Overview of Bioenergy Development in Hawaii

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March 19, 2018
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2nd APEC Workshop on Guidelines Toward High Biodiesel Blend Diesel (eg B20)
Honolulu, HI
Kauai
Oahu
Molokai
Maui
Lanai
Hawaii

Nearest Continental Land Mass – 4,000 km

Land area 16,000 km²
Population ~1.4 M

Google My Maps
• Established in 1907
• 3 universities & 7 community colleges
• Over 53,000 students
• Manoa is the largest and main research campus
  • 14,000 undergraduate students
  • 6,000 graduate students
• State and tuition funding ~ $350MM
Hawaii Natural Energy Institute

Organized Research Unit in the School of Ocean and Earth Science and Technology, University of Hawaii at Manoa

**Alternative Fuels:** Biomass, Biofuels, Hydrogen, Methane Hydrates

**Electrochemical Power Systems**
- Fuels Cells, Batteries

**Renewable Power Generation**
- Ocean Energy
- Photovoltaics

**Energy Efficiency**
- Building Technology
- Sea Water Air Conditioning

**Grid Systems Integration**
- Grid modeling and analysis
- Smart grid development
- Grid-scale storage
Primary Energy Sources in Hawaii, 2015

- Petroleum: 84.3%
- Coal: 5.5%
- Biomass: 4.1%
- Hydro: 0.4%
- Other Renewables: 5.7%
Electric Power Primary Energy Sources in Hawaii, 2014

- Petroleum, 67.9%
- Coal, 14.8%
- Geothermal, 2.5%
- Hydroelectric, 0.9%
- Other, 4.6%
- Biomass, 3.3%
- Wind, 5.7%
- Solar, 0.4%

Residential electricity rates range from $0.26 to $0.34/kWh and average monthly use is 484 kWh
Petroleum Use in Hawaii, 2016

- Air Transport, 31%
- Ground Transport, 26%
- Marine Transport, 5%
- Commercial, 3%
- Industrial, 9%
- Electricity Production, 26%
Major Goals of Hawaii Energy Strategy

• Reduce Hawaii’s dependence on oil
• Protect the environment
• Reduce the negative impacts related to using imported fuels
• Enhance renewable energy use and energy efficiency
• Improve the security, reliability, and resilience of Hawaii’s energy systems
Selected Legislation Enacted in Support of Hawaii Energy Strategy

- **Act 199 (1994):** Requires that 85% of gasoline for use in motor vehicles contain 10% EtOH by volume *(repealed 12/31/15)*
- **Act 240 (2006):** Mandates biodiesel preference of $0.05 per gallon in State procurement laws
- **Act 253 (2007):** Mandates development of a Hawaii State Bioenergy Master Plan
- **Federal Energy Independence and Security Act (2007):** requires 36 billion gallons of biofuels by 2022 w/ special consideration for advanced biofuels
- **Act 202 (2016):** Five year, renewable fuels production tax credit (equal to $0.31/gal or 0.08/liter for biodiesel) for five years
Hawaii Renewable Portfolio Standards for Electricity (HRS 269-92, 2015)

- 10% of net electricity sales by 2010
- 15% of net electricity sales by 2015
- 30% of net electricity sales by 2020
- 40% of net electricity sales by 2030
- 70% of net electricity sales by 2040
- 100% of net electricity sales by 2045
Surrounded by ocean with year-round tropical sunlight, steady trade winds and a volcano, the Hawaiian Islands are blessed with rich natural energy resources that make it ideal for achieving energy independence. These 65 projects have the capacity to generate an estimated 16,095 gigawatt hours per month, which is enough to power approximately 344,089 Hawaii homes for the next 20 years.

For more renewable energy projects, both operational and under development, visit https://www.energy.hawaii.gov/renewables/projects.html.
Global Algae Innovations’ Research Facility on Kauai
Green Energy Team

- 7 MW$_e$ wood fired power plant
- ~125 tonne wood per day
- Eucalyptus and albizia
- 8% of Kauai electricity demand
H-Power Waste to Energy Facility

- 90 MW$_e$ gross/75 MW$_e$ exportable power
- Capacity of 3,000 tons MSW tons per day
- Three boilers; two with RDF, one mass burn
- Owned by the City & County of Honolulu,
- Managed by Covanta
- Tipping fee: $45/ton municipal, $81/ton commercial

PVT Land Company

- Construction & demolition landfill
- 1,775 tons C&D waste per day
- ~50% of intake converted to feedstock
- Feedstock: wood, plastic, cloth, paper, and other organics
- Tipping fee $50 per ton
Biodiesel Power Plants

• 110 MW combustion turbine power plant at Campbell Industrial Park
• 8 MW internal combustion engine for emergency power at Daniel K. Inouye International Airport, Honolulu
• 50 MW dual fueled power plant at Schofield Barracks (in construction)
• Several others in the State use biodiesel for start up/shut down
Hawaiian Commercial & Sugar

- 15,000 ha sugar plantation
- 40 MW_E total generating capacity
- Biomass and hydro
- 12 MW_E power export
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Hawaii's Last Sugar Mill is Closing - The End of an Era on Maui
By Susan Fox | December 28, 2016 | 2 Comments | Share

