Biofuels Study
Interim Report to the Legislature
In Accordance with
Act 203, Session Laws of Hawaii, 2011

STATE OF HAWAII
Department of Business,
Economic Development & Tourism

December 2011

Report to the Legislature
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Biofuels Study Interim Report

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I. BACKGROUND

On July 7, 2011, the Hawaii State legislature passed Senate Bill 146, and on July 8, Governor Abercrombie signed into law Act 203, Session Laws of Hawaii 2011. This law directs the Hawaii State Department of Business, Economic Development and Tourism (DBEDT) to conduct a study and issue a preliminary (December 2011) and final (December 2012) report on "the conditions and policies necessary to expand biofuel production in the State to displace a significant amount of petroleum-based liquid fuel." Act 203 is in Appendix I.

In accordance with the requirements of Act 203, the final report will cover:

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Fuel Types

   (1)   Ethanol;
   (2)   Cellulosic ethanol;
   (3)   Fatty-acid-methyl-ester (FAME) biodiesel;
   (4)   Synthetic or bio-based:
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(A) Diesel fuel;
(B) Gasoline; and
(C) Jet fuel; and

(5) Any other type of biofuel deemed relevant to the study.

Information

For each type of biofuel listed above, the report will include the following information:

(1) The State's projected demand in the near-term, mid term, and long-term for the biofuel's petroleum based counterparts;
(2) Types of feedstock that could be used;
(3) Availability of feedstock within the State in the near-term, mid-term, and long-term;
(4) Availability of feedstock out-of-state in the near term, mid-term, and long-term;
(5) Production within the State in the near-term, mid term, and long-term;
(6) Production out-of-state in the near-term, mid-term, and long-term;
(7) Costs in the near-term, mid-term, and long-term for biofuel product produced within the State;
(8) Costs in the near-term, mid-term, and long-term for biofuel product produced out-of-state;
(9) Status of the technology;
(10) ASTM specifications;
(11) Realistic timeline of production within the State;
(12) Benefits to the State's economy;
(13) Emissions compared to other comparable biofuels and to its petroleum-based counterpart;
(14) Logistics of handling and usage compared to other comparable biofuels and to its petroleum-based counterpart; and
(15) Stability of supply and costs compared to other biofuels and to its petroleum-based counterpart.

For the purposes of this Act:
"Long-term" means longer than ten years.
"Mid-term" means from three to ten years.
"Near-term" means within three years.

Recommendations

Considering the Federal Renewable Fuel Standards II, as amended, recommendations will be made on the following:

(1) Whether any specific biofuel mandate is necessary in order for biofuel production and use in Hawaii to displace a significant amount of petroleum-based liquid fuel; and
(2) Whether the ethanol fuel requirement in section 486J 10, Hawaii Revised Statutes, should be maintained, modified, or repealed.

Act 203 also required that an interim report be submitted prior to the 2012 Legislative Session. This report satisfies the requirement for an interim report.

II. INTERIM REPORT ON PROGRESS OF THE STUDY

A. Tasks Completed in 2011

To fulfill the requirements of Act 203, DBEDT has consulted and will continue to consult with producers, including local biofuel producers and local refineries; researchers; landowners; distributors; and end users, including airlines, fleets, utilities, and the military.

To foster stakeholder involvement, an on-line input form was developed; existing biofuels groups were informed; and requests for input were, and will continue to be, distributed via a variety of methods and at a variety of events.

Contributors are requested to submit input via an on-line form (see Appendix II):

http://forms.hawaiicleanenergyinitiative.org/view.php?id=12

or via United States Postal Service to:

Department of Business, Economic Development & Tourism
Attention: SID – REB – KAM
PO Box 2359
Honolulu, Hawaii 96804

Several biofuels working groups have been briefed on Act 203, including the Green Initiative for Fuels Transition Pacific (GIFTPAC) group led by the Department of Defense (DoD) Pacific Command (PACOM); the Hawaii Energy Policy Forum (HEPF) Biofuels Group; and the Hawaii Clean Energy Initiative (HCEI) Fuels Working Group, co-chaired by the US Department of Energy (DOE) and DBEDT's Hawaii State Energy Office. Input was requested from these working groups and they were invited to share the request for information with others who might be interested in the study.

B. Plan for 2012

To further this ongoing collaborative effort with established working groups, several meetings and events are being planned to receive, discuss, and review input in 2012. The purpose of these events will be to identify and, if possible, address concerns; review information; and build consensus on the report and the objective stated by Act 203: to identify the conditions and policies necessary to expand biofuel production in Hawaii.

Input from these events, and input submitted directly to DBEDT, will be used to develop the final report. The final report will be submitted to the Legislature prior to the convening of the 2013 Legislative Session, as required by Act 203.

III. REPORT OF INDUSTRY PROGRESS, JULY 2011- PRESENT

The biofuels industry in Hawaii continues to evolve rapidly. Today, a profusion of companies are emerging to bring a wide range of biofuel concepts to market.

A thriving biofuels industry is expected to be helpful to Hawaii's economy. Several of Hawaii's primary economic activities, including tourism, agriculture, knowledge industries, and the military, rely heavily on imported petroleum, or petroleum-fueled electricity generation, and are impacted by high oil prices. Building a biofuel industry could counteract some of the negative effects of high energy prices by keeping energy dollars in Hawaii, reducing our reliance on petroleum, stimulating economic diversification, and improving employment opportunities in agriculture as well as in the innovation and technology sectors.

Support for biofuels in Hawaii and across the nation has led to federal and state policy initiatives supporting biofuel research, development and industry growth. Examples of industry developments since Act 203 was signed into law in July are summarized below.

This is a representative sample, and may not capture all of the companies or developments in Hawaii; additional information or updates may be provided as described in the previous section. Companies and developments in research may also be found in Section IV.

- **Aina Koa Pono** (AKP) reported that its engineering, procurement and construction partner, AECOM, had completed initial due diligence and verification of TekGar microwave depolymerization technology; results either met or exceeded projections. The company plans to use invasive species cleared from the land and then to grow energy crops to provide feedstock on 13,000 acres of farmland in Kau that have lain fallow for 14 years. AKP is re-negotiating a contract with Hawaii Electric Light Company (HELCO) to provide fuel to the Keahole Power Plant on Hawaii Island. If the new contract is approved by the Public Utilities Commission, the project will generate 24 million gallons per year of renewable diesel and create over 200 jobs in the community, ranging from plant maintenance and operation to agricultural workers, including management, professional and administrative positions.

- **Big Island Carbon** was awarded a Best in Business Innovation Award for Hawaii County in November 2011 at the Asia-Pacific Economic Cooperation (APEC) event in Honolulu. The Hawaii State Department of Health and the U.S. Environmental Protection Agency (EPA) District 9 in San Francisco recently reviewed and approved Big Island Carbon's Clean Air Permit. The permit has now been issued. Big Island Carbon transforms biomass material into granulated activated carbon used for air, water, and chemical purification, along with biomass to power the company's facility, located on Hawaiian Home Lands in Kawaihae, on the Island of Hawaii.

- **BioEnergy Hawaii Inc.** is included in the State's top 40 list of Renewable Energy Projects in Hawaii, which came online in November, 2011. BioEnergy Hawaii's proposed solid waste conversion facility at the Natural Energy Laboratory of Hawaii Authority would also create biofuel from algae. Solid waste diverted from the Puuanalulu landfill will be used to generate electricity and the carbon dioxide created at the plant will feed algae beds; the algae will be converted into biofuel for transportation.

