the ENERGY lab

PROJECT FACTS

ICCS - Area 2

Recovery Act: Re-utilization of Industrial Carbon Dioxide for Algae Production Using a Phase Change Material

Background

Worldwide carbon dioxide (CO_2) emissions from human activity have reached 33 billion tons annually. The use of new technologies for the capture, separation, and reuse of CO_2 will reduce the effect of industrial activity on global climate. The United States Department of Energy (DOE) actively seeks to encourage the development of practical technologies to capture and convert CO_2 into beneficial products without adversely influencing energy use or hindering economic growth.

One such promising technology is the use of CO_2 to promote the growth of algae that can be used to produce biofuels. During photosynthesis, algae and other photosynthetic organisms capture CO_2 and sunlight and convert it into oxygen and biomass. Up to 99 percent of the carbon dioxide in solution can be converted in large-scale open-pond systems. DOE National Energy Technology Laboratory (NETL) is partnering with Touchstone Research Laboratory (Touchstone) to advance the emerging algae biofuels industry.

Project Description

Touchstone will demonstrate a process for capturing and reusing CO_2 generated from a small, industrial coal-powered source by using algae grown in an open pond system. This project will introduce a Phase Change Material (PCM) that will serve as a layer covering the pond surface. This covering will effectively regulate daily temperature fluctuations, reduce water losses from evaporation, and will help control the growth of invasive species. The PCM absorbs infrared solar radiation during the day as latent heat and releases it to the water at night when temperatures drop.

During Phase 1 of the project, researchers constructed a small, sub-scale laboratory demonstration pond to show that the use of a PCM to grow algae for CO_2 capture from an industrial source is a viable application. This small, sub-scale site design was used to help forecast the performance requirements of the PCM and gas injection components needed for the Phase 2 system. Cedar Lane Farms (CLF) provides their site, existing infrastructure, and their emission source for the project. CLF is a commercial grower of plants for the retail garden center industry with two production plants located on a 13-acre parcel in Wooster, OH. CLF uses a 2.8 megawatt (MW) coal-fired combustor at one of its production plants.

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PARTNERS

GZA GeoEnvironmental, Inc

The Ohio State University – Ohio Agricultural Research and Development Center (OARDC)

OpenAlgae, LLC

Cedar Lane Farms (CLF)

DURATION

Start Date	End Date
01/01/2010	09/30/2013

COST

Total Project Value
$8,446,700

DOE/Non-DOE Share
$6,757,360 / $1,689,340

Government funding for this project is provided in whole or in part through the American Recovery and Reinvestment Act.

U.S. DEPARTMENT OF ENERGY

During Phase 2, Touchstone constructed a half-acre open pond pilot system using PCM technology and emissions from the existing, adjacent, coal-fired source. Touchstone will operate the new system over a two-year period and will gather data (PCM performance, CO_2 injection rates, water quality, algae growth, etc.) to substantiate future commercialization efforts. CFL will provide operational labor to Touchstone for the new system. The project will begin harvesting the algae and extracting lipids for conversion into biofuels utilizing an on-site processing unit designed and built by OpenAlgae, LLC. High-density inoculants of algae strains from Touchstone photobioreactors will be cultured in preparation for introduction to the test ponds. Pilot-scale process development and testing of an anaerobic digestion process to convert residual algae lipids to biofuels will be performed by the Ohio Agricultural Research and Development Center (OARDC). The Phase 2 portion of the project was constructed and will be operated in accordance with the approved site plan.

Goals and Objectives

The goals of this project are to demonstrate the effectiveness of the PCM approach and to enhance the open-pond production process. The specific objectives of this project are to demonstrate the efficiency and benefits of a carbon capture and re-use process by growing algae in open ponds by using PCM technology at the pilot-scale; establish the projected capital and operating cost for scaled systems; and determine the economic viability of the system at scale, including the co-product value (liquid fuel and electricity).

Accomplishments

The research team has performed experimental testing including continued testing of a sub-scale prototype raceway pond incorporating the PCM; and anaerobic digestion trials of the algae residual biomass for methane production and recycling of nutrients for algae growth; and continuation of the lipid extraction and analysis from a novel aqueous phase extraction process. Touchstone has completed the design, engineering, and construction of the pilot-scale system which includes four, 30,000 gallon raceway ponds. Mass and energy balances of the integrated CO_2 capture and re-use process have been completed along with a detailed Phase II project budget. In addition, the team produced a detailed Greenhouse Gas Lifecycle Analysis and the project Environmental Information Volume (EIV). Phase I has been completed and the operational portion of Phase II collecting pilot-scale data is currently underway.

Benefits

The development and commercial scale deployment of the PCM process will allow industrial production of algae to produce biofuels while decreasing CO_2 emissions from industry. This will contribute to our nation's goal of reducing dependence on foreign-sourced energy fuels while also reducing industrial emissions of CO_2 which contribute to climate change and other ecological problems.

Touchstone Research Laboratory's Pilot Algal Facility at Cedar Lane Farms