Part 2: Perspectives on the Bioenergy Industry: Issue Reports

“There are lots of uncertainties and competition.”

Stakeholder comment, April 2, 2009
2.0 Introduction

Part 2 provides the executive summaries and recommendations from nine separate reports on issues specified by Act 253. The cross-cutting issues - “specific objectives and timelines” and “policy requirements necessary for implementation of the master plan” - are addressed in Section 3.2.2. The complete issue reports are in the Volume II of this report.

2.1 Land and water resources
   College of Tropical Agriculture and Human Resources (CTAHR), University of Hawaii

2.2 Distribution infrastructure
   Marc M. Siah & Associates, Inc.

2.3 Labor resources
   Department of Urban and Regional Planning/Political Science, University of Hawaii

2.4 Technology
   Hawaii Natural Energy Institute and CTAHR, University of Hawaii

2.5 Permitting
   Marc M. Siah & Associates, Inc.

2.6 Financial incentives
   Hawaii Economic Research Organization, Energy and Greenhouse Gas Solutions, University of Hawaii

2.7 Business partnering
   Agribusiness Incubator Program, CTAHR/University of Hawaii

2.8 Economic impacts
   Department of Urban & Regional Planning, University of Hawaii

2.9 Environmental impacts
   Pacific Consulting Services, Inc.

2.10 State, County, and Federal plans, policies, statutes, and regulations
   University of Hawaii
2.1 Water and Land Resources

EXECUTIVE SUMMARY

Project Background

Based on Act 253, SLH 2007, 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.”

The primary concern for consideration in the development of any bioenergy crops in Hawaii is the availability of the land and water necessary to produce such products. In addition to availability of large areas of land necessary for production, site suitability is also an important factor. Aspects related to this include bioenergy crop growing conditions, climatic factors, soils, geology and geography, land use patterns, surface and groundwater water resources, and infrastructure. In addition, potential agronomic productivity of the land must be evaluated. It is important to determine suitable locations in the Islands that can efficiently produce bioenergy crops while still being conveniently accessible to major consumers, including agricultural, industrial, and population centers, that will utilize the fuel once it is produced.

To evaluate Hawaii's water resources and their potential to support production of biofuels as a significant renewable energy resource, as well as to provide information, analysis, and recommendations, this study includes the following scope of work:

- Identify appropriate stakeholders, technical experts, and information sources throughout the state.
- Document the availability of existing water supplies for growing biofuels and biomass crops (indicate areas currently in production for food crops or diversified agriculture);
- Document the use, availability and allocation of water from streams, wells, and aquifers including environmental impacts and competing uses;
- Document the potential for additional sources of non-traditional water supplies – non-potable water, wastewater, stormwater, reclaimed water, desalinated water, and other;
- Document the potential for biomass production in conjunction with phytoremediation and bioremediation processes;
- Document methods to increase water use efficiency for bioenergy production including selection of biomass feedstocks, modeling of crop water use; technologies including irrigation techniques; and
- Estimate and document biofuel production potential based on water resources and available land assets.

To evaluate Hawaii's land resources and their potential to support production of biofuels as a significant renewable energy resource, as well as to provide information, analysis, and recommendations, this study also includes the following scope of work:

- Identify appropriate stakeholders, technical experts, and information sources throughout the state;
• Document the suitability (zoning, soil type, slope, temperature, etc.) of land resources for growing biofuels and biomass crops (indicate areas currently in production for food crops or diversified agriculture);
• Document the ownership, permissible use, location, availability, and allocation of appropriate land, and competing uses;
• Document methods to increase productivity of land use for bioenergy production including selection of biomass feedstocks, agricultural practices, and any other factors; and
• Estimate and document biofuel production potential based on water resources and available land assets.

This report presents results of a study conducted to explore and evaluate the land and water resources available for bioenergy crop production. The report presents data and information with GIS maps, graphs, tables, and appendices. In addition to the Executive Summary, this report consists of five major sections: i) Introduction, ii) Existing Water Supplies and Lands, iii) Existing Lands for Biofuels and Biomass Crops Production, iv) Agricultural Water Use for Potential Biofuels and Biomass Crops Production, and vi) Summary, Conclusions, and Recommendations.

Nature of Land and Water Resources Data
GIS maps of Agricultural Lands of Importance to the State of Hawaii (ALISH) date back to 1977 (Hawaii Statewide GIS Program, 2008) when most of the Hawaiian agricultural lands were under mono-cropping systems. The State Government made substantial changes in land leasing after the end of large-scale agricultural production. The historical land use changes have raised questions on the accuracy of the ALISH maps which need to be updated using remote sensing data validated through a ground-truthing process.

Sugarcane plantations used well engineered sophisticated irrigation systems. After four decades of neglect these systems need rehabilitation and maintenance. In addition to rehabilitation of existing irrigation systems, large-scale bioenergy crop production can make use of treated waste water resources. Any serious plan to use treated waste water will require building a system to deliver these water resources from their point of treatment to the agricultural lands. In places such as Kekaha in Kauai, even if the irrigation systems are still functional, the cost to rehabilitate them to deliver the amount of water needed for high water consumption crops could be prohibitive.

Input from Stakeholders
Participants in a stakeholders meeting held April 2, 2009, as well as other stakeholders, reviewed the first draft of this report. The emphasis was mainly on: i) critical information needed for decision making regarding bioenergy crop production, ii) current land and water resource availability and constraints, and iii) actions needed in the near-term that would address the priority constraints. Various sections of this report include and address the comments of various participants in the April meeting.
**Existing Water Supplies for Biofuels and Biomass Crops Production**

Efforts to utilize biofuels should include better characterizations of the “water budget” for various hydrological systems as it is an important factor in planning water use. The budget accounts for all of the inflows, outflows, and changes in storage within the system. Groundwater recharge is an important element of the water budget. Groundwater recharge is needed in managing groundwater resources including estimating aquifer sustainable yields. Utilization of groundwater resources for biofuel production will necessitate assessing its influence on aquifer recharge and on estimated aquifer sustainable yields. The entire water system is a complex network of inter-connected ditches, irrigation systems, diversions, flumes, and reservoirs.