- **Cellana** (formerly HR BioPetroleum) is developing microalgae strains in preparation for a planned commercial-scale algae biomass plant that will help fuel Maui Electric's Maalaea Power Plant. Cellana received a three-year, $5.5 million USDA/US DOE grant to develop a protein supplement from algae as a byproduct of algal biofuels production, and to demonstrate its nutritional and economic value in livestock feeds. This project includes partnerships with ClearFuels and Alexander & Baldwin. The algae will be produced at Cellana's six-acre facility, one of the most advanced operational demonstration facilities in the United States, at the Natural Energy Laboratory of Hawaii Authority (NELHA) on the Island of Hawaii. Cornell University will be conducting large-scale animal feeding trials using this biomass to identify the most economical and efficacious strains of algae.

- **ClearFuels Technology Inc.** (ClearFuels), with corporate offices in Honolulu, is majority owned by Rentech Inc. The company reported in November that all systems required to start up the 20 ton-per-day Rentech-ClearFuels biomass gasifier, integrated bio-refinery (IBR) in Colorado are mechanically complete. The project has reached this milestone within the original budget and schedule. The IBR project was co-funded by a $23 million grant from the US DOE, jointly received by Rentech and ClearFuels, to validate refining technologies. The gasifier is designed to produce synthesis gas from various wood wastes, sugar cane bagasse, and other sources of biomass feedstock. The gasifier will be

integrated with Rentech's existing product demonstration unit, to convert biomass feedstocks to syngas of defined composition. The syngas is processed in the Rentech catalytic conversion unit and upgraded using UOP technology to produce renewable drop-in synthetic jet and diesel fuels at demonstration scale. The demonstration-scale project is expected to lead to the final design basis for commercial-scale facilities using the combined technologies, including for potential biomass-to-energy projects that are contemplated in Hawaii, the southeastern United States, and Canada.

- **General Atomics** was awarded a Phase II contract for pilot-scale testing after successfully completing a Phase I, $19.9 million Defense Advanced Research Projects Agency (DARPA) project focused on technology development. Partners on Phase II include Hawaii BioEnergy, Kuehnle AgroSystems, and Kauai Island Utility Cooperative (KIUC), providing carbon dioxide from the adjacent power plant. The project has the objectives of developing commercially viable production, both volume and cost, of algae oil for jet fuel. Construction of the 30 acre pilot-scale algae ponds and a processing facility is well underway (as pictured in October/November). Crop trials are also taking place, adjacent to the algae ponds. If funded, Phase III will involve a demonstration plant.

- **Green Energy Team LLC**'s biomass-to-energy project is included in the State's top 40 list of Renewable Energy Projects in Hawaii, and is targeted to come online in December of 2013. Initially, Green Energy will be clearing and removing highly invasive Albizia trees, and subsequently establishing short rotation intensive culture woody crops on Kauai for conversion into 6.7 net MW of energy, and is in the midst of finalizing financing. Construction of the closed loop biomass plant is projected to involve over 200 jobs to build the plant, a significant project for Kauai. Once operational, the project is expected to reduce importation of fossil fuel by 3.7 million gallons annually and create 39 agricultural jobs. All significant entitlements are in hand, with the PUC approving the 20 year PPA, and the Consumer Advocate projecting savings of between $5.5 million and $20 million annually for the people of Kauai, as stated in the public October 31, 2011, PUC Decision and Order. Further, the savings per average household were calculated in the PUC Order to provide between $70 and $190 for each Kauai household per year.

- **Hawaii BioEnergy LLC** and the Boeing Company entered into a collaborative agreement on November 10, 2011. Announced on the eve of the APEC CEO Summit, the companies will work together to identify biofuel sources and supporting technologies for producing sustainable jet fuel in Hawaii. Liquid biofuel will be created by an established process using high temperature in the absence of oxygen. Hawaii BioEnergy (HBE) has conducted extensive research to assess viable and sustainable biofuel feedstocks and processing technology, and is a consortium established by three of Hawaii's largest landowners: Kamehameha Schools, Grove Farm Company Inc., and Maui Land & Pineapple Company, Inc. with venture capital partnerships including the Hawaii-based Ulupono Initiative.

- **Hawaiian Commercial & Sugar Company** (HC&S), a division of Alexander & Baldwin, has received approximately $12 million for biofuel research from federal agencies. HC&S is exploring its renewable energy production in a partnership with the University of Hawaii (UH) and the federal government; the US DOE is providing at least $2 million for UH research at HC&S. In a separate project, the Office of Naval Research has awarded HC&S $2 million for five years for complementary crop and technology assessments. The projects could be impacted by decisions on water use for HC&S by the state Commission on Water Resource Management. HC&S is the State's largest producer of biomass energy using bagasse, the fiber byproduct of sugarcane manufacturing, for boiler fuel. This is converted into steam and electricity via combined heat and power production or cogeneration. HC&S provides between 5 and 7 percent of Maui Island's electrical needs, with approximately 65,000 to 95,000 MWh annually.

- **Hawaiian Electric Industries'** recent biofuel progress in Hawaii includes:
  - The Campbell Industrial Park generation station is in full operation, fueled entirely by biodiesel. At present, the biodiesel is supplied by an Iowa-based company which uses waste animal fats and restaurant grease and delivers it to Oahu in containers by ship.
  - Bio-crude (minimally processed biofuel) was successfully tested in a steam generator at Kahe Power Plant. The tests started with a blend of 30 percent bio-crude and low-sulfur fuel oil. It was gradually progressed until the unit was able to run at full

capacity using 100 percent bio-crude. This is the first known instance of this accomplishment.

- On Maui, biodiesel has been tested over several months in 2011 at Maalaea Power Plant. Maui Electric has used biodiesel before, but only for short times, to reduce pollution during unit shut down and start up. The longer test will provide information on long-term biodiesel use.
- Hawaiian Electric Company's RFP resulted in 10 submissions, and the company has entered into four contracts, with a fifth in active negotiations. The four contracts include Pacific Biodiesel, Phycal, HBE and Aina Koa Pono.
  - Aina Koa Pono (AKP), a local start-up company, signed a contract with Hawaii Electric Light Company which would provide biodiesel to Keahole Power Plant from a planned processing plant in Kau, on Hawaii Island. The company planned to first use invasive species cleared from the land and then grow energy crops such as grasses to provide feedstock. AKP reports it plans to use 13,000 acres of farmland in Kau that have lain fallow for 14 years to grow sweet sorghum, eucalyptus and other biofuel crops. In late September the Hawaii Public Utilities Commission (PUC) rejected the initial contract, and the Hawaii Electric Light Company is renegotiating with AKP. If new contract terms can be reached, it will be submitted to the PUC for approval.
  - Hawaii BioEnergy entered into a 20-year contract with Hawaiian Electric Company on September 12 to supply 10 million gallons per year of locally grown and processed biofuel for power generation at Hawaiian Electric's Kahe Generating Station. The contract must be approved by the PUC, with input from the State Consumer Advocate.
  - Pacific Biodiesel signed a three-year contract, with renewal options, in August to supply at least 250,000 gallons of locally produced biodiesel to the new 8 MW Honolulu International Airport Emergency Power Facility to be operated by Hawaiian Electric. This contract calls for Pacific Biodiesel to supply biodiesel from locally recycled cooking oil collected and processed at either the Pacific Biodiesel plant on Oahu or the Hawaii Island Biodiesel refinery in Keaau, which is currently under construction.
  - Phycal entered into a contract in September with Hawaiian Electric for a supply of algae-derived biofuel produced for testing at the Kahe Generating Station on Oahu. The agreement calls for delivery of 100,000 to 150,000 gallons of algae-based biofuel meeting Hawaiian Electric specifications by April 2014. The biofuel will be provided at a fixed price not tied to the price of fossil fuels. The contract must be reviewed and approved by the PUC.

