



ALGAE: *FROM RACEWAY TO RUNWAY*

Opportunities for Renewable Energy and Economic Development





Microalgae Raceways and Cone Bottom Tanks, Pecos Algae Research and Development Facility



Biofuels and biopower will soon play a significant role in providing energy for the United States. Key components of a successful agriculture-based bioenergy industry are securing an economical and environmentally sustainable supply of biomass, creating value-added coproduct streams, and improving delivery logistics. With its high oil content, algae garners interest for production of diesel and jet fuel as well as other bioproducts, and it can be produced using

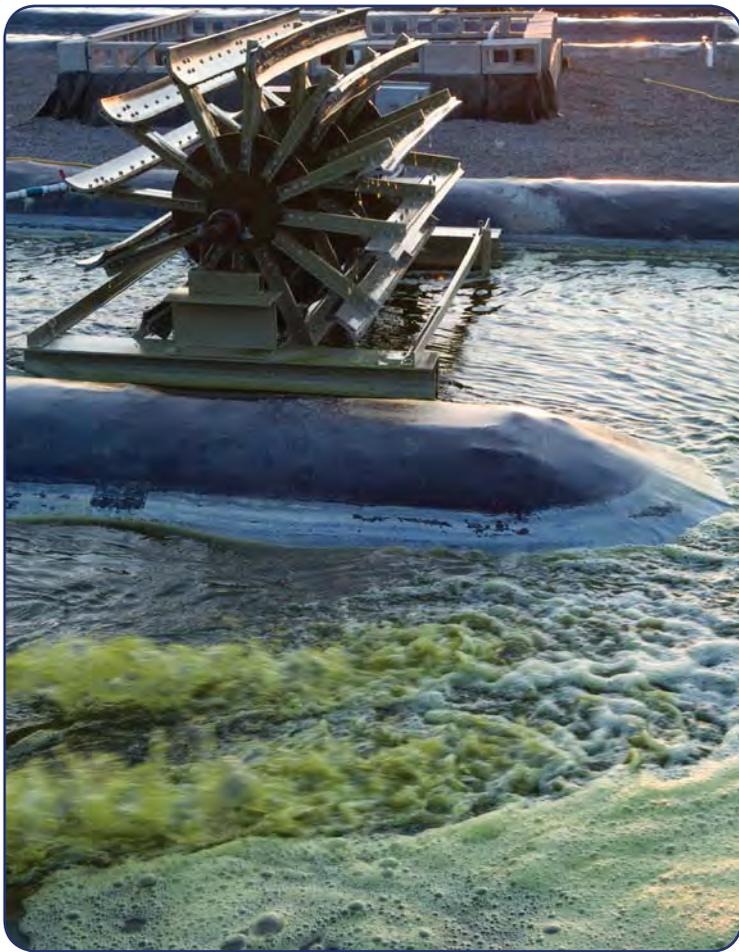
underutilized land with brackish water.

In 2007, General Atomics and Texas AgriLife Research formed a strategic, collaborative alliance to research, develop, and commercialize biofuel production through farming microalgae in Texas and California. The U.S. Department of Defense awarded a multi-year grant to General Atomics and AgriLife Research for algae research and development. Soon after, Texas AgriLife

Research, with General Atomics as a partner, was awarded a \$4 million grant from the State of Texas Emerging Technology Fund to develop an algae test facility at the Texas AgriLife Research Pecos (Texas) Research Station. These two grants provided impetus that led to additional funding, from the Department of Defense and the U.S. Department of Energy, for commercialization of algae production. Additional funding was awarded in large part as a result of

research advancements at the Pecos facility and expands the project scope to include algal coproducts, such as feed additives for the livestock and mariculture industries.

Through collaborations with the military and major universities, AgriLife Research and General Atomics are also expanding their efforts in cellulosic-derived biofuels and bio-oil production processes. And they are working to demonstrate the feasibility of large-scale biofuels production



Paddlewheels in Raceways

from wastewater treatment facilities, using a combination of algae and microorganisms, for applications throughout the world.

With technical support from General Atomics, Texas AgriLife Research constructed and operates the Pecos Algae Research and Development Facility. At their headquarters in San Diego, General Atomics made major research, development, and commercialization commitments, building a world-class microalgae facility. Together, these two lead organizations have built a team of the most advanced industry, university, national laboratory, and government partners synergistically working on development of this

technology. In Pecos, the goal of this phased research and development program is to develop and demonstrate algae growth and harvesting techniques and bio-oil extraction processes that can be commercially scaled and economically replicated in the Southwestern desert regions of the U.S. for industrial production of biofuels.

HIGH-YIELDING, COST-EFFECTIVE, SUSTAINABLE ALTERNATIVE FUELS

Energy efficiency, new energy systems, conservation, and advanced conversion processes are all part of the equation for energy independence. Coastal production of microalgae for biofuels

presents another significant opportunity. Projects at the AgriLife Research Mariculture Laboratory in Corpus Christi are designed to establish and optimize a cost-effective prototype system for high-density microalgae in open systems (raceways), using seawater and flue gas carbon dioxide captured from power-generating plants. In production, large-scale microalgae systems annexed to power-generating plants could effectively reduce carbon dioxide emissions while producing a range of high-value products.

