“Green Algae Hydrogen Production”

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Abstract

Since the beginning of the industrial era, anthropogenic activities released huge amounts of CO_2 in the atmosphere via the combustion of fossil fuels. Carbon dioxide is a greenhouse gas and the biggest responsible of the global warming phenomenon. The development of a sustainable way of utilizing alternative energy sources is necessary to minimize the production of pollutants from carbon-based fuels. One of the potential candidates to replace fossil fuels is molecular hydrogen (H_2), that’s currently obtained from different reforming techniques that uses fossil fuels as raw material.

Green Algae Hydrogen Production is a project dedicated to the study of strategies that exploits microalgae to produce sustainable Green Hydrogen. There are several advantages regarding the use of biomass for hydrogen production, including: large storage capacity, low price, great potential for commercialization, carbon neutrality and mild reaction conditions. The production of said hydrogen is strictly linked to CO_2 biofixation; so the development of a microalgae strain capable of quick and efficient CO_2 capture is mandatory and one of the topics we will investigate.

Our main interest for the first part of the project concerns biogas upgrading. Biogas is a mixture of mostly CO_2 and CH_4, derived from the anaerobic digestion of organic matter. The capture of the former via microalgal photosynthesis can be exploited to produce grid-quality biomethane that comes from renewable resources.

Regarding Hydrogen, it can be produced in two different ways from algae biomass, majorly thermochemical and biological. Pyrolysis is the most widely used thermochemical treatment process to produce bio-oil and biochar from biomass in the absence of oxygen. Some biological methods include the production of biohydrogen during the algal metabolism exploiting peculiar culture conditions.

The ultimate goal of this project is the realization of a circular biorefinery, where the chosen algae can proliferate as quickly and as efficiently as possible. After their growth inside a dedicated photoreactor, part of the biomass can be collected and used to produce green hydrogen with one of the methods briefly described above, alongside other chemicals with high added value. The carbon dioxide produced during the gasification/pyrolysis is partially used as a carbon source for another batch of algae, making the whole process carbon neutral/negative.