- **Honua Power, LLC** has completed all its environmental permits for its renewable energy facility. Site work has begun in Campbell Industrial Park in preparation for the construction of the first phase of the project to supply 6 MW of electrical power to the HECO grid on Oahu. This facility will use feedstock from PVT Landfill, composed of wood waste from the demolition of old houses. It will operate a state-of-the-art gasification process to turn the wood material into a combustible synthesis gas to fire the power generating system. The facility is scheduled to be on-line by the end of 2013.

- **Hu Honua Bioenergy, LLC** (HHB) is progressing through the permitting process for their planned bioenergy facility, a 24 MW power station that will convert locally grown biomass into electricity on the Island of Hawaii. In September the company was granted an air permit by the Hawaii State Department of Health, Clean Air Branch. HHB is now moving ahead with its engineering design, construction and refurbishing of the former Hilo Coast Power Company power plant at Pepeekeo into a modern biomass.

- **Pacific Biodiesel** started construction in 2011 on Big Island Biodiesel (BIB); completion is scheduled for early summer 2012. According to Pacific Biodiesel, the BIB facility will utilize recently developed zero-waste, super efficient processing with a projected capacity of over 16,000 gallons per day and more than 5 million gallons per year. The production plant will be engineered for multi-feedstock processing and will be able to utilize both locally farmed crop oil and locally collected waste oils.

Pacific Biodiesel has also made progress on the Hawaii Military Biofuel Crop project, in partnership with the U.S. Army Corps of Engineers. This project's purpose is to demonstrate the feasibility of growing quick turnaround oil crops in Hawaii, which may then be processed into fuel to supply to the military. So far the project has had one successful cycle of planting and harvesting of sunflower, safflower and camelina. Another round of planting will include more varieties of oil seed crops and will begin in January 2012.

Phase II of Pacific Biodiesel's "Aina Mo" project is set to start in January 2012. This SBIR funded project is evaluating the use of a biodiesel production co-product as a soil conditioner and apple snail abatement. Lab work and field trials in phase II will refine product efficacy protocols and evaluate impacts on the snails and non-target species in

Hawaii. Phase I identified the active ingredients in the byproduct mix and was completed in 2011.

In December of 2011, Pacific Biodiesel acquired two 2,000 gallon biodiesel dispenser tanks and put them in service on the Big Island. These tanks were partially funded through the federal Alternative Fueling Infrastructure Tax Credit.

In 2011, the Marine Corps Base Hawaii became the first Hawaii military base to offer B20 (20% biodiesel blend) to their non-combat fleet base-wide. According to DLA Energy, joint base Pearl Harbor-Hickam is soon to follow with the same action in 2012.

- **Pacific West Energy, LLC** (PacWest) is an integrated energy production and marketing company presently developing a biomass-to-power project on the island of Kauai. According to the company, Phase I includes the conversion of existing and former sugar cane and woody biomass lands into an energy plantation and the construction of an approximately 20 MW capacity biomass power plant. In Phase 2, PacWest intends to integrate biofuel (including ethanol) production.

- **Phycal Inc.** is progressing with plans to construct and operate 30 acre pilot facility located in Wahiawa, capable of over 100,000 gallons of oil per year. This pilot project, backed by a $51.5 million USDOE award, will produce biocrude for HECO; renewable jet fuel; and renewable diesel. Algae pond operations will be supported with reclaimed water conditioned to standards for agricultural use. Phycal has successfully obtained many of their permits at the federal, state and county levels. Phycal is deploying to Hawaii because of its favorable market for algal biofuel, climate, resources, and significant public support. Hawaiian Electric reached agreement in September with Phycal to supply algae-derived biofuel for testing at its Kahe Generating Station on Oahu. After testing the biofuel, Hawaii Electric expects to negotiate a subsequent agreement for 3 million gallons of biofuel per year, for three years.

- **The Gas Company** was awarded a $1 million grant in October from the Hawaii Renewable Energy Development Venture, funded by the US DOE. This project will test and evaluate thermal cracking of various types of bio-oil feedstocks and assess process and operating parameter scalability in a newly installed pilot production plant in Campbell Industrial Park. The plant is designed to process up to 1 million gallons per year of renewable liquid biomass feedstock (plant oils, animal fats and other sources) into higher value products such as bio-based naphtha, propane, diesel, hydrogen and synthetic natural gas. The plant is designed to allow for expansion to accommodate increasing demand and feedstock supply availability, with the intent to provide

sustainable energy from local agricultural products that were previously discarded or shipped out of state.

- **UOP / Tesoro** announced late August that construction had begun in Hawaii of a biofuels demonstration unit that will convert forest residuals, algae and other cellulosic biomass into green transportation fuels. (The ground breaking ceremony is pictured.)

Backed by a $25 million US DOE award, the Honeywell UOP Integrated Biorefinery will upgrade biomass into high-quality renewable gasoline, diesel and jet fuel. Located adjacent to the Tesoro refinery in Kapolei, the Integrated Biorefinery will be used to demonstrate viability of the technology, test the fuels produced and evaluate the environmental footprint of the fuels and technology. The project, which will generate more than 80 new jobs during construction, is scheduled to begin initial production in 2012. (Adjacent photograph shows plant construction in November.) It is expected to be fully operational by 2014. UOP is partnering with a number of local stakeholders including Tesoro Hawaii Corporation, Rentech (formerly Clear Fuels), HBE, Group 70, Kai Hawaii, UH and Leeward Community College.

IV. RESEARCH PROGRESS

Significant progress has also occurred in research, development, and demonstration, including work in assessment of potential crops, cultivation, processing, and conversion technologies; production capabilities; and market information related to a range of biofuels usable in Hawaii's aviation, marine, ground transportation, and electricity production sectors.

Recent announcements and advances are summarized below, together with previous research and studies that established the foundation or described the context and need for current work.

- **Defense Production Act Title III Program; Advanced Drop-in Biofuels Production Market Research Request for Information (RFI):** In a joint effort between the US Navy, US Department of Energy (USDOE) and US Department of Agriculture (USDA), $510 million dollars have been identified to support development of biofuel refining capability. As a first step, an RFI was released by the US Air Force as the DoD Executive Agent for the Defense Production Act (DPA) Title III Program on August 29, 2011, to obtain information about capabilities and market information related to advanced drop-in biofuels production, a technology of interest for planning purposes. This RFI was issued based on the demand for 25% of current aviation, marine and ground diesel fuel. Of particular interest are the technical, manufacturing and market barriers to establishing a viable business for advanced drop-in biofuels.

  The RFI was in response to a 30 March 2011 directive issued by President Obama to the Navy, the DOE, and the USDA to work with private industry to create advanced drop-in biofuels, which will power both the Department of Defense (DoD) and private sector transportation throughout America.

  With funding to be provided through the DPA Title III Program and the USDA Commodity Credit Corporation, the principal objective of this envisioned government-industry partnership is the construction or retrofit of multiple domestic commercial or pre-commercial scale advanced drop-in biofuel plants and refineries with the following characteristics: 1) capability to produce ready drop-in replacement advanced biofuels meeting military specifications at a price competitive with petroleum, 2) geographically diverse locations for ready market access, and 3) no significant impact on the supply of agricultural commodities for the production of food.

  "Important considerations" in this RFI include the following:

  > "Recognition that Hawaii is a critical command location for all US military services. Because of its dependence on imported oil and the very real opportunity for agriculture to enhance energy security for the State and the Department of Defense, creation of a sustainable biofuel supply chain in Hawaii, independent of long transoceanic supply lines, would be of particular interest."

