A cluster of jatropha, a plant grown to produce biofuel.

Agriculture & Energy

Growing alternatives to fossil fuels.

BY JENNIFER SUDICK

Gaining the interest of business investors, scientists and consumers, biofuels are one of the hottest areas in the energy industry. Biofuels can be made from anything from used vegetable oil, to algae, to plants such as jatropha. This oily-seeded plant is in fact being grown commercially on the Big Island to be turned into biofuel.

Research in the field of biofuels is strong in Hawai'i, says CTAHR's Dr. Andrew Hashimoto, professor in Molecular Biosciences and Bioengineering and part of a team working on biofuel research.

"In a relatively small area we can test a lot of energy crops in different environments," says Hashimoto. "We have that ability to test crops in diverse microenvironments, extract the information and be able to project how crops will grow in other areas of the world."

That research has shown that Hawai'i can produce three to four more times biomass feedstock per acre than the Mainland U.S. While Hashimoto estimates that these biofuel crops could eventually account for up to 25 percent of Hawai'i's total energy needs, the state's primary contribution to the advancement of biofuels will likely be centered in research and development, not production.

"Hawai'i is going to be a player in that we will find opportunities to

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produce fuel, but we don't have a lot of land area," he explains. "The other issue is how this fits in when you talk about the whole gamut of policy issues—balancing food, fuel and green space. We try to position ourselves based on the competitive advantages we have, such as diverse bio-environments and the ability to look at a lot of different crops that aren't being looked at in the contiguous U.S."

Hashimoto's team, as well as government agencies, organizations and businesses, are all contributing to Hawai'i's advancements in the technology, research and production of biofuels.

MILITARY USAGE

In August, the U.S. Department of Agriculture, the U.S. Department of Energy and the U.S. Navy announced an investment of up to $510 million during the next three years in partnership with the private sector to produce advanced drop-in biofuel—fuel that does not require engine modification—to power military and commercial transportation. The USDA highlights the region covering Hawai'i as important for the research of energy cane, sweet sorghum and other subtropical/tropical perennial grasses, as well as wood biomass, particularly in small-farm production systems.

This summer, the U.S. Navy will use 450,000 gallons of fuel from the largest government purchase of biofuel to date in a demonstration of a new "Green Strike Force" in this summer's Rim of the Pacific Exercise (RIMPAC) in Hawai'i. It is part of a larger mission by the Navy to have half of its energy consumption come from non-fossil fuels by 2020.

RENEWABLE ENERGY

In 2008, petroleum provided nearly 85 percent of the total energy consumed in Hawai'i, compared with the national statewide average of 37.5 percent, according to a 2011 Department of Business, Economic Development and Tourism (DBEDT) economic report outlining the state's renewable energy industry. The report, which notes that "clean, locally developed renewable energy will, in the long run, boost Hawai'i's economy," says that Hawai'i is the most vulnerable state in the U.S. to disruptions in world oil markets, with fluctuations in oil prices significantly affecting the economy.

James Spaeth, senior advisor, Pacific Region, of the U.S. Department of Energy, works with the state on the Hawai'i Clean Energy Initiative (HCEI), launched in 2008 to help Hawai'i become a 70-percent clean energy economy by 2030.

"Certainly there is an opportunity for biofuels in the electric sector, and in the ground transportation sector, as well as with long-term military and commercial aviation to offset for the use of jet fuel," Spaeth says. "The market demand is almost unlimited."

The state is looking to areas such as algae, jatropha and camelina oil, which can also be used as aviation fuel. Ultimately, Spaeth says, those crops need to be harvested in Hawai'i.

"It is not advantageous to be shipping biofuels from the Mainland," he says. "To ship in expensive biofuels is not the way to go about the long-term solution." The HCEI highlights the need to support Hawai'i biofuel development by investing in key logistical infrastructure and fuel-processing facilities.

"DBEDT has a list of renewable energy projects under development," says Mark Glick, the state's energy administrator. "There are roughly 75 projects we have listed based on a variety of factors. Biofuel is one of the areas of greatest concentration, so clearly developers and investors see this as a ripe opportunity."

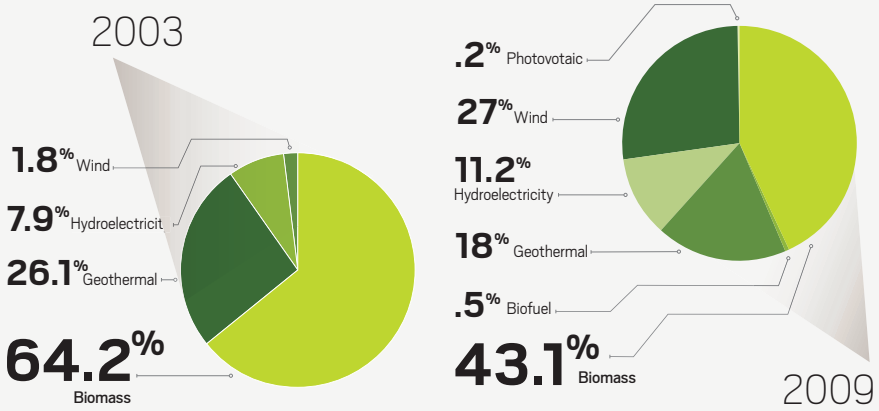
Hawaiian Electric Company estimates that Hawai'i-sourced biofuels will take three to seven years to come

COURTESY DR. ANDREW HASHIMOTO

CTAHR's Dr. Andrew Hashimoto, professor in Molecular Biosciences and Bioengineering, examines energy crop trials underway at Hawaiian Commercial and Sugar Co. (HC&S). Also shown is Lee Jakeway, director of energy development at HC&S., Dr. Richard Ogoshi, CTAHR, and Dr. Tim Eggeman, chief technology officer of ZeaChem.