In College Station and Galveston, Texas AgriLife researchers focus on determining characteristics of algae species to increase the oil content

“Through innovative, science-based programs, expertise, infrastructure, and partnerships, General Atomics and the Texas AgriLife Research Bioenergy Program are leading the way in developing alternative fuel solutions.”

and on the economic analysis of microalgae and potential bioproducts. Through innovative, science-based programs, expertise, infrastructure, and partnerships, General Atomics and the Texas AgriLife Research Bioenergy Program are leading the way in developing alternative fuel solutions.

Raceway Sample



Cone Bottom Tanks

RESEARCH COMPONENTS

- Algae Coproducts for Animal Feed
- Economics
- Propagation Laboratories
- Separation Techniques
- Construction and Installation
- Microalgae Raceway Production

At the Pecos Algae Research and Development Facility, research in bioenergy and bioproducts spans the full range of discovery:

- Developing high-tonnage biomass plants at the molecular level and more efficient processes in the manufacturing of



- biofuels
- Testing algae under various conditions for maximum growth and oil production
- Investigating harvesting methods to reduce operating costs
- Transportation for bioenergy production, including

- environmental aspects
 - Using modeling to determine economic and sustainable production areas
 - Tracking of all unit costs to determine cost per kilogram of biomass
- A 1,000-acre algae farm could add as many as

245 jobs and more than \$12 million in total value, although the economic viability of microalgae is enhanced by all aspects of production, including coproducts. Deriving value from post-extraction algal residues is also essential to the overall economic sustainability of algal fuel production.

ABOUT TEXAS AGRI LIFE RESEARCH

Texas AgriLife Research, a member of The Texas A&M University System, is the statewide agency dedicated to research in the agricultural, environmental, and life sciences. Headquartered in College Station, AgriLife Research, with a 100+ year history, employs some 1,380 professionals in 14 research centers across the state and 14 disciplinary departments on campus. Research spans numerous scientific disciplines and serves to improve the productivity, efficiency, and profitability of agriculture, while maintaining a sustainable environment. Through collaborations and partnerships, AgriLife

Research strengthens the state's position in the global market by meeting modern challenges in Texas, the nation, and worldwide.

“TOGETHER, THESE ORGANIZATIONS HAVE BUILT A TEAM OF THE MOST ADVANCED INDUSTRY, UNIVERSITY, NATIONAL LABORATORY, AND GOVERNMENT PARTNERS WORKING ON DEVELOPMENT OF THIS TECHNOLOGY.”



Algae Clean Room

ABOUT GENERAL ATOMICS

General Atomics is a San Diego–based innovation firm with a 55-year history of providing successful solutions to environmental, energy, and defense challenges. Affiliated manufacturing and commercial service companies include General Atomics Aeronautical Systems, Inc, which produces the Predator® family of unmanned aircraft systems.

Throughout its history, GA has been recognized for its ability to meet major multidisciplinary technical challenges, resulting in world-class, first-of-a-kind equipment for critical energy and defense requirements. With more than 5,000 employees, GA

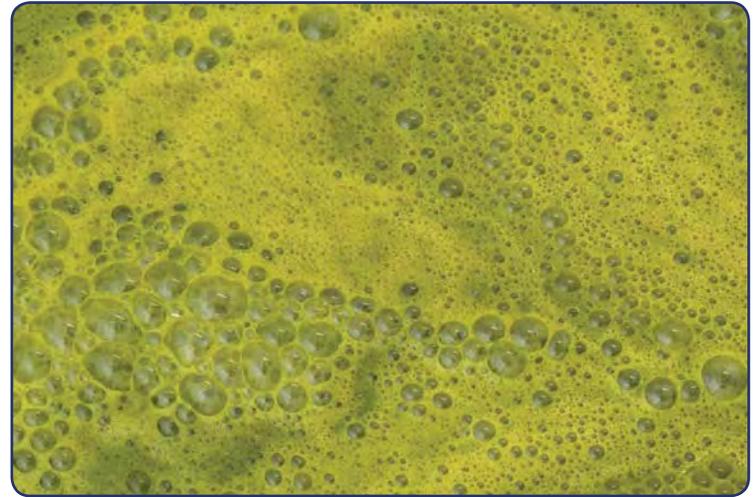
Algae Samples for Testing



carries out the largest and most successful nuclear fusion program in private industry. The company has been the primary developer of modular helium-cooled nuclear power reactor systems, and its TRIGA research reactors have operated around the world for over 45 years.

GA's areas of expertise include energy research and technology, power electronics, electromagnetic systems, magnetic levitation, demilitarization and security systems. For over 50 years, GA and its affiliates have been qualified by U.S. government organizations, including

the Department of Defense, the Department of Energy, and the National Science Foundation, as a government contractor and facilities operator. GA and its affiliates' facilities contain over three million square feet of engineering, laboratory, and manufacturing installations in the San Diego area.



Algae in Raceways



Dry Algae, Separation Process

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For high-resolution photos, interviews, videos, and additional information on the AgriLife Research Bioenergy Program or General Atomics, visit algaeorfuel.agrilife.org

Algae Testing, Propagation Lab





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