The State of Hawaii owns and operates a number of water systems. Water from the State wells is mainly used for potable water supply, and irrigation. The water collected from existing State diversion is used primarily for agricultural operations. There are many systems that are privately owned and there is a lack of knowledge about the condition of these systems. Supplemental sources of water must be developed to meet the demands of an increasing population and sustainable water resource management, including the use of recycled water and rainwater catchment, to assure a continuous and reliable supply of water without concern about droughts or water restrictions. This option for developing a reusable water system provides additional advantage for utilizing the existing/dissolved nutrients in the wastewater thereby reducing the need for fertilization in most instances. Another advantage of establishing a recycled water system is that it is an environmentally friendly approach compared to the traditional disposal methods, i.e., through outfalls and injection wells. Although the applications of reusable water have historically increased in Hawaii, there are opportunities to continue expansion.

Continued development of bioenergy production systems requires accurate information on a reliable biomass feedstock supply, production and harvesting costs, and environmental impacts. Development of the bioenergy industry necessitates determining ways to lower biomass production costs including handling and transportation, reducing uncertainty of supply, and capturing the value of environmental benefits and transferring them to the producer.

**Existing Lands and their Agricultural Water Use**

Because of Hawaii’s geography and environmental conditions, each of its islands has unique soil types, climatic factors, land-use distribution (i.e., agricultural, conservation, rural and urban), and water resources. Acreages of different land uses in the State of Hawaii are shown in Fig. 1. ALISH (DOA, 1977) classes include “Prime Agricultural Lands”, “Unique Agricultural Lands”, “Other Agricultural Lands”, and “Unclassified Agricultural Lands” (Fig. 2). The following sections focus on lands designated for ‘Agricultural’ use by the State of Hawaii’s Land Use Commission. For bioenergy production, the most important factors include: i) mechanism and capability to harvest bioenergy crops, ii) transporting the harvested crops to processing facilities, and iii) delivering the final product to distribution points. In addition to the availability of land and water, community education is also a critical factor. Irrigation water needs and the high cost of agricultural lands may pose challenges for any large-scale operation to begin producing biofuel crops in sufficient quantity to meet the islands’ demand.
Table 1 summarizes the existing agricultural lands and their irrigation water use in Hawaii. There is a total of 1.9 million acres of lands in the state Agricultural District of which 49% (942,000 acres) are classified by ALISH including prime, unique, or other important lands. In 2000, a total of 121,500 acres (which includes farmland plus non-agricultural uses like landscaping, golf courses and parks) were irrigated with an average 363.5 million gallons per day (MGD) of water (DBEDT, 2005).
Table 1. Agricultural lands and irrigation use for main Hawaiian islands and 10 studied irrigation systems (Source: DBEDT, 2005*)

<table>
<thead>
<tr>
<th>Island</th>
<th>Agr. District 10,000 ac.</th>
<th>ALISH 10,000 ac.</th>
<th>Irrigated Area 1,000 ac.</th>
<th>Irr. Water Use MGD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kauai</td>
<td>13.9</td>
<td>9.1</td>
<td>27.2</td>
<td>30.0</td>
</tr>
<tr>
<td>Oahu</td>
<td>12.9</td>
<td>8.8</td>
<td>31.1</td>
<td>39.2</td>
</tr>
<tr>
<td>Maui</td>
<td>24.5</td>
<td>14.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molokai</td>
<td>11.2</td>
<td>3.9</td>
<td>55.9</td>
<td>274.6</td>
</tr>
<tr>
<td>Lanai</td>
<td>4.7</td>
<td>2.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Big Island</td>
<td>121.4</td>
<td>55.3</td>
<td>14.5</td>
<td>19.7</td>
</tr>
<tr>
<td>State</td>
<td>193.1</td>
<td>94.2</td>
<td>121.5</td>
<td>363.5</td>
</tr>
</tbody>
</table>

*Sources: Hawaii DBEDT (2005) for state Agricultural District area and USGS (2000) for state Irrigated Area and Irrigation Water Use.

The Department of Natural Resources and Environmental Management (NREM) of the College of Tropical Agriculture and Human Resources (CTAHR) studied 10 irrigation systems across the Hawaiian Islands (Table 2) that account for < 5% of ALISH lands (NREM, 2008). The studied irrigation systems have design capacities to divert and utilize large quantities of water. Maximum capacities at the 10 larger systems total 387.4 MGD. Actual water use is typically much lower. Water measurement at the studied systems varies greatly in methods and accuracy. Ignoring these differences, recent NREM surveys found water diversions from the 10 systems total 190.5 MGD (NREM, 2008). This is about half the United States Geological Survey (USGS) irrigation water estimate, though the latter has likely increased since 2000. The studied systems account for over 90% (363.5 MGD) of 2000 irrigation water use (387.4 MGD capacity) on all islands except Maui and Lanai highlighting the importance of these systems in state water planning. The remaining, approximately 10% of the water, 23.9 MGD, may be used for growing bioenergy crops. Analyses were performed for the service and surrounding areas of the 10 irrigation systems studied and comprehensively documented in the NREM 2008 report to obtain baseline agricultural land maps and acreage estimates, which were: 1) ALISH, 2) soil types or land capability classes, 3) crop types (current land uses), and 4) potential wastewater sources for agricultural irrigation.
Table 2. Service area, ALISH, maximum capacity and average water use in the 10 studied irrigation systems (Source: NREM, 2008)