  The RFI outlines the reasoning for use of the DPA Title III Program:

  > "A robust advanced drop-in biofuels market is an essential element of our national energy security. Energy security for the Nation requires unrestricted, uninterrupted access to affordable energy sources to power our economy and our military. Traditional fossil-fuel based petroleum is derived from crude oil that has increasingly challenging market and supply constraints. Chief among these is

limited, unevenly distributed, and concentrated global sources of supply. America's growing dependence on foreign sources of crude oil undermines foreign policy objectives and comes at an ever increasing impact to the Nation's trade imbalance. Advanced biomass-derived transportation fuels that use a domestic, renewable feedstock can provide a secure alternative that reduces the risks associated with petroleum dependence.

Given the current economic environment, significant start-up risks, and competitive barriers posed by the firmly established crude oil markets, industry will not assume all of the uncertainty and risk associated with providing a commercially viable production capability for advanced drop-in biofuels. Therefore, it is necessary that the Government take steps to create a strong demand signal and to make targeted investments to achieve the necessary production capacity required for a robust domestic advanced drop-in biofuels industry."

- **The Hawaii Clean Energy Initiative** (HCEI): The HCEI Road Map to achieve 70 percent clean energy by 2030 states:

"Several important considerations form the basis of the need for a strong biofuels policy for the State of Hawaii:

1. Overall, alternative fuels will be an essential component of meeting the 70% goal for both electrical generation and transportation. This is especially true for transportation since there are a fewer options for attaining the goal of 385 MGY of petroleum fuel reduced.

2. Biofuel feedstock production offers a means of preserving traditional agricultural lands and jobs. Ideally, as much of the local demand as possible should be met through local sources. If it is not deemed possible to meet all demand through local sources, imports of domestic US products should be the next option for the State, followed by foreign imports as a lowest priority source of fuel.

3. At the present time, there is not a detailed understanding of what feedstock crops at what scale could potentially be grown in Hawaii. Therefore, if local fuels production is the optimal socially desirable outcome, identifying this potential must be the key focus for years 1-5 of this Road Map. If insufficient potential exists, other alternatives to meet this demand must be found. One potential option of this type is hydrogen fuel, which is currently being studied in Hawaii on a small scale.

4. If fuels are produced locally, efforts must be taken to ensure that the industry is sustainable in nature. This means that all feedstock production practices must not be just economical, but sustainable from an agricultural perspective as well. As an example of this, the HECO companies have adopted National Resource Defense Council standards for their recent biofuel request for proposals (RFP)."

Additional information on the Fuels section of the HCEI roadmap is provided in Appendix III.

- **Hawaii Natural Energy Institute** (HNEI): The University of Hawaii (UH)'s HNEI released a report in August, now available online, assessed lands suitable for algae production in Hawaii; "Analysis of Land Suitable for Algae Production: State of Hawaii". Algae have high productivity rates, the ability to grow in a wide range of water qualities, and the potential to be produced on land unsuitable for food production.

Earlier this year, HNEI, with a team of researchers from the **College of Tropical Agriculture and Human Resources**' (CTAHR's) Department of Tropical Plant and Soil Science, the **School of Ocean and Earth Science and Technology**'s Department of Oceanography, the **College of Business Administration**, **RealGreen Power** and **Pacific Biodiesel**, won a $1 million sustainability research competition with a project to advance the use of biofuels, while developing and placing water, energy, and soil sustainability technologies in local industry. The two-year project will conduct research and plant test sites of Jatropha curcas (pictured), a fast-growing, drought resistant tropical oil-bearing plant that can be converted to biodiesel. It will also explore the conversion of waste biomass into carbonized material that can be used for soil enrichment. The project was sponsored by the UH Manoa office of the Vice Chancellor for Research and Graduate Education, and is focused on commercializing technology and products in the next several years.

- **Cooperative Research Center for Bioenergy Research and Development:** This organization, based at UH, is a member of the Industry/University Cooperative Research Center (I/UCRC) for Bio Energy Research and Development (CBERD) of the National Science Foundation. CBERD's mission is to assist the National Science Foundation in achieving the national priority goal of augmenting the petroleum-based economy with renewable energy, chemicals and biomaterials. Universities participating in the center

have identified six research areas, and each of these focus areas are addressed through numerous projects. The focus of the center is on activities that support and extend recent advances made by industrial partners:

- Feedstock agronomy and supply
- Feedstock breeding and genomics
- Bioprocessing microbes and enzymes
- Biomass processing
- New platform technologies
- Modeling and process lifecycle analysis

- **Oceanic Institute** and the **University of Hawaii:** Work on animal and fish feed is being undertaken by the Oceanic Institute and UH. Researchers, with industry partners, are studying food, feed, and other co-products from Hawaii-grown crops and algae production systems. The Oceanic Institute in early December 2011 hosted a workshop on the use and processing of biofuel co-products in feeds for fish, shrimp, urchin and shellfish.

- **Pacific International Center for High Technology Research** (PICHTR): The Hawaii Renewable Energy Development Venture (HREDV), a program of PICHTR, awarded over $4.3 million through a competitive selection process to five companies in the areas of renewable energy, including two in advanced biofuels. The Gas Company will build a pilot plant to process 1 million gallons per year of oil from agricultural and algae feedstocks into higher value products such as synthetic natural gas, gasoline, diesel and hydrogen. The project will produce a renewable gas stream that can be sent to residential and commercial customers on Oahu through existing pipeline infrastructure. Big Island Biodiesel, a new company created by Maui-based Pacific Biodiesel, will design and build a High Vacuum Distillation (HVD) unit in a new 5 million gallon-per-year biodiesel facility on the Island of Hawaii. The HVD system will enable the facility to process a wider range of oil feedstocks – and make higher quality fuel. The project will allow the use of new agricultural and waste feedstocks to meet Hawaii's need for transportation fuel.

- **Bioenergy Master Plan:** This project, required by Act 253 of 2007, was completed in December 2009 through a contract between DBEDT and the University of Hawaii's Hawaii Natural Energy Institute (HNEI). Issues and outcomes were studied in the context of the four primary value chain components necessary for a successful bioenergy industry: feedstock production and logistics; conversion; distribution; and end use. As stated in Act 253, Part III, "The primary objective of the bioenergy master plan shall [be to] develop a Hawaii renewable biofuels program to manage the State's

transition to energy self-sufficiency based in part on biofuels for power generation and transportation." Results included:

- Outcome I - Hawaii does have the potential to meet the production scenario goal of 20% displacement of 2007 Hawaii fuel consumption.

- Outcome II - Priority actions for a renewable biofuels program, in alignment with the four primary areas of industry concern (availability and use of resources, value chain co-dependencies, industry impacts, and program level coordination) include, in order of priority:
  1. Establish a bioenergy program.
  2. Establish a bioenergy technical advisory group.
  3. Develop clear and consistent policy for use of State lands.
  4. Develop methodology for evaluation of bioenergy projects.
  5. Require Life Cycle Analysis for use of State lands or funding support.
  6. Provide a tax credit for irrigation systems.
  7. Provide a tax credit for infrastructure systems.
  8. Appropriate funds for a research position.

