Optimizing biofuel production from algae using carbon dioxide emissions

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The combustion of fossil fuels drives the world's energy production, but it also emits carbon dioxide (CO_2) and other greenhouse gases. In recent years, researchers have worked to cultivate alternative, renewable energy sources, including using algae-based systems. Now, a team reports in ACS' journal *Industrial & Engineering Chemistry Research* an optimized way of producing biofuel from algae that also removes CO_2 emissions from the environment.

Algae-based biorefineries only need nutrients, water, sunlight and CO_2 to run. The aim of these systems is to produce cleaner energy in the form of biodiesel, methane or ethanol. However, current configurations are costly both in terms of money and energy. To address this issue, Eusiel Rubio-Castro and colleagues developed a mathematical model to determine the optimal design of an algae-based biorefinery where flue gases from different industrial facilities are used as raw materials.

The team developed a mixed integer non-linear programming (MINLP) model and applied it to a case study in Mexico. Their model determined that using flue gases as a source of CO_2 reduced costs associated with the algae-growing stage of the process—the most expensive part—and reduced all other costs by almost 90 percent.

Using water recycled within the biorefining process also reduced fresh water needs by about 83 percent. However, as the technology stands, the researchers say that the costs are still too high to justify an algae-based biorefinery on its own. Instead, they say that producing cleaner, algae-

based fuels should be seen as a necessary expense in the global effort to reduce and capture carbon emissions.

More information: Oscar Martín Hernández-Calderón et al. Optimal Design of Distributed Algae-Based Biorefineries Using CO Emissions from Multiple Industrial Plants , *Industrial & Engineering Chemistry Research* (2016). DOI: 10.1021/acs.iecr.5b01684

Abstract

This work proposes an optimization approach for capturing carbon dioxide from different industrial facilities to yield an algae-based biorefinery. The proposed approach is based on a distributed system to account for the economies of scale and includes site selection for the processing facilities. Additionally, the model considers optimization for the technologies used in the process stages and different technologies to yield several products. The algae oil that is obtained from each facility can be sent to processing hubs located in the same plant and/or to a central processing unit. The objective function is to minimize the total annual cost for the treatment of flue gases, including the capital and operating costs for the different processing stages and the overall transportation costs associated with the system minus the sales of products plus the tax credit for reducing CO2 emissions. The results show several economic benefits.

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