<table>
<thead>
<tr>
<th>Island</th>
<th>Irrigation Systems</th>
<th>Service Area acre</th>
<th>ALISH acre</th>
<th>Max. Capacity MGD</th>
<th>Avg. Water Use* MGD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kauai</td>
<td>East Kauai (Kapaa-Kalepa)</td>
<td>5920</td>
<td>5510</td>
<td>100</td>
<td>5.5-8.0</td>
</tr>
<tr>
<td></td>
<td>Kauai Coffee</td>
<td>4660</td>
<td>4370</td>
<td>33</td>
<td>27</td>
</tr>
<tr>
<td></td>
<td>Kekaha</td>
<td>6570</td>
<td>6450</td>
<td>50</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>total Kauai</td>
<td>17150</td>
<td>16330</td>
<td>183</td>
<td>55</td>
</tr>
<tr>
<td>Oahu</td>
<td>Waiahole Ditch</td>
<td>6270</td>
<td>5730</td>
<td>50</td>
<td>5-6</td>
</tr>
<tr>
<td></td>
<td>Waimanalo</td>
<td>1580</td>
<td>1520</td>
<td>n/a</td>
<td>0.5-0.7</td>
</tr>
<tr>
<td></td>
<td>total Oahu</td>
<td>7850</td>
<td>7250</td>
<td>32.7</td>
<td></td>
</tr>
<tr>
<td>Maui</td>
<td>Upcountry Maui (Olinda-Kula)</td>
<td>1720</td>
<td>1030</td>
<td>17.4</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>West Maui (Wailuku)</td>
<td>6430</td>
<td>6300</td>
<td>120</td>
<td>55-66</td>
</tr>
<tr>
<td></td>
<td>total Maui</td>
<td>8150</td>
<td>7330</td>
<td>137.4</td>
<td>67</td>
</tr>
<tr>
<td>Molokai</td>
<td>Molokai</td>
<td>9890</td>
<td>7780</td>
<td>n/a</td>
<td>3.4</td>
</tr>
<tr>
<td>Lanai</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Big Island</td>
<td>Lower Hamakua Ditch</td>
<td>4660</td>
<td>3950</td>
<td>17</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Waimea</td>
<td>1370</td>
<td>1240</td>
<td>n/a</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>total Hawaii</td>
<td>6030</td>
<td>5190</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>State</td>
<td>Total</td>
<td>49070</td>
<td>43880</td>
<td>387.4</td>
<td>168.6</td>
</tr>
</tbody>
</table>

Sources: *Average diversions, except Waiahole Ditch includes water returned to streams under CWRM (Commission on Water Resource Management) order, Waimanalo is farm metered use, Molokai water measured at reservoir, and Waimea water entering reservoir. Where range given, island totals based on upper bound.

**Land and Water Projections**

The NREM report (NREM, 2008) projected agricultural acreages as an intermediate step to the year 2030 in 5-year increments, broken down by island, under different scenarios including optimistic, pessimistic, and most likely. Statewide for six crop groups (e.g., sugar, pineapple, seed crops, vegetable & melons, fruit & nut trees, and nursery & flowers) the report indicated an increase of 12,000-45,000 ac. under the three macroeconomic scenarios. Projections for the most likely scenario are shown in Table 3 where sugarcane accounted for the largest share in Kauai and Maui. Oahu, Molokai, and Big Island showed the least expected growth. In addition to the existing sugarcane acreage in Hawaii, GIS analysis of former plantation lands identified another 53,000 ac. that might be utilized for new bioenergy crops. Since large-scale bioenergy production in Hawaii is still speculative, this is an optimistic projection.

With the help of projected crop acreages presented in Table 3, future irrigation water demand for agriculture was estimated (Table 4). Equal water demands (approximately 15 MGD) for bioenergy crops are shown for Kauai and the Big Island followed by Oahu and Maui (< 10 MGD). In the optimistic scenario, state farm-level demand for water would grow to around 750 MGD in the year 2030 if all crops are fully irrigated, which is more than double the latest USGS estimate (Table 1) of irrigation water use for all purposes with an increase in demand by another 35 MGD of irrigation water for new bioenergy crops beyond current sugar operations (NREM, 2008). To meet these future needs, further study is needed regarding allocation and development of the state’s water resources.
Table 3. Projected crop acreages for five islands under most likely scenario (Source: NREM, 2008).

<table>
<thead>
<tr>
<th>Island/Year</th>
<th>Big Island</th>
<th>Maui</th>
<th>Molokai</th>
<th>Oahu</th>
<th>Kauai</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sugar</td>
<td>496</td>
<td>39</td>
<td>37,239</td>
<td>34,993</td>
<td>419</td>
</tr>
<tr>
<td>Pineapple</td>
<td>0</td>
<td>0</td>
<td>5,118</td>
<td>5,394</td>
<td>0</td>
</tr>
<tr>
<td>Seed crops</td>
<td>423</td>
<td>11</td>
<td>1,011</td>
<td>513</td>
<td>1,933</td>
</tr>
<tr>
<td>Veg. &amp; Melons</td>
<td>2,972</td>
<td>1,641</td>
<td>1,174</td>
<td>908</td>
<td>923</td>
</tr>
<tr>
<td>Fruit &amp; nut trees</td>
<td>33,226</td>
<td>26,114</td>
<td>2,956</td>
<td>673</td>
<td>890</td>
</tr>
<tr>
<td>Nursery, flowers</td>
<td>3,139</td>
<td>2,441</td>
<td>841</td>
<td>549</td>
<td>74</td>
</tr>
</tbody>
</table>

Table 4. Projected irrigation water demand (MGD) for five islands under most likely scenario for different crops including potential bioenergy crop (Source: NREM, 2008).

<table>
<thead>
<tr>
<th>Island/Year</th>
<th>2030 Bioenergy</th>
<th>2030 Pasture</th>
<th>2030 Crops</th>
<th>2005 Crops</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big Island</td>
<td>12</td>
<td>157</td>
<td>83</td>
<td>64</td>
</tr>
<tr>
<td>Maui</td>
<td>3</td>
<td>57</td>
<td>152</td>
<td>134</td>
</tr>
<tr>
<td>Molokai</td>
<td>0</td>
<td>25</td>
<td>13</td>
<td>5</td>
</tr>
<tr>
<td>Oahu</td>
<td>7</td>
<td>9</td>
<td>19</td>
<td>14</td>
</tr>
<tr>
<td>Kauai</td>
<td>13</td>
<td>35</td>
<td>45</td>
<td>30</td>
</tr>
<tr>
<td>Totals</td>
<td>35</td>
<td>283</td>
<td>312</td>
<td>247</td>
</tr>
</tbody>
</table>

