects (SUPRABIO, EuroBioRef, BIOCORE), furthermore the methodology is adapted to the requirement of energy systems with algae. Within this assessment the methodology is applied in the project FUEL4ME and for the algae production plant of ecoduna AG in Bruck an der Leitha.

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Results

The results suggest a standard methodology to assess an energy system with microalgae for the three sustainability dimensions: economic, environmental and social. The key elements of the methodology are identified, and described, e.g. system boundary, allocation issues, future technology development, selection of reference systems and products. Within the development of the methodology some questions have been raised and a solution has been suggested, e.g. how to assess the use of CO₂ from power plants using fossil energy. The developed methodology is used to assess the sustainability for the two case studies (FUEL4ME, ecoduna production plant). The results of the sustainability assessment are used to identify obstacles for an efficient process in different dimensions and will help to guide the development of the two case studies towards the highest possible sustainability in comparison to a substituted reference system.

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