

Algae Production: Next Steps

Improving lives through science and technology

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Bioenergy Program Scope

- Over 40 projects with a portfolio value of over \$40 million
- Major programs with:
 - NAABB (Algae)
 - Ceres (Sorghum)
 - Chevron (Oil seeds and energy cane)
 - BP (Energy crops)
 - State of Texas (ETF and appropriations)
 - U.S. Govt. (DOE, DOD, USDA, NSF)
- \$30 million in new proposals underway



Human Energy™



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Algae Program

- Texas Governor's Emerging Technology Fund 2007/2012
- U.S. Air Force Strategic Fuels Supply 2007/2011
- General Atomics' DARPA Algae for JP-8 2009/2011
- NAABB DOE Algae Consortium 2010/2013
- DOE ASAP, NSF, DOD





Pecos Station Algae Research Facility

Three large-scale outdoor pond test beds
Support laboratories and greenhouse
Harvest barn



Coastal Algae Production Facility

Twelve small-scale open pond raceways

Support labs

Natural-gas fired PP and land owner collaborators

Founding Member



- Biology – transformation & transcriptome profiles
- Cultivation – real-time, in-situ sensor development ;
Corpus and Pecos production
- Harvest/Extraction – chemical & electrolytic harvest
techniques; solvent-assisted wet extraction
- Conversion – fast pyrolysis
- Co-products – animal feeds & soil amendments; high
value products
- Sustainability – site-specific & world market analyses

Criteria for Algae Commercialization

Parameter	Target Range
Biomass Productivity	40 - 80 MT/ac
Avg. Areal Growth	20 - 40 g/m ² ·d
Seasonal Species	4 - 8 species
Recycling Efficiency	90 - 98%
Oil Content	20 – 40%
CAPEX/ac	\$40,000 - \$80,000
Co-product Value	>\$300 MT

Advances in Production

- Modeling of 1000 ac·ft of water algae facility
- Reduction of CAPEX
 - Liner alternatives (35%)
 - Minimum mixing (pumps) to keep algae adequately suspended (15%)
 - Reduced debt payment in OPEX (40%+)
- Reduction of OPEX
 - Nutrient source alternatives (30%)
 - Minimum mixing energy (electrical demand) for suspension (10%)

Advances in Engineering

- Progress in research and securing intellectual property
- Separation Technologies
 - Electrolytic Coagulation and Flocculation
 - Output is 6-10% solids
 - Energy consumption is 0.034 kW·h/kg
 - Solvent-assisted Wet Extraction
 - Input at 6-10% solids
 - Output is oil and PEAR (post-extracted algae residue)
- Conversion Technologies (starch/oil independent)
 - Fast Pyrolysis and Gasification
 - Distributed system for intermediate process
 - Outputs are bio-oil, bio char, and synthesis gas

Co-product Advances

➤ Ruminant (beef cattle) feed

- Competitive with cottonseed meal as protein supplement
- \$100-250/ton PEAR value

➤ Shrimp & Fish feed

- \$6 B/yr industry to double in 10 yrs
- \$400-900/ton PEAR value as replacement to fish and/or soybean meals
- 10% incorporation into aquafeeds

➤ Poultry feed

- Layer hens diet incorporation study

Conclusions

- Algae production is farming
 - Low-cost solutions will win
 - Degree days, nutrients, water
- Learn from 1000's of years of agronomy
 - Cultivation → land preparation
 - Planting → seedstock
 - Fertilization → nutrient/media development
 - Integrated pest management (IPM) plan → control contaminants
 - Harvest → unit operations for separation



Thank you and Gig'em!

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