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Anthropogenic CO_2 as a Feedstock for Cyanobacteria-Based Biofuels

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Biofuels have great potential as low-carbon alternatives to fossil-based transportation fuels, and can serve as drop-in fuels for existing transportation infrastructures. This talk will focus on utilization of anthropogenic CO_2 in an advanced biofuel system and the integration of that system with fossil-fuel power plants. The biofuel system is the Algenol Direct to Ethanol® technology, which provides an efficient, cyanobacteria-based system for producing ethanol, as well as a bio-crude co-product [1]. The talk will begin with an overview of the Algenol technology: the genetic enhancement approach for enabling ethanol production in the organisms; ethanol and biomass production in outdoor cultures contained in large photobioreactor arrays; downstream processing systems; and phenomenological productivity modeling in terms of quantum yields, photo-saturation effects, respiration, and carbon partitioning. Overall, the results are consistent with a very efficient photosynthetic system in which more than 75% of the photosynthetically fixed carbon is diverted into the ethanol production pathway. The Algenol process consumes CO_2 in a solar energy conversion process that yields a biofuel with much lower greenhouse gas emissions than gasoline [2-3]. Different options for CO_2 capture and utilization are considered and their impact on the overall system operation evaluated. Comparisons of life-cycle carbon footprints are made for the Algenol technology versus other transportation fuel options, including electric vehicles [3]. Finally, we expand the boundary of the life cycle analysis to include the power plant, specifically considering natural gas and three coal-based options, and compare carbon footprints for the integrated systems to CCS (carbon capture and sequestration) as well as to the status quo of CO_2 release to the atmosphere [4].

[1] For more information see www.algenol.com. This talk summarizes the work of over 200 Algenol employees in Fort Myers, Florida and Berlin, Germany, as well as collaborators at Georgia Tech.

[2] D. Luo, Z. Hu, D. Choi, V.M. Thomas, M.J. Realff, and R.R. Chance, "Lifecycle Energy and Greenhouse Gas Emissions from Ethanol Produced by Algae," *Environmental Science and Technology* **44**, 8670 (2010).

[3] Notice of EPA pathway approval: http://epa.gov/otaq/fuels/renewablefuels/new-pathways/approved-pathways.htm

[4] R. P. Lively, P. Sharma, D. Luo, B. McCool, J. Beaudry-Losique, V. Thomas, M. Realff, and R. R. Chance, "Anthropogenic CO_2 as a feedstock for the production of algal-based biofuels," *Biofuels, Bioproducts, and Biorefining* (in press, July 2014, 10.1002/bbb.1505).