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U.S. Department
of Transportation



Project Title: **Hydrogen Fuel Production from Microalgae**

DR. SVETLANA OARD

Project Goal

The long term goal of the research is development of economically viable hydrogen (H₂) biofuels. We aimed to develop renewable H₂ fuels utilizing solar-powered CO₂-sequestering microalgae. Three components of an economical process were developed: scalable and economical algae cultivation, improved microalgae capable of producing H₂ in the presence of O₂, and H₂ utilization as transportation fuels.

Project Outcomes

- This project completed the development of microalgae/H₂ /fuel cell systems.
- A reliable system for microalgae transformation was selected, and stable genetic transformation of microalgae *Chlamydomonas* was demonstrated in the PI's laboratory. The best strain for genetic engineering of *Chlamydomonas* was selected after testing eight candidate strains. A chimeric gene cassette for inducible expression of the algal hydrogenase with the highest H₂ forming activity was constructed. This chimeric gene enables regulation of gene induction that will allow tuning of metabolic balance in algal cells.
- An advanced computational methodology that combined structure homology analysis, three dimensional mapping, and molecular dynamics simulations resulted in discovery of three functional networks in the hydrogenase protein matrix. Each network is linked to the catalytic site. Discovery of these networks will greatly facilitate design of mutations to increase hydrogenase resistance to O₂.
- Components of an economical process for scalable manufacturing of H₂ were analyzed. These included methods for scalable and economical algae cultivation, H₂ separation/purification, and storage/utilization.
- Preliminary analysis of process economics was performed and the rates of H₂ yield for commercial manufacturing were estimated.



PI: Dr. Svetlana Oard

Louisiana State University
AgCenter Biotechnology
Lab

Co-PI:

Dr. Michael Mailander

Louisiana State University
AgCenter BAE

Co-PI:

Dr. Chandra Theegala

Louisiana State University
AgCenter BAE

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