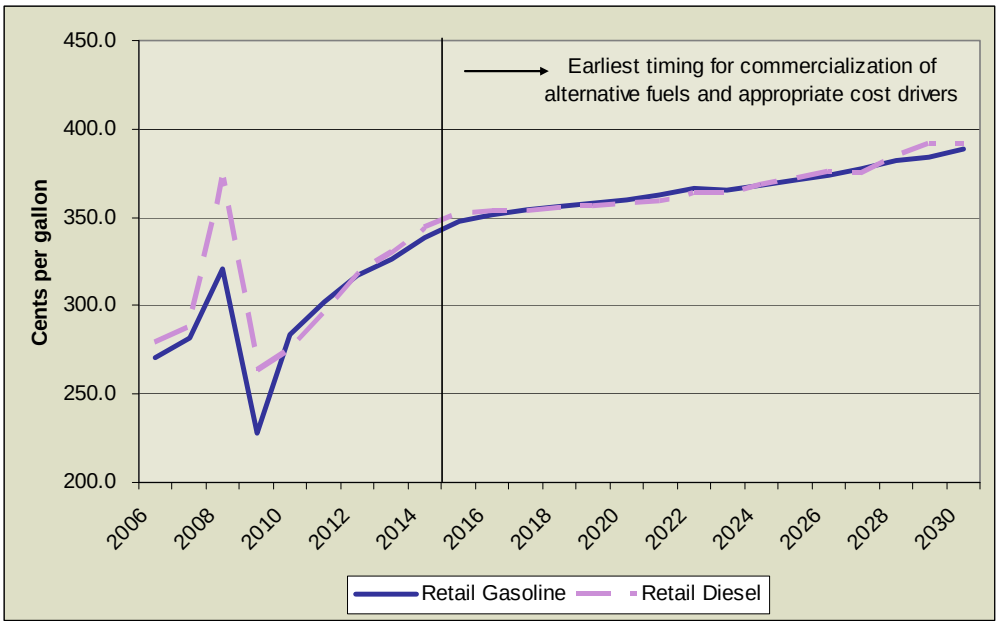
- Outcome III - Strategic Partnerships identified partnering arrangements that have arisen from participants identifying a common goal or information gap. Several entities were already in place to help facilitate strategic partnering at points along the value chain and can all contribute to partnership building due to their involvement in activities related to bioenergy research, development, testing, and deployment; HCEI, Hawaii Renewable Energy Development Venture (HREDV), Hawaii State Energy Office, UH, Hawaii Agriculture Research Center (HARC), and others.

- Outcome IV - Biofuels Demonstration Projects summarizes projects identified largely from stakeholder input. Candidate projects fell in the categories of feedstock production, conversion technology verification, and transportation/end use demonstration including:
  - Field plantings
  - Farmer operated/managed feedstock demonstrations
  - Feedstock production combined with technology demonstrations
  - Oil crop production
  - Pyrolysis of biomass
  - Gasification
  - Controlled storage of biofuels
  - Conversion of private cars/buses to operate on biofuels
  - Larger marine vessel conversion to renewable diesel

- Outcome V – identified several activities that could promote Hawaii's renewable biofuels resources including:
  - Legislative actions to reduce regulatory burden and create financial incentives
  - Maintenance of the Bioenergy Master Plan website
  - On-going participation in conferences and workshops
  - Keeping the State energy office staff engaged and informed about the bioenergy environment
- Questions identified for additional study included:
  - What feedstocks have the highest yields on non-prime agriculture land under various climatic conditions and management practices?
  - Can energy crops be grown sustainably and economically?
  - To what degree should agricultural land be dedicated to biofuel crops?
  - What biofuel products make the most sense for Hawaii's future needs?
  - Are the conversion technologies commercially available?
  - How are economic and technology risks of new technologies reduced?
  - What will be the cost to modify Hawaii's distribution infrastructure to accommodate the various biofuel options?
  - What are the appropriate incentives to encourage the production of energy feedstocks?

- **Biofuels Production Assessment**: In accordance with Act 240 of 2006, DBEDT retained Black & Veatch, with the University of Hawaii (UH) as a subcontractor, to prepare a statewide multi-biofuel production assessment focused on ethanol, biodiesel, and hydrogen, with some mention of advanced biofuels. The assessment, completed in 2009, addressed the potential feedstocks, technologies, and economics of biofuels production utilizing Hawaii resources. It stated:

> "Based on the projected future prices of retail gasoline and diesel fuels and the development pathways of the alternative fuels presented in this section, it would not be expected that any alternative fuels besides conventional ethanol would be commercially competitive until … conventional fuel prices … surpass $3.50/gallon (average US prices, 2007 dollars)."



And

"The results of this study demonstrate that Hawai'i has the resources necessary to meet the Renewable Fuel Standard (RFS) that has been laid out in Act 240, SLH 2006." (20% of ground transportation fuel demand to be met with alternative fuels by 2020.)

V. CONCLUSION

Significant progress has occurred in Hawaii's biofuels sector and the final report required by Act 203 of 2011 will be informed by knowledgeable and engaged experts.

APPENDIX I: Act 203, Session Laws of Hawaii, 2011

Approved by the Governor
on JUL 8 2011

THE SENATE
TWENTY-SIXTH LEGISLATURE, 2011
STATE OF HAWAII

ACT 203

S.B. NO. 146 S.D. 1 H.D. 2 C.D. 1

A BILL FOR AN ACT

RELATING TO BIOFUEL.

BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF HAWAII:

SECTION 1. The legislature finds that the State needs to expand the use of biofuels as a viable source of energy in order to reduce dependence on fossil fuels and imported oil. The use of biofuels is consistent with the State's goals relating to renewable energy and sustainability. The legislature further finds that imposing a statutory requirement to utilize biofuels as energy may be premature at this time in view of the lack of research and development in the industry, the nascent nature of the industry, and the uncertain availability of biomass crops in Hawaii to produce liquid or gaseous fuel.

The purpose of this Act is to direct the energy resources coordinator to conduct a study and issue a preliminary and a final report on the conditions and policies necessary to expand biofuel production in the State to displace a significant amount of petroleum-based liquid fuel.

SECTION 2. The energy resources coordinator shall conduct a study and issue a report on the potential for biofuel production in Hawaii to displace a significant amount of

petroleum-based liquid fuel. In compiling its report, the coordinator shall consult with producers, including local biofuel producers and local refineries; researchers; landowners; distributors; and end users, including airlines, fleets, utilities, and the military, on the conditions and policies necessary for biofuel production and use in Hawaii to displace a significant amount of petroleum-based liquid fuel.

The report shall include information on the following types of biofuel:

(1) Ethanol;

(2) Cellulosic ethanol;

(3) Fatty-acid-methyl-ester biodiesel;

(4) Synthetic or bio-based:

(A) Diesel fuel;

(B) Gasoline; and

(C) Jet fuel; and

(5) Any other type of biofuel the coordinator deems relevant to the study.

SECTION 3. (a) For each type of biofuel listed in section 2 of this Act, the energy resources coordinator's report pursuant to section 2 of this Act shall include the following information:

(1) The State's projected demand in the near-term, mid-term, and long-term for the biofuel's petroleum-based counterparts;

(2) Types of feedstock that could be used;

(3) Availability of feedstock within the State in the near-term, mid-term, and long-term;

(4) Availability of feedstock out-of-state in the near-term, mid-term, and long-term;

(5) Production within the State in the near-term, mid-term, and long-term;

(6) Production out-of-state in the near-term, mid-term, and long-term;

(7) Costs in the near-term, mid-term, and long-term for biofuel product produced within the State;

(8) Costs in the near-term, mid-term, and long-term for biofuel product produced out-of-state;

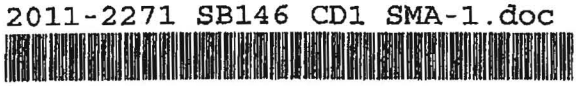
(9) Status of the technology;

(10) ASTM specifications;

(11) Realistic timeline of production within the State;

(12) Benefits to the State's economy;

(13) Emissions compared to other comparable biofuels and to its petroleum-based counterpart;



(14) Logistics of handling and usage compared to other comparable biofuels and to its petroleum-based counterpart; and

(15) Stability of supply and costs compared to other biofuels and to its petroleum-based counterpart.