This study is just one phase of an evaluation of resources for bioenergy crop production and the potential of this renewable energy resource. We hope that the issues raised in this report will be addressed in the future phases. As reflected from Table 3, the lands available from discontinued cultivation of sugarcane and pineapple provide a potential for renewable bioenergy crop production. Based on the analyses conducted during this study, the following points should be considered for further studies and future strategies to support development of Hawaii’s bioenergy industry:

- Based on environmental conditions (windward vs. leeward) and seasonal variations (cold vs. warm), candidate species should be found that can adapt to site/region specific conditions.
- Soil management practices should be evaluated for 528,000 acres of unclassified lava lands. In addition, the current lands used for agriculture and forest plantings must be maintained despite reduction in sugarcane and pineapple production.
- This study does not address potential climate change impacts on Hawaii agriculture. A thorough study is needed to assess the impact of potential climate change on natural resources, especially water resources of Hawaii. Availability of irrigation water will be one of the key factors for bioenergy crop production.
- Conduct a study on ways to increase the supply of sustainable water for biomass crops.
- Long-term impact of planting bioenergy crops on land and other infrastructure need to be studied. For example, what happens when a certain crop is no longer in demand; can
the land be converted back for use with other crops? What would be the impact of discontinued production?

- Dual purpose use of resources such as biomass production from phytoremediation activities. As suggested by SunFuels Hawaii, creation of an ongoing fact-finding and policy discussion forum, an independent statewide panel with expertise in science, technology assessment and land use analysis.

- Remap ALISH to incorporate latest land use changes, availability of new lands (lava and non-ALISH lands), and proven potential of Hawaiian lands for diversified cropping.

- Detailed studies are needed with regards to: i) ground water resources, locations, and potential yields, ii) surface water sources, locations, and potential yields, iii) surface water diversions and locations, iv) modeling and economics of biofuel crop production, v) potential use of reclaimed water, and vi) implementation of important agricultural lands (IAL) classification.

- Further support of the objectives of water and land tasks and/or plan implementation pursuant to Act 253 regarding 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.

RECOMMENDATIONS (See Vol. II, Issue Report 2.1, Land and Water, Section 5.8)

Several limitations were observed during our analysis and are presented in this report. Among them are:

- Bioenergy crop performance is not known under all environmental conditions available in different Hawaii locations (temperature, moisture, soil depth) in the state. This information is needed to match bioenergy crops with their optimum production environmental conditions for optimum yield.

- The current bioenergy crop list is limited; there might be other species that could be better suited for certain Hawaii environments.

- There is a lack of on information on crop production for many of these new bioenergy crops. For instance, there is little experience with oil palm and Jatropha production in Hawaii. Mechanical harvesters for Jatropha are beginning to be available, but are not well tested.

- Crop varieties are constantly being improved. This may make this analysis obsolete in the near future.

The following recommendations are offered as a starting point for further work. These recommendations include suggestions from stakeholders.

- Find candidate species adapted to cool and cold regions for use at higher elevations. Most of the agriculturally zoned lands have cool and cold temperature regimes. Yet almost all the species evaluated seemed to perform better in the warm environment with
the exception of *Eucalyptus*. There may be other species adapted to these temperature regimes that may equal or outperform *Eucalyptus*, which would give growers more options in deciding how to manage their lands. Find crop species adapted to dry environments. There are about 186,000 acres classified as dry throughout the state. Find crop species adapted to shallow soils.

- Develop a cropping system that could integrate bioenergy crops with regular crops for efficient utilization of resources such as land, water, time, and labor.

- An assessment is needed on the co-existence of bioenergy crops with other agricultural crops. A balance between food and fuel crops will ensure the equal and sustainable use of resources. Prioritize the use of resources for production of food and fuel crops.

- Develop a decision support system (DSS) that could match biological characteristics of crops to physical characteristics of soil and to environmental and ecological acceptance. Such a GIS-based DSS may help growers decide the best crop for their farms. Build a database for bioenergy crops detailing crop characteristics, potential yield, land and water requirements, and their suitability for integration with other crops and with environmental conditions in different regions in Hawaii.

- Help farmers conduct a cost-benefit analysis for a specific bioenergy crop.

- Climate change may pose a significant threat to bioenergy crop production. The present analysis is insufficient to forecast outcomes and is not able to deal with climate change scenarios. Better models will need to be developed to answer questions regarding the magnitude of the effects of climate change on crop production.

- Increase sustainable water supplies (traditional and non-traditional) for agriculture including bioenergy and biomass crops. Test water-harvesting technologies (e.g. stormwater harvest, reclamation and reuse) in Hawaii to minimize water runoff and maximize water storage. Other ways to increase and protect water resources in Hawaii may include watershed protection and improvement programs, reduce water conveyance losses and improve irrigation delivery efficiency, and others mentioned by Commission on Water Resource Management (CWRM) reports.

- Utilization of new groundwater resources for biofuel production will necessitate assessing its influence on aquifer recharge and on estimated aquifer sustainable yields.

- Study the potential effect of bioenergy crop production on drinking water resources. Assess the sustainable use of land and water resources. Any plan for developing biofuel crops should also include the potential effect on drinking water resources.

- Growing high water demanding bioenergy crops and biomass feedstocks in windward areas will use the available soil moisture and rainfall and require less supplemental irrigation.

- Growing less water demanding bioenergy crops and biomass feedstocks in leeward areas will suite environmental conditions and water availability in the area.