As 2016 comes to an end, it brings forth the end of an era for not only Maui but the entire state of Hawaii. In January of this year, Hawaii’s last sugarcane company, HC&S, announced that they will begin their final harvest and cease operations at the end of the year.
Cellana

- Algae products development company
- 6 acres (2.5 ha) facility
- High value products, fish feed, oil
Land Use in Hawaii

- Total land area in Hawaii – 4.1 M acres (1.6 M ha)
- Urban and Rural land use districts - 0.2 M acres (81 k ha)
- Conservation land use district – 1.97 M acres (800 k ha)
- Agricultural land use district – 1.93 M acres (800 k ha)
- Area in farms – 1.13 M acres (460 k ha)
- Total cropland – 175,000 acres (71 k ha)
- Harvested cropland – 99,000 acres (40 k ha)

Source: 2016 Hawaii State Data Book, Dept. of Bus. Econ. Dev. & Tourism
http://hawaii.gov/dbedt/info/economic/databook/db2016/
Research and the Bioenergy Industry Value Chain

<table>
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<tr>
<th>Feedstock Production</th>
<th>Feedstock Logistics</th>
<th>Conversion</th>
<th>Distribution</th>
<th>End Use</th>
</tr>
</thead>
</table>

Agriculture ---- Industry ---- Investors ---- Government ---- Community

Resource Assessment of Bioenergy/Biofuel Feedstock Supply/Availability

Development of Conversion Technologies and Process Assessment Tools for Tropical Bioenergy/Biofuel Feedstocks

Integration of Bioenergy/Biofuel Products With Existing Petroleum Infrastructure & End Use

Life Cycle Assessment of Bioenergy/Biofuel Production System

www.hnei.hawaii.edu
Biomass-Bioenergy-Biofuel Activities

• Resource assessment/Planning
• Conversion technology and process assessment
• Integration of bioproducts with existing infrastructure
• Life cycle assessment of bioenergy systems
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Resource Assessment/Planning

- Hawaii Bioenergy Master Plan
  - Assessment of land, water, labor, infrastructure, technology, permitting, financial incentives, policy requirements, economic and environmental impacts

- GIS-based analysis of bioenergy production potential
  - soil type, water access, rainfall, slope, insolation, land use zoning, community

Potential Areas for Sugar or Banagrass Production on Kauai

Legend
- Rainfall >7/8 inches, 10%<Slope<30%
- Rainfall >7/8 inches, Slope <10%
- Rainfall <7/8 inches, 10%<Slope<30%
- Rainfall <7/8 inches, Slope <10%

Biomass-Bioenergy-Biofuel Activities

- Resource assessment/Planning
- Conversion technology and process assessment
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Conversion Technology Activities

- Pretreatment of biomass materials to improve fuel properties
- Syngas production from biomass for higher valued products (fuels, chemicals, hydrogen)
- Plasma reforming of methane, dodecane, F76, and algal HRD76
- Pyrolysis and torrefaction of biomass materials
- Improved charcoal production techniques
Gasification Facility

Objectives
• Develop analytical methods to measure contaminants in product gas
• Characterize tropical biomass feedstocks for gas production and contaminant levels
• Evaluate contaminant removal and control strategies
• Investigate biomass derived syngas conversion to liquid fuels

Sampling ports:
Port 1: trace element sample pt
Port 2: outlet of sorbent bed
Port 3: outlet of catalytic tar reformer
Port 4: outlet of water gas shift

Biomass-Bioenergy-Biofuel Activities

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Swelling of Nitrile Rubber: Neat Fuels & Aromatics Mixtures

Aromatic 100

F-76

HRD-76

CHCD-76

SIP-76

\[ \mu = \left( \frac{d_i}{d_0} \right)^3 - 1 \] \times 100\%

\( \mu \) is the volume swell (%) and \( d_i \) and \( d_0 \) are the diameter of the O-ring in time \( i \) and \( 0 \).

\( t \) is the time when O-ring volume no longer changes

\( \mu \): 7.15%  
\( t \): ~85min

\( \mu \): -0.29%  
\( t \): ~85min

\( \mu \): 1.17%  
\( t \): ~150min

\( \mu \): -1.37%  
\( t \): ~150min
Biomass-Bioenergy-Biofuel Activities

- Resource assessment/Planning
- Conversion technology and process assessment
- Integration of bioproducts with existing infrastructure
- Life cycle assessment of bioenergy systems
Net energy analysis of Eucalyptus production

Dibble Tubes
Potting Mix
Fertilizer
Water
Shade House
Seed
Labor

Herbicide
Tractor
Implements
Fuel
Labor

Labor
Fertilizer
Water

Herbicide
Sprayer
Fertilizer
Labor
Fuel

Feller/Buncher
Skidder
Chipper
Transport
Labor
Fuel

Hand
Implements

Seedling
Production

Site
Preparation

Planting

Fertilization
Weed Control

Harvesting

Regeneration

Air, Land, Water Emissions

Plantation Boundary

Bolts
Chips
Net energy analysis of Eucalyptus production

Energy Contributors
1. Diesel – 70.2%
2. Herbicide – 14.6%
3. N-Fertilizer – 7.1%

Energy Out/In Ratio
40.6

Fossil Energy Input
51,160 MJ / ha
Questions?