For the purposes of this Act:

"Long-term" means longer than ten years.

"Mid-term" means from three to ten years.

"Near-term" means within three years.

(b) The energy resources coordinator's report shall include recommendations, taking into account the federal Renewable Fuel Standards II, as amended, on the following:

(1) Whether any specific biofuel mandate is necessary in order for biofuel production and use in Hawaii to displace a significant amount of petroleum-based liquid fuel; and

(2) Whether the ethanol fuel requirement in section 486J-10, Hawaii Revised Statutes, should be maintained, modified, or repealed.

The coordinator shall include the rationale for all recommendations made in the report.

(c) The energy resources coordinator shall issue a preliminary report of findings and recommendations to the legislature no later than twenty days prior to the convening of the regular session of 2012 and a final report of findings and recommendations to the legislature no later than twenty days prior to the convening of the regular session of 2013; provided that the preliminary and final reports may be included in the energy resources coordinator's respective annual reports to the governor and legislature, pursuant to section 196-4(11), Hawaii Revised Statutes.

SECTION 4. This Act shall take effect upon its approval.

APPROVED this 8 day of JUL , 2011

GOVERNOR OF THE STATE OF HAWAII

APPENDIX II: Online Form – Biofuels Report: Request for Input

Biofuels Report

Request for Input

In 2011, the Hawaii State legislature passed, and Governor Abercrombie signed, Act 203 (SB146) directing DBEDT to conduct a study and issue a final REPORT (December 2012) following a preliminary report (December 2011) on “the conditions and policies necessary to expand biofuel production in the State” to displace a significant amount of petroleum-based liquid fuel.

In compiling the report, DBEDT is consulting with producers, including local biofuel producers and local refineries; researchers; landowners; distributors; and end users, including airlines, fleets, utilities, and the military.

The report will include information on the following types of biofuel:
(1) Ethanol;
(2) Cellulosic ethanol;
(3) Fatty-acid-methyl-ester (FAME) biodiesel;
(4) Synthetic or bio-based:
- (A) Diesel fuel;
- (B) Gasoline; and
- (C) Jet fuel; and
(5) Any other type of biofuel deemed relevant to the study.

For the purposes of this Act:
"Long-term" means longer than ten years.
"Mid-term" means from three to ten years.
"Near-term" means within three years.

Please add information for each type of biofuel listed above, relevant to your company/organization.

(1) Major fuels users, your projected demand in Hawaii in the near-term, mid term, and long-term for the biofuel(s) and petroleum-based counterpart(s) being replaced;

(2) (All), types of feedstock that could be used;

(3) Availability of feedstock within the State in the near-term, mid-term, and long-term;

(4) Availability of feedstock out-of-state (if applicable) in the near term, mid-term, and long-term;

(5) Production within the State in the near-term, mid term, and long-term;

(6) Production out-of-state (if any) in the near-term, mid-term, and long-term;

(7) Costs in the near-term, mid-term, and long-term for biofuel produced within the State;

(8) Costs in the near-term, mid-term, and long-term for biofuel produced out-of-state (if any);

(9) Status of the technology;

(10) ASTM specifications;

(11) Realistic timeline of production within the State;

(12) Benefits to the State's economy, such as estimated:

- **Job retention, and;**

- **Job creation;**

- **Growth of your company;**

- **Suppliers/contractors/subcontractors retained;**

- **Construction;**

• **Research conducted and published;**

• **Co-products developed and produced;**

• **Other benefits.**

(13) Emissions compared to other comparable biofuels and to its petroleum-based counterpart;

(14) Logistics of handling and usage compared to other comparable biofuels and to its petroleum-based counterpart; and

(15) Stability of supply and costs compared to other biofuels, biofuel imports, or petroleum -based counterpart(s).

Recommendations required

Considering the Federal Renewable Fuel Standards II, as amended, please offer your recommendations including rationale, on the following:
(1) Whether any specific biofuel mandate is necessary in order for biofuel production and use in Hawaii to displace a significant amount of petroleum-based liquid fuel;

(2) Whether the ethanol fuel requirement in section 486J-10, Hawaii Revised Statutes, should be maintained, modified, or repealed.

Organization

Name

First Last

Title

Email

Phone

(###) ### - ####

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APPENDIX III: HCEI Road Map 2011; Fuels Working Group

V. Fuels (2011-2020)

Renewable fuels, including biofuels and other non-petroleum-based fuel types that can be produced sustainably (e.g. hydrogen), are an essential part of the HCEI clean energy strategy. Biofuels, or stored energy, are defined for the purposes of this Road Map as any liquid fuel produced from biomass or natural oils that can be used for electrical generation or transportation purposes. While all types of biofuels will be necessary for the attainment of HCEI goals, a distinction must be made between drop-in replacement fuels, (i.e. biofuels with chemically similar structures to petroleum products that can be blended with petroleum fuels without causing performance issues) and non-drop in replacement fuels, such as ethanol, which is an imperfect substitute for gasoline and may require a corresponding additional infrastructure investment in certain cases. This Road Map does not discriminate between drop-in replacement and non-drop-in replacement fuels, other than to note that not all future fuel usage can be met through the use of non-drop-in fuels only (for example, jet fuel constitutes 30% of current fuel demand in the State, and does not currently have a non-drop-in substitute). Several important considerations form the basis of the need for a strong biofuels policy for the State of Hawaii.

1. Overall, alternative fuels will be an essential component of meeting the 70% goal for both electrical generation and Transportation. This is especially true for transportation since there are a fewer options for attaining the goal of 385 MGY of petroleum fuel reduced
2. Biofuel feedstock production offers a means of preserving traditional agricultural lands and jobs. Ideally, as much of the local demand as possible should be met through local sources. If it is not deemed possible to meet all demand through local sources, imports of domestic U.S. products should be the next option for the State, followed by foreign imports as a lowest priority source of fuel
3. At the present time, there is not a detailed understanding of what feedstock crops at what scale could potentially be grown in Hawaii. Therefore, if local fuels production is the optimal socially desirable outcome, identifying this potential must be the key focus for years 1-5 of this Road Map. If insufficient potential exists, other alternatives to meet this demand must be found. One potential option of this type is hydrogen fuel, which is currently being studied in Hawaii on a small scale
4. If fuels are produced locally, efforts must be taken to ensure that the industry is sustainable in nature. This means that all feedstock production practices must not be just economical, but sustainable from an agricultural perspective as well. As an example of this, the HECO companies have adopted National Resource Defense Council standards for their recent biofuel request for proposals (RFP)[8]. Important areas of concern include: local feedstock support mechanisms, sourcing requirements for palm oil, additional baseline environmental criteria for all feedstock, chain of custody tracking for feedstock and oils, greenhouse gas emissions accounting and reporting, establishment of a biofuels public trust fund, public review and notification and public progress reporting and contingencies

In addition to understanding the true potential of locally produced fuels, significant attention must also be paid to the existing petroleum infrastructure in the State. The critical issues that must be understood in any fuels policy include:

1. Any future reduction in overall petroleum usage will reduce the revenues of the two local petroleum refineries. For them, a shift to refining biofuels will likely be necessary to maintain viability. These refineries provide a reserve of local expertise in chemistry, engineering, and industrial processes that could be helpful in the development of local biorefining capability.