ELECTRICITY GENERATED BY RENEWABLE ENERGIES BY SOURCE (STATE TOTAL)

SOURCE: RESEARCH & ECONOMIC ANALYSIS DIVISION, DEPARTMENT OF BUSINESS, ECONOMIC DEVELOPMENT & TOURISM



to market in sufficient volume. Until then, the company plans to continue importing biofuels as needed, including from Iowa-based Renewable Energy Group, the largest biodiesel producer in the U.S. HECO recently signed agreements with Pacific Biodiesel, Hawai'i BioEnergy and Phycal for Hawai'i-sourced biofuels.

Maui-based Pacific Biodiesel, which will supply 250,000 gallons to power the planned 8-megawatt emergency power facility at the Honolulu International Airport starting in October, is building a Big Island plant in Kea'au that will have a capacity of more than 8,000 gallons of biofuel a day. The plant will process used cooking oils, jatropha oil, sunflower oil, algae oil and animal fats.

Kelly King, vice president of Pacific Biodiesel, notes, "The common argument has been that land is too expensive and oil is too cheap. Well, oil is not that cheap anymore."

Pacific Biodiesel is also working with the U.S. military under a $2.4 million grant to develop a biofuel crop production model incorporating oil-producing plants such as safflower, sunflower and camelina as part of the Military Biofuels Crop Demonstration Project on O'ahu. In November, the company was also honored with the 2011 Green Jobs Award, a national recognition from the nonprofit SJF Institute that highlights private businesses contributing to the economy and the environment.

The most important market for biofuel use in Hawai'i is transportation, King says, particularly for interisland barges. The fate of Hawai'i's biofuel industry rests in large part with government support, King says, including the passage this year of Hawai'i Senate Bill 772, which would amend the existing ethanol facility income tax credit to include other biofuel production and to enable larger facilities to be eligible for the tax incentive.

"It's not a matter of whether it is economically viable right now, but when it will be economically viable in the future," King says of biofuel production. "We have to start now. When fuel does get up to $10 a gallon, it is too late."

In 2011, HECO and Honolulu-based Hawai'i BioEnergy agreed on a 20-year contract to provide 10 million gallons per year of locally grown and processed biofuel for HECO's Kahe Generating Station, representing 4 percent of the plant's annual fuel use. The company, established by three of Hawai'i's largest landowners—Kamehameha Schools, Grove Farm Company, and Maui Land and Pineapple Company—would use sustainable energy crops grown on Kaua'i on underutilized Grove Farm land. The crops would be processed into biofuel on Kaua'i for shipment to O'ahu, the company said.

The contract, which is under review by the Hawai'i Public Utilities Commission (PUC) with input from the State Consumer Advocate, would begin within five years of PUC approval. Liquid biofuel would be created using high temperatures in the absence of oxygen to cause thermo-chemical decomposi-

"For a short-term crop, there is no processor; for a long-term crop, there is no idea what the yield is going to be. Everyone in agriculture knows that a crop for fuel only is not going to make it."

tion of organic matter, HECO said.

Hawai'i BioEnergy is also working with San Diego-based General Atomics on a jet-fuel pilot project with microalgae. The project now covers 33 acres of land.

THE ECONOMICS

"In order to proceed there has to be the commitment for substantial investment, whether it is going to be the planting of crops or any kind of conversion facility," says Joel Matsunaga, executive vice president and chief operating officer of Hawai'i BioEnergy. "Like any form of agriculture, the crop has to be suitable for the land, and other resources available in the area. We match the crops for what is best suitable for the land keeping in mind to make sure that whatever crops we do select are in accordance with whatever rules are in place to make sure the crops are not invasive."

Stephanie Whalen, executive director of the Hawai'i Agriculture Research Center (HARC), said the organization began collecting germplasm (a collection of genetic resources for an organism) from around the world about five years ago to test the productivity of specific crops. HARC works with a variety of biofuel crops, including jatropha, sweet sorghum and energy cane.

"Everyone is waiting for the economics," Whalen says. "The moment it can make money we will plant it, but the economics hasn't shown that the crops are good enough for someone to take the risk to plant. For a short-term crop, there is no processor, for a long-term crop, there is no idea what the yield is going to be. Everyone in agriculture knows that a crop for fuel only is not going to make it."

CTAHR's Dr. Charles Kinoshita is looking into the conversion of fibrous crops into ethanol and drop-in fuel. Kinoshita is part of a group, including Hashimoto, which has submitted a grant proposal to fund the study of taking fast-growing energy crops and grasses and converting them into fuel.

"I don't think the public wants to rely on ethanol, which has to be blended with gasoline," Kinoshita says. "The general public would like to see some sort of drop-in fuels."

"We would like to find species that can grow on marginal lands," he says. "That will get us away from the competition between food and fuels and use lands that don't have access to water."

Kinoshita also stressed the importance of identifying high-value byproducts in the process of creating biofuels. This would include everything from animal feed, on the low end of the spectrum, to plastics and industrial proteins on the high end. That would help produce the profit margin needed to make biofuels more economically viable, he says.

"In spite of the fact that we all complain about the high costs of gasoline and electricity, energy costs are still relatively low," he says. "We would like to see some valuable byproducts come out of this."

"There are technical issues as well as economic issues," Hashimoto says. "From a technology or scientific perspective, these are all doable, but how much do you have to pay to make this happen? Some of the options are not commercially competitive. You probably will not want the highest yield, but rather the highest yield with the minimum resource input. The economically viable yield is different from the maximum yield." ■

Pongamia, a type of tree that produces seeds that can be turned into biofuel, is hardy enough to be growing in brackish water with no irrigation.

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