



Pilot Scale Integrated Biorefinery for Producing Ethanol from Hybrid Algae

**Cooperative Research and Development
Final Report**

CRADA Number: CRD-10-389

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CRADA Report
NREL/TP-5100-60552
November 2013

Contract No. DE-AC36-08GO28308

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Cooperative Research and Development Final Report

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CRADA Title: Pilot Scale Integrated Biorefinery for Producing Ethanol from Hybrid Algae

Parties to the Agreement: Algenol Biofuels, Inc.

Joint Work Statement Funding Table showing DOE Commitment:

Estimated Costs	NREL Shared Resources
Year 1	\$ 424,480.00
Year 2	\$ 184,068.00
Year 3	\$ 60,021.00
TOTALS	\$ 668,569.00

Abstract of CRADA Work:

This collaboration between Algenol Biofuels Inc. and NREL will provide valuable information regarding Direct to Ethanol technology. Specifically, the cooperative R&D will analyze the use of flue gas from industrial sources in the Direct to Ethanol process, which may demonstrate the potential to significantly reduce greenhouse gas emissions while simultaneously producing a valuable product, i.e., ethanol.

Additionally, Algenol Biofuels Inc. and NREL will develop both a techno-economic model with full material and energy balances and an updated life-cycle analysis to identify greenhouse gas emissions relative to gasoline, each of which will provide a better understanding of the Direct to Ethanol process and further demonstrate that it is a breakthrough technology with varied and significant benefits.

Summary of Research Results:

1) Impact of long term cultivation with industrial CO₂ sources:

NREL evaluated the trace contaminants present in flue gas from both coal- and natural gas-fired power plants as well as concentrated CO₂ captured from a coal-fired power plant and from a steam methane reformer. A model was developed to calculate the accumulation of the various trace contaminants after long-term operation of an Algenol bioreactor and the impact on productivity was estimated based on a literature review of toxic effects of the different compounds.

2) New insights on physiology of cyanobacteria under conditions relevant to ethanol production:

To support the Algenol Integrated Biorefinery project, NREL set up cyanobacterial cultures under conditions that are relevant to Algenol outdoor photobioreactor operations and performed long-term

physiological studies. The results showed diversity of physiology among cyanobacterial strains and in response to environmental changes. This knowledge will guide cyanobacterial biofuels production in outdoor photobioreactors.

3) Life Cycle Assessment:

NREL has identified a number of pathways for spent biomass and photobioreactor disposition based on a range of assumptions regarding the duration of culture productivity and photobioreactor lifetimes. We provided TEA and LCA data on these aspects for incorporation into Algenol models.

Subject Inventions Listing:

None

Report Date:

09/27/13

Responsible Technical Contact at Alliance/NREL:

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