[8]HECO Biofuels RFP, March 31, 2010, http://www.heco.com/vcmcontent/StaticFiles/pdf/RFPrev1.pdf, last accessed 11/23/10

2. Even with a significant demand for biofuels in-State, there will still be a major need for traditional petroleum products for blending in transportation, aviation and electrical generation fuel. By using the existing petroleum refining infrastructure to create these blends, the State preserves a high value option for supplying its future petroleum, as well as biofuel, demand.
3. The existing petroleum shipping infrastructure could also be leveraged to support a biofuel industry in-State

Overall, having a detailed understanding of the future markets for various types of biofuel and how it lines up with the potential supply of feedstock that can be produced in the State, is essential for the development of a sustainable local fuels industry.

ACCOMPLISHMENTS TO DATE (2010)

Understanding the domestic potential of Hawaii's agricultural sector to support a large, sustainable, biofuels industry has been the primary focus of HCEI's activities to date. However the strategy adopted by HCEI in this sector will eventually expand well beyond that to incorporate all aspects of the renewable fuels supply chain.

STRATEGY	REPRESENTATIVE* ACCOMPLISHMENTS TO DATE
Evaluate local agricultural potential/ support its development	• Hawaii Bioenergy Master Plan completed • Phase I of DARPA Algae Study complete (Phase II pending) • Several small-scale crop trials underway across a range of institutions
Invest in key logistical/generation infrastructure	• HECO CIP CT-1 Biofuel Generators Installed and testing of biodiesel in unit is completed • HECO completed test of 100% biodiesel at Kahe power plant
Evaluate and develop renewable fuel processing infrastructure	• Pacific biodiesel Big Island project underway • Several pilot scale drop-in replacement fuel refinery projects underway in State (e.g. Phycal, and UOP/Tesoro projects)
Match potential fuels supply to sources of in-State demand	• HECO RFP issued for 210 MGY of locally produced biofuels (first contract signed) • DoD RFI issued for 25% of current aviation, marine and ground diesel fuel demand • HCEI transportation analysis complete, indicating additional need for ground transportation fuels (~150 MGY by 2030)

*For a full list of accomplishments, please see Appendix A

GOALS

In the short term, the Fuel sector will be a work in progress. By all estimates, advanced technologies for the large scale production of drop-in replacement biofuels are approximately 5 years away from being commercially viable, as the current wave of pilot plants are being constructed now. While viable technologies capable of producing biodiesel are currently in operation on the islands, production has been limited in scale to date by the lack of large-scale availability of oil-based feedstocks. Thus, short term goals and critical items for biofuels are relatively conservative until the results of these pilots are understood and the agricultural sector can be expanded to generate a steady supply of feedstock to support the refineries. The 2015 goals for the fuels sector in Hawaii are:

V. Fuels

SOURCE OF DEMAND	ESTIMATED TOTAL GREEN REPLACEMENT FUEL DEMAND (2015)
The HECO Companies	~45 MGY renewable Fuel
KIUC	100,000 gal/year
The Department of Defense	TBD MGY renewable JP8 TBD MGY renewable J5 TBD MGY renewable F76 TBD MGY renewable Diesel Fuel/biodiesel
The Ground Transport Sector	Maintain current E10 standard and biodiesel usage

These goals are based on five key drivers:

1. HECO's estimated 2015 demand is directly related to its ability to attain its RPS goals. Should it exceed its target for generating electricity through other renewable services to meet the RPS, this estimated demand could be revised down, and vice versa
2. The utilities must abide by PUC decisions regarding competitive pricing for any renewable fuels they wish to use in their generators
3. The Department of Defense has set a goal that a quarter of all of its marine, aviation and diesel fuels be met through the use of biofuels
4. All ground transport demand estimates are based on the assumption that the current E10 standard will remain in place through 2015, with renewable drop-in gasoline eventually supplementing ethanol in the 2015-2020 time frame
5. The supply of biofuels from the current biorefineries in the State, while critical to the attainment of HCEI goals, will be unlikely to match the scale of demand forecast here without significant new sources of feedstock

Given the diverse nature of the demand for many different types of biofuels in the market and the relative uncertainty of what local supply will be available to meet them, our core strategies and important actions for the next five years must be centered around evaluating potential feedstock production capabilities in the state and matching them to the various demand niches in the market. These niches are highlighted in the table below:

TYPE OF FUEL	DEMAND TYPE
Ethanol	Ground transportation only
Renewable Gasoline	Ground transportation only
Biodiesel	Ground transportation and generation
Renewable Diesel	Ground/marine transportation and generation
Renewable Residual Fuel (e.g. raw pyrolysis oil)	Generation only
Renewable Jet Fuel	Air transport only

With the different qualities of these various types of fuels, sub-markets may develop around each as we progress. Understanding the nature of these markets and identifying areas where Hawaii can be competitive in the long term are the essential components of our overall strategy for years 2011-2015.

Core Strategies

Biofuels will play a critical role in Hawaii's successful attainment of its 70% clean energy goal. Since biofuels have to compete not just with petroleum, but global imports, cost-effectiveness of production becomes the key item of strategic importance. HCEI seeks to accelerate the process of developing a cost-effective local industry by evaluating and encouraging investment in all core aspects of the fuels supply chain. This chain breaks down into four areas of critical strategic importance to the State (highlighted on the following page):

V. Fuels

STRATEGY	REPRESENTATIVE* IMPORTANT ACTIONS: YEARS 1-5 (2015 TARGET DATE)
Evaluate local agricultural potential/ support its development	• Work with government agencies to resolve land, water and labor issues re: use of agricultural lands • Evaluate optimal business models, matching feedstock production to refining infrastructure needs where possible • Integrate and update recent studies to map agricultural crops to specific lands, factoring in necessary production scale • Expand feedstock demos, with emphasis on identifying highest yielding crops for Hawaii
Invest in key logistical/generation infrastructure	• Analyze the biofuels supply chain to identify key transportation/pre-processing infrastructure needs • Establish work-force training programs to re-build agricultural knowledge base • Expand pre-processing and refining construction sectors
Evaluate and develop renewable fuel processing infrastructure	• Work with counties to streamline permitting process from start (crop growth) to finish (fuel refining) • Complete UOP/Tesoro integrated biorefinery Pilot • Evaluate progress of in-State algae pilots
Match potential fuels supply to sources of in-State demand	• Track subsequent changes in market demand for fuels across all fuel types • Develop long-term contracts for the use of biofuels in generation and military transport • Monitor the development of advanced biofuels technologies, including the National Advanced Biofuels Consortium

*For a full list of accomplishments, please see Appendix A

Given the current pilot phase of many of the technologies being considered for use in the State, and the unknown ability of the State to generate the feedstocks necessary for the production of large-scale biofuels cost-effectively, HCEI expects clearer answers to many of the questions regarding the ability of the local industry to support a biofuel industry of any scale by the 2015 time period when the current round of integrated biorefinery pilots is complete.

Also in this time period, the question of demand for aviation fuel needs to be more fully understood and an aviation fuel goal developed along with a list of prioritized action items. This will require outreach to the private sector airlines operational in Hawaii as well as the U.S. Department of Defense (DoD) to determine estimated future levels of demand. HCEI hopes to have a series of aviation fuels goals outlined within the next 2 years as more information becomes available on the progression of the market.