- Models that use daily water budget approach to calculate crop irrigation water requirements should be preferred in modeling crop water use.
• Drip irrigation system is considered a water saving system with high irrigation application efficiency. It can be preferred over micro-sprinkler irrigation system as its efficiency is not impacted by wind, and it can be used with recycled irrigation water.
• Develop or enhance water infrastructure sufficient to support biofuel use.
• Rehabilitate irrigation systems that are currently not in use where sugarcane growing has discontinued. In places such as Kekaha in Kauai, even if the irrigation systems are still functional, the cost to rehabilitate them to deliver the amount of water needed for high water consumption crops could be prohibitive.
• Since biofuel has commodity characteristics, bioenergy production may develop into a large industry. Therefore, a possible conflict and competition in the use of resources between bioenergy and food crops can exist. A study should be conducted to address this and related issues.
• Since the Department of Land and Natural Resources (DLNR) issues revocable permits to ranchers on state land that is zoned for agriculture, the impact of possible use of these lands for bioenergy crop production on the cattle industry needs to be assessed.
• Conduct a systematic study for costs/benefit analysis of potential reuse of treated water for bioenergy crops. Such analysis may include resources needed for expansion and upgrading of treatment facilities, construction of water delivery infrastructure to the agricultural lands, and scale of bioenergy crop production.
• Long-term impacts of planting a certain crop on the land and other infrastructure need to be studied. For example, what happens when that crop is no longer in demand? Can the land be converted back for use with other crops? What would be the impact of discontinued production? This could be studied based on the experience gained from sugarcane and pineapple industry.
• Maintain land currently used for agriculture and forestry, and additionally, increase land available for bioenergy use sufficient to support biofuel use.
• Further understand Hawaii’s water and land resources availability and constraints for bioenergy crops.
• Learn to manage lava lands. A significant portion of the 528,000 acres of unclassified land is lava. These lands are currently covered with volunteer trees that indicate it can support plant growth. Learning to cultivate these has the potential of opening large tracts of land for bioenergy crop production.
• Remap ALISH to incorporate latest land use changes, availability of new lands (lava and non-ALISH lands), and proven potential of Hawaiian lands for diversified cropping.
• Enact land policies necessary to keep agriculturally zoned lands in agriculture.
• Further support of the objectives of water and land tasks and/or plan implementation pursuant to Act 253 regarding Hawaii renewable biofuels program to manage the State's transition to energy self-sufficiency based in part on biofuels for power generation and transportation.
• Make sure that the changes in the State Administration do not affect implementation of this Master Plan. Educate the next generations as well as coming administrations for seamlessly carrying on of the work, and the wise use of land and water resources.

• As suggested by SunFuels Hawaii, creation of an ongoing fact-finding and policy discussion forum, an independent statewide panel steeped in science, technology assessment and land use analysis.

• A detailed study of projection and comparison of energy from biofuel crops with that from other technologies, e.g., solar- and wind-based energy. The study may focus on how will biofuel crops compete for the use of resources potentially set aside for wind and solar energy production.

• State residents are the most critical stakeholders, as they will benefit most from bioenergy production in Hawaii. Other stakeholders include scientists, researchers, students, policy makers, land owners, and growers/farmers.

• Technical experts for research and strategic planning on the State’s future bioenergy plans include Principal Investigators of the current project, academia, and researchers and scientists working in local, state, and federal agencies.

• Encourage close collaborations among scientists, researchers, policy makers, extension agents, and farmers as a comprehensive link of information dissemination in order to provide the context for informed decision-making.

• Existing reports on the completed projects of Hawaii’s water resource and planning studies (CWRM, 2003, 2005, 2007), DBEDT’s reports, and agricultural land and water use plans (AWUDP, 2004, NREM, 2008), are sources of information.

NREM (2008) suggests further studies on various topics that closely relate to the current Bioenergy Master Plan. Descriptions of the suggested studies are summarized below.

• *Ground Water Resources, Locations, and Potential Yields:* Inventory of the records from different agencies i.e., DLNR. Groundtruthing and field determination of potential yield for the locations that have missing records. Estimating the costs of rehabilitation and upgrading of the existing infrastructure of the existing systems (if any).

• *Surface Water Sources, Locations, and Potential Yields:* Inventory of the records from different agencies i.e., DLNR. Groundtruthing and field determination of potential yield for the locations that have missing records. Estimating the costs of rehabilitation and upgrading of the existing infrastructure of the existing systems.

• *Surface Water Diversions and Locations:* Surveying the existing records to determine all diversion locations that are either active or were active in the past. Evaluating the status of the existing diversions. Assessing the needs to rehabilitate these diversions. Quantifying the potential delivery capacity of the existing systems.

• *In-Depth Study of Biofuels:* Simulating different crop energy sources based on their energy yield and their demand on natural resources, and economic analysis of the different potential scenarios.
• *Potential Use of Reclaimed Water*: Survey and analyses (engineering and statistical) of current reclamation schemes including physical facilities, water service, and costs. Identify barriers to expanding reclaimed water use, develop recommendations to overcome barriers.

• *Connection with Important Agricultural Lands (IAL) Classification*: Review of state and county policies for IAL designation and criteria related to water.
2.2 Distribution Infrastructure for Both Marine and Land

EXECUTIVE SUMMARY

This section of the Hawaii Bioenergy Master Plan describes distribution infrastructure issues for liquid and solid forms of bioenergy. Infrastructure components for liquid biofuels discussed hereafter are those that are situated downstream of the biomass conversion plant, i.e. finished biofuel products as they are transported from the biofuel refinery storage to the end user. Infrastructure components for solid biomass discussed are concerned with transporting biomass to thermal power plants. Gaseous biofuels are not addressed as biofuel candidates in regard to distribution system considerations. Gaseous biofuels, such as referred to as “biogas”, are typically produced close to the point of demand, which would typically be biogas powered electricity or steam plants. Biogas is an established and important renewable energy source in many countries of the world and biogas could provide important renewable energy supplies to Hawaii.

State and national energy goals support the increased supply of biomass-derived liquid, hereafter referred to as biofuels, to replace or augment petroleum products. The most common biofuels used today are ethanol, which can replace motor gasoline used in internal combustion engines, and biodiesel, which can replace petroleum diesel used in internal combustion diesel engines and in other prime movers for power generation. Straight vegetable oils, i.e. biofuels that are not refined further to obtain biodiesel, can be used in power plants. The straight vegetable oil would therefore replace heavier fractions of petroleum, such as residual oil.

The distribution modes for biofuel are basically the same as for petroleum products. The liquid products can be conveyed in pipelines, transported in rail tankers, tanker trucks or fuel tankers and stored in atmospheric storage tanks. The ideal scenario, the transformation of Hawaii’s fuel economy to one based on a significant portion of biofuels, would use the existing petroleum infrastructure, so that expensive new distribution infrastructure for biofuels could be avoided. The currently most common biofuels, ethanol, and biodiesel, however, have physical properties that cause a certain degree of incompatibility with existing petroleum systems.

