Decarbonizing climate by producing synthetic fuels from seawater
A case study on the Ecole Polytechnique lake

X-Fuel

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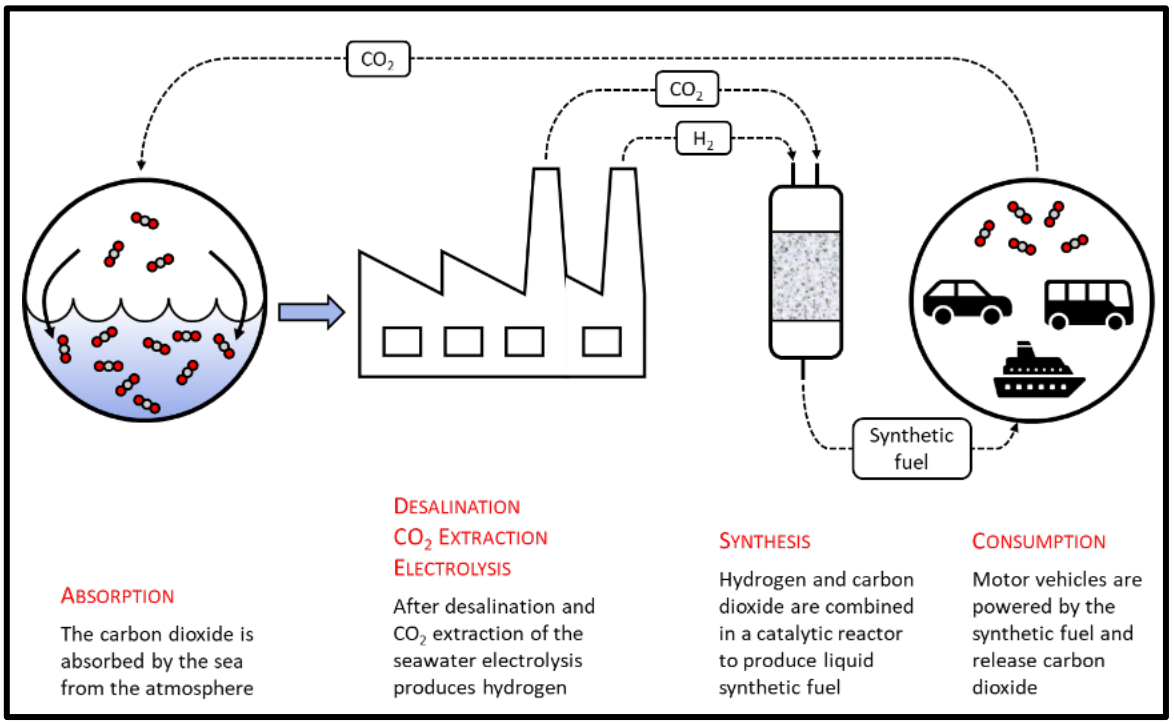
Context

A study recently initiated the idea that a synthetic fuel (methanol, CH_3OH or MeOH) could be produced from CO_2 dissolved in seawater using "photovoltaic-powered solar methanol island".[1] The interest of extracting CO_2 from seawater rather than its direct capture in the atmosphere is simply due to the large difference in concentration (99 g CO_2/m^3 in the ocean vs. 0.79 g CO_2/m^3 in the atmosphere). To summarize briefly this approach, the CO_2 extracted from seawater would be combined in a reactor with dihydrogen (H_2) – produced from electrolysis of desalinated seawater – to give methanol (Scheme 1). The energy required for the different processes would be generated by photovoltaic (PV) solar panels. Those devices would be integrated on a floating island located in specific region of the world where insolation and water depth are optimal, with low probability of hurricanes.



Scheme 1 – Decarbonization of the atmosphere by synthetic fuels.

1. Patterson, B. D.; Mo, F.; Borgschulte, A.; Hillestad, M.; Joos, F.; Kristiansen, T.; Sunde, S.; van Bokhoven, J. A. Renewable CO_2 recycling and synthetic fuel production in a marine environment. *Proc. Natl. Acad. Sci. U. S. A.* **2019,** *116*, 12212 (link).

In the frame of the SeaFuels project of the Energy4Climate center (https://www.e4c.ip-paris.fr/), the proposed internship will focused on a feasibility study to develop a demonstrator on the Ecole Polytechnique lake, by combining the expertise from the LCM chemistry lab and the LMD climate science lab. The study will consider the different parameters required to build this on-site demonstrator: scaling of the demonstrator (liters of fuel produced/day/surface of the solar panels to power the device); cost and availability of the different modules; chemical composition of the lake water (CO_2 and ions concentration, pH); surface area of the whole demonstrator (inland and offshore); global environment considerations (protected area, rowing club, etc.).

Approach

Several steps are foreseen:

- Bibliographic and technical research in order to research for the modules that could be available
- Data collection and analyses in order to decide on the adapted material and the sizing of all components. Data collection includes lake water analyses and solar resource analyses.
- Theoretical study of the performance of the system, by taking into account the chosen modules and sizing characteristics. Calculation of the liters of fuel produced/day/surface).

The joint expertise in photovoltaics and chemistry from the advisors is unique and is key to conduct such original study. Regular joint meetings LMD/LCM will be held in order to take advantage of the multi-disciplinary expertise.

Profile of the M1/M2 student

The internship candidates should be in a Master track with strong background in physics and/or chemistry. Additional training on climate and environment sciences is not mandatory but welcome.