Algae Biodiesel: A Path to Commercialization

Center of Excellence for Hazardous Materials Management (CEHMM)
Carlsbad, New Mexico

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www.cehmm.org
Center of Excellence for Hazardous Materials Management

Non-Profit Organization Focused on Applied Research

- Established 2004 with a Department of Energy (DOE) grant
- Wildlife conservation and biomonitoring
- Algae biodiesel is largest CEHMM project
Project Overview: The Missing Piece of the Biodiesel Puzzle

- Began producing biodiesel from local WVO as community awareness initiative
- Understand need for adequate quantities of economically renewable feedstock that produces an oil which can replace petroleum
Project Overview: Local Resources for Algae Biodiesel

• Established R&D objective to develop algae as a feedstock using local resources
  – Flat desert land
  – Sun
  – Saltwater
Project Overview: Approach

• Began laboratory and bench scale testing 5/2006
• Made first biodiesel from local freshwater algae 6/2006

• Inoculated first outdoor tank 8/2006
• Currently operating numerous lab and bench-scale growth tanks

• Inoculated first pilot-scale 25,000 gallon pond 7/2007

• Developed collaborative project with NMSU and the City of Carlsbad

• Awarded $1M New Mexico Energy Innovation Fund Grant both in 2008 and 2009
Ribbon Cutting Ceremony for New Open Raceway Pond
Algae Biodiesel in New Mexico

Former NREL site

CEHMM pilot project

CEHMM Commercial Demonstration (future)
Areas of Innovation

- Simplified pond construction
- Brine microalgae
  - Maintain monoculture in open pond
  - Robust growth without infusing CO2
  - Development of proprietary growth compounds
  - Predation and Invasion Protocol
- Oil Extraction
  - Consistently fifty percent lipid content
Challenges

- Water management
  - Evaporation
  - Water to support a commercial facility
- Optimizing oil yields
- Venture capital
- Permitting
Permitting/Compliance Issues

- Currently, there are no State standards for algae grown in open ponds
- Dairy pond regulations are applied by the State of New Mexico
- A groundwater discharge permit is required by the State despite the fact that no water discharge occurs. Six month turn around time.
- Groundwater monitoring wells required
- Wild type species not genetically modified organism so no special permit required from the State or federal government
- Water rights
- National Environmental Protection Act (NEPA) considerations
- Need to achieve American Society for Testing and Materials (ASTM) standards for biodiesel (ASTM 6751)
Reasons for Algae Biofuel Development in New Mexico

- Large tracts of inexpensive non-arable land
- Moderate to hot temperatures year around
- A source of saline water that has no other use
- Marine algae have few predators or invaders
- CEHMM species can be grown year around

- Can grow algae in produced water from oil and gas wells. This water is considered waste and injected back into the ground. In 2007 the number of gallons statewide was 669,723,306 and in 2008 the number of gallons was 744,335,308
- Ample sunshine makes the use of solar energy an option to power a commercial facility
Path to Commercialization

- Patents and Trade Secrets
- Spin-off for profit corporation as tech transfer vehicle
- Technical feasibility by 12/2009
- Design and construct commercial-scale demonstration by 2/2014
DOE Solicitation for Integrated Biorefinery Proposal

• CEHMM, New Mexico State University, Sandia National Laboratories, Solution Recovery Systems (SRS) and Aurora Biofuels submit a proposal June 30, 2009 to the DOE to build an integrated biorefinery based on the CEHMM paradigm already in place.

• Production of biofuel, CO2 sequestration, uses for the residual biomass and eventual commercialization
How Much Crude Oil?

• The US imports an average of 3.5 billion barrels of oil annually (10 year average from EIA data).
• The average price was $48.93/barrel in 2009 real US dollars.
• Roughly speaking, this means crude oil is a $173 billion a year industry.

• If bio-crude could be substituted for this quantity at the average 10 year real price then the potential market for bio-crude would be $173 billion annually.

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<thead>
<tr>
<th>Imports of Crude Oil (average from 2000-2008 in barrels)</th>
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<tbody>
<tr>
<td>3,544,660,889</td>
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<tr>
<th>Average Price of Crude Oil (real US$/bbl)</th>
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<th>Total Gross Value of Market (real US$)</th>
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<td>$ 173,443,582,734</td>
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*From http://www.eia.doe.gov data

Developed by Dr. Meghan Starbuck, New Mexico State University
Potential Profits*

- If algal crude could be produced and sold for the prevailing 10 year average price ($0.2735/liter) and the current imported quantity of petroleum replaced, than the total revenue of the industry would be $173.4 billion.
- Potential profits for the industry could be more than $8 billion annually.

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<th>Total Oil Produced and Potential Profit of Industry</th>
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<tr>
<td>Liters of Oil Produced</td>
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<tr>
<td>Revenue Generated</td>
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<tr>
<td>Profits Produced by Industry</td>
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*Developed by Dr. Meghan Starbuck, New Mexico State University
CEHMM

• Years of experience cultivating and harvesting algae
• Dedicated staff who have experimented in all facets of algae growth and harvesting to achieve our current capability
• Development of elementary and secondary level curricula in biofuels
• A paradigm for others to emulate in the quest for commercial development