Technoeconomic analysis of an integrated microalgae photobioreactor, biodiesel and biogas production facility

ABSTRACT

As fossil fuel prices increase and environmental concerns gain prominence, the development of alternative fuels from biomass has become more important. Biodiesel produced from microalgae is becoming an attractive alternative to share the role of petroleum. Currently it appears that the production of microalgal biodiesel is not economically viable in current environment because it costs more than conventional fuels. Therefore, a new concept is introduced in this article as an option to reduce the total production cost of microalgal biodiesel. The integration of biodiesel production system with methane production via anaerobic digestion is proved in improving the economics and sustainability of overall biodiesel stages. Anaerobic digestion of microalgae produces methane and further be converted to generate electricity. The generated electricity can surrogate the consumption of energy that require in microalgal cultivation, dewatering, extraction and transesterification process. From theoretical calculations, the electricity generated from methane is able to power all of the biodiesel production stages and will substantially reduce the cost of biodiesel production (33% reduction). The carbon emissions of biodiesel production systems are also reduced by approximately 75% when utilizing biogas electricity compared to when the electricity is otherwise purchased from the Victorian grid. The overall findings from this study indicate that the approach of digesting microalgal waste to produce biogas will make the production of biodiesel from algae more viable by reducing the overall cost of production per unit of biodiesel and hence enable biodiesel to be more competitive with existing fuels.

Keyword: Microalgae; Tetraselmis suecica; Photobioreactor; Biodiesel; Anaerobic digestion; Biogas