YEARS 2016-2020

Due to the lag necessary for the development of the technologies needed for large-scale renewable fuels production, 2015-2020 will be critical to the success of HCEI's fuels goals. Both HECO and DoD have stated that they anticipate accelerating biofuel usage significantly in this period, and as such, the goals for this time period represent a significant jump from 2015 levels, as summarized below:

SOURCE OF DEMAND	ESTIMATED TOTAL GREEN REPLACEMENT FUEL DEMAND (2020)
The HECO Companies	80 MGY renewable generation fuel (based off estimated RPS demand)
KIUC	TBD
The Department of Defense[9]	32 MGY renewable fuels
The Ground Transport Sector	50 MGY of renewable fuels

As the long term fuels strategy is based primarily on the continued development of technologies capable of providing large scale renewable fuels production, these goals should be revisited based on the results of pilot studies across all feedstock types.

STRATEGIC PATH FORWARD:

While the need to understand the potential of the agricultural sector and the market demand for biofuels is critical

[9]DoD targets based on prorated share of stated DoD RFI Demand (i.e. 50% of total demand by year 2020)

in years 1-5, moving forward, the State will need to have a firm picture of what the local production capacity for feedstock is, how the logistics of transporting, pre-processing it, and refining it will be by the time years 2016-2020 arrive. To this end, this time period should focus on:

Evaluate local agricultural industry potential and support its development as needed:
By 2016, the optimal business models for the development of a strong agricultural sector will have been identified, and food and fuel feedstock produced in some combination at levels suitable to what is sustainable in Hawaii. This optimal level will largely determine what sort of logistics are needed for feedstock transport.

Understand and invest in key logistical infrastructure to develop economies of scale:
Where possible, economies of scale should be developed throughout the transportation system for both food and fuel products. For example, central pre-processing plants may be optimal for the generation of economies of scale in a scenario where many small plots of land need to combine their feedstock to produce a liquid biocrude for transport and refining. In this scenario, leveraging the previous sugar industry transportation and shipping cooperative model may be one option for moving feedstock to central refining facilities. In another scenario, where fuel is refined and consumed on-site, this investment in large scale transport infrastructure may not be necessary.

Evaluate and develop renewable fuel processing infrastructure:
Depending on local feedstock production capabilities and the logistics chain, additional infrastructure for the development of small-scale, local refining facilities (in the case of low feedstock production capacity) or the leveraging of existing petroleum refining infrastructure to generate large-scale capacity (in the case of high feedstock production capacity) will be necessary in this time period. If large scale capacity is not available, a systematic plan dealing with the need for imports will have to be developed, ideally based on the need to keep the State's current refining infrastructure operational (to continue to provide for cost-effective petroleum products in addition to biofuels.)

Match potential fuels supply to key sources of demand in-State:
While demand is unlikely to wait until the overall local production capabilities are completely clear, secure contracts for the supply of biofuels from local suppliers will need to be negotiated in this time frame, where cost-effective and applicable. Aligning these contracts with specific end use demand and what local production is available is essential to the development of an economically sustainable industry in-State, as the local use of fuels will help local products maintain their competitiveness with imports that bear significant shipping costs.

MEASURING SUCCESS, AND ADJUSTING GOALS OVER TIME

As all fuel goals are set in terms of MGY of fuel produced/consumed in State, tracking the fuel production and use goals will be done via the use of Renewable Identification Numbers (RINs) assigned to specific fuel units by the Environmental Protection Agency (EPA)[10] .

Imports may also be tracked through RIN numbers, although these will need to be recorded by the importer in question in order to verify their use in-State.

[10]EPA RIN Program: http://www.epa.gov/oms/fuels/renewablefuels/compliancehelp/index.htm, last accessed 11/23/10

VI. Fifteen Year Goals (2021-2025)

Unlike Sections II through V, this section evaluates the four energy sectors together. By 2021, significant progress should have been made towards HCEI goals. From a vantage point in 2010, it is difficult to forecast exact projects completed or technologies that may be available; however, a sample of potential progress based on the milestones from the previous time periods for each group is provided in the table below:

HCEI TARGET SECTOR	2025 GOAL
Electricity	32.5% of total generation is renewable
End-Use Efficiency	3,500 GWh reduced (subject to PUC revision)
Transportation	300 MGY of transport fuel reduced
Fuels	350 MGY of renewable fuels consumed

For all scenarios, the future price of oil will be deciding factor, as it will materially impact the bottom line for each of the alternative outcomes under consideration. Likewise, any future price put on the emission of carbon will likely materially impact the potential attainment of our goals. Finally, any new technologies or approaches that suggest major strategy revision or change of direction will need to be factored into our future evaluation as well (e.g., Is OTEC fully developed and cost effective? Has algae oil succeeded in driving the cost of biofuels down significantly?) However, in focusing on the alternatives that are largely within the control of the State, the major decision points that will underpin potential future outcomes are:

1. Island connectivity: Are one or more of the islands connected via undersea cable to allow greater resource flexibility?
2. Energy efficiency: Have the goals of the EEPS been met, alleviating the need for increased investment in generation technology and improving the ratio of firm to variable resources on the grid?
3. Biofuels: Has an in-State biofuel industry been created, allowing a secure source of fuel for generation and transportation? If so, at what scale? If not, how do biofuel imports cloud the economics of HCEI?
4. Electric vehicles: Have EV and hydrogen vehicle technology progressed as hoped, and has the State succeeded in deploying advanced vehicles in significant numbers?

VI. Fifteen Year Goals (2021-2025)

Depending on what combination of these scenarios come about, HCEI's progress towards its goals at year 15 will vary. The potential impact and progress accounted for across these decision points is laid out in the table below:

SCENARIO	LOWER BOUND	UPPER BOUND
Inter-island connectivity	None. This limits Hawaii to only those resources available to each island individually, leading to decreased (or more expensive) renewable energy penetration on Oahu	Oahu, Lanai, Molokai, Maui and the Big Island are all connected via inter-island cable, allowing significant wind and geothermal resources to be harnessed and applied to the areas of greatest need
Energy Efficiency	Progress made during the recession reverses itself, and only limited amounts of MWh are taken offline. This leads to a need for increased investment in potentially expensive generation technologies to meet HCEI goals, especially on Oahu, where most of the load is located and renewable resources are limited	EEPS goals are maintained, or closely matched. This allows Oahu to meet its 70% clean energy goal without investing in more expensive alternative generation technology options
Biofuels	No in-State industry is formed, forcing all biofuels to be imported. Does not materially contribute to HCEI goals of increasing energy security or lowering energy price volatility	A healthy in-State industry is formed, and a significant fraction of electricity generation and transportation demand is offset through contracts with local suppliers/refiners. Allows firm clean generation while meeting HCEI goals
Electric Vehicles	Price premiums for vehicles do not fall significantly, charging equipment is under-invested, and low levels of EVs are purchased. This leads to limited transportation options, either forcing the State to pursue more efficient standard vehicle mix or increased biofuel blending standards to offset the lack of EVs	Price premiums for vehicles fall with battery prices, charging infrastructure is installed, and plug-in vehicles reach up to 20% of the fleet by 2030. Increases need for renewable generation to meet RPS, but lowers need to strengthen blending standards for transportation fuel. High efficiency standard vehicle mix should still be pursued

PROGRESS TOWARDS HCEI GOALS IN YEAR 15, BY SCENARIO

This section should be revisited in five-year increments to be sure that nominal notions of "success" stay in tune with market realities. In year 10, a list of critical items should be generated for the potential end-scenarios identified above, based on progress at that time.

Should the preponderance of these updated goals not be met by the end of year 15, key gaps should be identified and strategies for replacing non-viable items generated. Adjusting the final goals should be considered only as a matter of last resort, if it becomes apparent that the progress of HCEI is far away from the milestones set in year 10.