Due to incompatibility issues, the transport of fuel grade ethanol and biodiesel requires either new dedicated distribution infrastructure or the modification of existing petroleum fuel systems. The incompatibility issues might require additional capital investment and operating costs for new dedicated distribution infrastructure or converted petroleum fuel systems. Replacing large amounts petroleum products with biofuels that have limited compatibility with existing fuel transport and storage systems would therefore require that biofuel compatible distribution systems be in place before an expanded biofuel supply is available to the end user.

Since the biofuel industry is a rapidly evolving energy field, new types of biofuels are developed that offer a higher degree of or even full compatibility with existing petroleum fuel distribution and engine systems. Examples of such new and promising fuels are bio-butanol and renewable diesel. Using such new biofuels would have the significant advantage that existing petroleum fuel systems could be used for the distribution of these biofuels with no or only
slight modifications. These fuels would therefore allow a basically seamless transition of the fuel distribution from petroleum to renewable fuels and biofuels.

The issue of biofuel compatibility with existing petroleum distribution infrastructure has a significant impact on the required scope and capital investment of future biofuel use in Hawaii. The present market value of Hawaii’s existing petroleum infrastructure is estimated at about $3.6 billion (excluding the value of the two local petroleum refineries) and thus represents a significant asset, which cannot be easily and expeditiously replaced. Furthermore, during the transition period from petroleum fuels to biofuels, both the petroleum and biofuel infrastructure would have to be maintained if there were to be incompatibility of biofuels with existing distribution infrastructure. Since possible production shortfalls or interruptions of a growing bioenergy industry might require, from time to time, supply substitution from out-of-state sources, import facilities for all the biofuels that will be used in Hawaii would serve as important infrastructure redundancies and would increase energy security.

It may be possible to convert components of the existing fuel infrastructure for distribution of ethanol and biodiesel if the material composition and other characteristics of the specific fuel containment components are exactly known. For large and interconnected fuel systems that combine many components, such as tanks, pipelines, and terminals, chances are that efforts to convert these complete existing petroleum fuel systems may present high investments or be practically impossible.

The distribution of solid bioenergy represents a technically and logistically smaller distribution challenge. In Hawaii, heavy truck operations are the mode of transporting solid biomass to bioenergy conversion plants. Heavy hauling trucks used for transport of biomass on public roads would be similar in size to trucks carrying 40-foot containers. The maximum weight of such trucks would be limited to 80,000 pounds. In most cases, the available cargo volume of trucks would be filled with lower bulk density solid biofuels before the maximum weight limit is reached. Therefore the transport of solid biofuel would typically be a “volume-limited” operation and measures to increase the bulk density of solid biofuel would decrease the amount of truckloads and hence impacts from solid fuel transport on public roads.

Trucking operations on private land could use larger and heavier trucks. The primary impact of solid biomass distribution would be from increased heavy truck traffic on public roads.

RECOMMENDATIONS (See Vol. II, Issue Report 2.2, Distribution Infrastructure, Section 11)

(Note: The underlined items are reflected in Table 4, Issue Report Recommendations.)

State policy supports the use of liquid and solid bioenergy products to help meet Hawaii’s future demand for clean and renewable energy. Liquid bioenergy products can provide base load power supply, which is presently provided by petroleum and coal, as well as transportation fuel. Solid bioenergy products can provide base load power supply.
The following summarizes the major conclusions pertaining to liquid bioenergy (biofuel) distribution infrastructure:

1. As biofuel usage grows in Hawaii, it is imperative that a distribution infrastructure is developed to accommodate the increased volumes of biofuel flowing through the supply systems, so that the biofuel products can be supplied to the end user in a cost efficient and efficient way.

2. The existing fuel distribution infrastructure in Hawaii is built to supply large amounts of petroleum to power Hawaii’s ground transportation, air transportation and electricity power generation. The existing petroleum distribution infrastructure in Hawaii is large and complex and uses storage tanks, terminals, pipelines, barges and tanker trucks to provide Hawaii with a secure and robust energy supply. The preferred future biofuel distribution system would utilize this petroleum fuel system and require no or minimum modifications of existing distribution assets.

3. The distribution of liquid biofuels utilizes infrastructure components that are similar to the existing petroleum fuel system. Conventional biofuel, such as ethanol and biodiesel are, however, not fully compatible with existing petroleum system, since they act as strong solvents and have strong affinity to water, which could result in water contamination of the fuel.

4. The most widely used biofuel in the US market today is ethanol followed by biodiesel. These biofuels represent “first generation” biofuels and they have a limited compatibility with existing petroleum distribution and end-uses. Newer types of biofuels that are under development or are in pre-commercial stages exhibit much better compatibility with existing petroleum equipment and distribution assets. Using types of biofuel that can be distributed in existing petroleum systems offer a considerable cost and operational advantage.

5. The selection of biofuel according to the compatibility with existing distribution infrastructure should be given high importance and weight. Certain properties of the conventional and established biofuels, ethanol and biodiesel, result in incompatibilities with most of the established petroleum distribution infrastructure and operation. Other evolving biofuels, such as bio-butanol and renewable diesel (i.e. diesel different from the ester type biodiesel and compliant to ASTM D975) should be compatible with existing petroleum distribution infrastructure components. From the viewpoint of facilitating the development of a biofuel distribution infrastructure that can support a rapidly expanding biofuel industry in Hawaii, such biofuel would be preferable to ethanol and biodiesel.

6. Whether existing petroleum storage tanks can be used or can be converted for use with biofuel has to be decided on a case-by-case basis. More recently built petroleum storage tanks might be more compatible with biofuels such as ethanol and biodiesel than older tanks. The use or conversion of existing petroleum storage for biofuels tanks would be less costly and would require less land than developing new biofuel storage
tank capacities. Considering the bioenergy use scenario of the Hawaii Bioenergy Master Plan, about 14% of the existing number of petroleum tanks would have to be built or converted, in order to create an appropriate stockpile of the envisioned volume of ethanol, biodiesel and renewable fuel oil.

7. Infrastructure developments require significant capital investment and time to implement. It is important that distribution infrastructure is flexible to changes in fuels. Distribution systems that are built for specific biofuels, should be avoided since they become obsolete as the biofuel use may change resulting in large sunk costs that might not be recovered.

8. Straight vegetable oil, e.g. biofuel that is not converted to higher quality products such as biodiesel, can be used for electricity generation. Straight vegetable oil could replace petroleum residual fuel, which is presently used in power plants in Hawaii. Straight vegetable oil seems to be fully compatible with the distribution system for residual fuel. Most likely straight vegetable oil would be conveyed through existing pipelines built to convey residual fuel. This assumed compatibility with existing petroleum fuel systems significantly facilitates the broad introduction of straight vegetable oil in Hawaii.

9. The timeline for the introduction of new distribution infrastructure should be preferably 5 to 10 years rather than a short 2 to 3 years. With regard to distribution infrastructure, the transition from petroleum to biofuel requires specific operations know-how that can be more readily attained by a small number of larger consumers (i.e. conversion of power generation to biofuel) rather than building the distribution system for a large and dispersed group of small users (i.e. providing a large distribution network of transportation biofuel dispensing stations).

10. Pipeline operators typically are reluctant to make their existing petroleum transmission pipelines available for fuel grade ethanol or biodiesel. Therefore, it seems unlikely that long transmission pipelines, such as the pipelines on Oahu that connect the refineries with urban Honolulu, will be available to convey sizeable amounts of ethanol and biodiesel anytime soon. The new construction of dedicated biofuel pipelines over long distances in Oahu is equally unlikely in the near future. Therefore the transport of biofuel by means of tanker trucks may be the preferred transport mode for biofuels in the years to come. With the biofuel volume envisioned under the bioenergy use scenario of the Hawaii Bioenergy Master Plan, about 100 tanker truck operations per day would be required throughout the state to transport fuel grade ethanol and biodiesel. The transport of the biodiesel would be over public roads in the four counties.

11. The conversion of existing petroleum distribution infrastructure into dedicated biofuel systems might be a cost effective way to provide storage and transport capacities to the evolving biofuel industry in Hawaii. However, it is likely that Hawaii will still import sizeable amounts of petroleum products in the years to come, while petroleum is being replaced with cleaner and renewable fuel products. Hawaii’s petroleum infrastructure will therefore remain important and enough resources will have to be invested into the maintenance of the petroleum fuel system. Operating and maintaining two fuel systems...
in parallel, while the use of petroleum fuel decreases and that of biofuel increases, will require significant resources.

12. The preferred biofuel distribution infrastructure would allow petroleum and biofuels to be transported and stored side by side, without the need to segregate large parts of the fuel distribution system by either neat petroleum or neat biofuel needs. The type of biofuels used in Hawaii would preferably be blended upstream of the distribution value chain. Alternatively, biofuels and petroleum could be transported batch wise through the common distribution systems, similar to different petroleum products using distribution assets (e.g. batchwise conveyance through pipelines that serve compatible product groups).

13. While the large-scale introduction of biofuel in Hawaii could significantly affect the fuel distribution infrastructure in Hawaii, it is most likely that a large-scale use of biofuel in Hawaii would also affect the importation of petroleum to Hawaii. A decreased demand for certain petroleum fuel products due to displacement by biofuels could have impacts on the operations of the two local refineries. In order to respond to a reduced demand of certain petroleum products the refineries would have basically two options. Option One would be to lower the volume of imported and locally processed crude oil to adjust for the reduced demand of refined petroleum products. In this case imports of petroleum products might be required to make up for the production shortfall. Option Two would be to retain the present petroleum fuel production rate of the refineries and export the excess petroleum products. Both Option One and Two could affect the viability of the future operations of the two local refineries and therefore could significantly affect the energy and fuel supply to Hawaii. Stakeholders have pointed out that Option One, in which refinery throughputs are reduced as demand for conventional petroleum products declines, might be the most likely alternative. Stakeholders suggest that, since refinery yield flexibility is limited, reductions in throughput would likely result in an increased requirement for imports of selected refined petroleum products, which would no longer be supplied in the required volume from local fuel production. This would most likely require additional capital investments in new fuel facilities in Hawaii. Such investments for new petroleum infrastructure might take available capital investment away from a dedicated biofuel distribution infrastructure. If, however, the future biofuels used in Hawaii would have a high compatibility with the petroleum fuel products used in Hawaii, then much needed synergy in fuel distribution could be achieved.

The following summarizes the major conclusions pertaining to solid bioenergy (biofuel) distribution infrastructure:

14. The use of solid biomass provides opportunities to replace imported petroleum with locally grown fuel. Due to the lower heat content and density of solid biomass versus petroleum, the transport of solid biomass from the location of harvesting to conversion requires more volume and mass to be transported for the same amount of heat content.
Candidate solid biofuel feedstocks for presently proposed projects are various types of woods, forest residue and sugarcane.

15. The preferred mode of transport of the solid fuels to the conversion plants is by heavy trucks. Transport over private land is preferred over heavy trucks using public roads, where the dimensions and gross weight of the trucks is limited to 65 feet in length and 80,000 pounds. Typically transport with trucks is volume limited, which means that the trucks run out of available cargo volume before they reach the maximum allowable gross weight.

16. The frequency of truck operations to transport solid bioenergy to the power plants depends on the generation capacity and efficiency of the power plant, the heat value of the solid biofuel and the bulk density of the solid fuel. The types of wood fuel considered for the proposed solid bioenergy projects require less truck operations than less dense sugarcane bagasse.

17. The anticipated frequency of up to five truck operations per hour would cause some traffic impact on public roads. The level-of-service of these public roads might however not be significantly affected. It is more likely that more significant traffic impact would be more localized, such as close to the ingress and egress of biomass loading and power plant sites. It is anticipated that appropriate traffic mitigation measures could be implemented to avoid significant impacts from solid bioenergy trucking operations.
2.3 Labor Resources and Issues

EXECUTIVE SUMMARY

This section of the report focuses on the labor considerations associated with biofuels in Hawaii. In particular, it discusses how a potential biofuels industry might affect the labor market, as well as possible requirements for the industry. While the labor market generally responds to industrial dynamics, the following ideas and estimates should be accounted for when policy makers and leaders consider how best to support biofuels.

One major labor market question discussed here is whether the state’s workforce could support a vibrant biofuels industry. Should Hawaii’s bioenergy industry require the growing and harvesting of agricultural crops, particularly plantation grown crops, there may be a significant need for a lower-skilled labor force similar to that required for sugar cane production. For this type of labor, which is characterized by lower wages, there are two possible sources. First, labor might be imported from the U.S. mainland and/or internationally, as has been the case for earlier periods of agricultural growth in the state. Where such labor resources come from is largely a function of the types of work created (e.g. technical, manual, etc.). In addition to imported labor, the other major pool of currently available labor for a possible biofuels industry is the locally unemployed. Fortunately, higher unemployment rates on the Neighbor Islands may match biofuels production sites. Beyond these available sources, training and education might be a long term strategy for filling biofuel labor needs.

In terms of the scale of jobs created through biofuels, it is very difficult to base estimates on existing experience because there are many remaining technical questions on how the industry might evolve in Hawaii. Nevertheless, according to our rough preliminary estimates, it is possible that by 2030 that the industry might add 584 jobs in the processing side only, where the state is likely to have the greatest comparative advantage. Thus, if biofuels were the only alternative energy source substituting for current imported oil sources, by 2030 the industry would employ a small (excluding agriculture workers), but perhaps important part of the labor force.

It is not yet clear how a biofuels industry – and in particular which parts of the value chain are best located in Hawaii. In any case, it will be important for industry, government, labor and educational institutions to take initiative and develop programs to meet the full range of skills needed for “green” industries including bioenergy. Such a comprehensive approach towards supporting the biofuels labor market as part of a broader green energy agenda makes most sense from the view that investment in biofuels skills development will be at the leading edge of efforts to make the state an innovator in green industries.

One of the biggest challenges in Hawaii is the wages/cost-of-living ratio. Biofuels-related jobs in the state must provide “livable” wages that meet baseline needs of state residents as well as show potential for keeping up with steep rises in the consumer price index. In any case, the high and rising cost of living in Hawaii strongly suggests that the lower end of the biofuels jobs spectrum may not be attractive if other employment opportunities are available that pay above the minimum wage.
The growth of a biofuels industry in Hawaii is likely to require some significant investment from state resources. In particular, a state role in bridging the gap between existing training programs and industry needs can contribute to overall success and link the state to existing energy worker training programs. State legislation supporting these programs and promoting green jobs might help bolster industry success. The state can also explore opportunities to partner such job training programs with other public objectives in order to better integrate the workforce, including creating programs for low-income workers. For example, green-collar job training funds can be used to target low-income adults and youth in poverty.

This section of the report provides five recommendations and “thinking” points:

1. Given the likely small size of any biofuels workforce in Hawaii, other than agricultural workers, it is important for legislators to create synergies with other growing sectors of the economy. In particular, those fast-growing occupations related to the higher end of biofuels skills, such as industrial engineers, pharmacy technicians, and computer software engineers, who might share a workforce with biofuels professionals. On the lower-skilled end of occupations, manual laborers in the biofuels industry will likely share some concerns with other agricultural workers such as pay scales and working conditions.

2. The biofuels industry in Hawaii, as it evolves, will create some jobs for local residents as well as attract some new workers. To create a responsive and loyal employment base in the industry, legislators and business leaders might consider nurturing community—and regionally—specific worker bases to mobilize as much of the local unemployment base as possible. Such outreach is likely to create industry loyalty and identity since the size of the biofuels workforce is not likely to be large. This will increase labor channeling and networks that are easier to carve out as a stable employee base with less training.

3. Liveable wages are a problem for many workers in Hawaii. The report classifies those occupations in high- and low-wage categories, with the former likely to support a livable wage for Hawai`i, and the latter not likely to support a livable wage. Labor market subsidies to private sector firms, for example, might focus on those higher-end occupations and leave the lower-wage occupations to be performed by workers outside of the state of Hawaii, where they are likely to be more liveable wages. In this way, policy should focus on attracting those parts of the industry where wages are above manual labor level. There is some unemployment in Hawaii – especially on the neighbor islands – and efforts might be made to connect these jobless workers to any biofuels manual labor needs, however, and state investments to subsidize these production jobs, while good from a social service perspective, might not be the most effective way to build a sustainable biofuels industry in the state. State incentives should be focused on those investments that will enable the labor market to achieve a critical mass that becomes self-sustaining over time, rather than as a permanent subsidy.

4. A potential biofuels industry for Hawaii fits within a broader national and state effort to promote green technology and jobs. Thus, legislators should promote a model of workforce development in which biofuels training is connected to a broader effort to promote green technology jobs in the state.
2.4 Technology to Develop Bioenergy Feedstock and Biofuels

EXECUTIVE SUMMARY

A bioenergy technology assessment was conducted as part of the Hawaii Bioenergy Master Plan mandated by Act 253. This effort included the characterization of the status of crops and crop production technologies for bioenergy applications and of conversion technologies used to transform selected feedstocks into bioenergy products.

Crop characterizations included sugarcane (*Saccharum officinarum*), starch producers corn (*Zea mays*) and cassava (*Manihot esculenta*), fiber producers banagrass (*Pennisetum purpureum*), *Eucalyptus* sp., and *Leucaena* (*Leucaena leucocephala*), and oil producers *Jatropha* (*Jatropha curcas*), oil palm (*Elaeis guineensis*), microalgae and biowastes. Of these, only sugarcane has an established history of commercial production in Hawaii. Although the state currently has several extensive *Eucalyptus* plantations, they have not been harvested to date. Harvesting was a common technology gap identified for terrestrial crops. Technology gaps associated with microalgae were found to be more extensive.

A summary of the assessment of conversion technologies is presented in Table E.1. The development status of each technology has been characterized as pilot, demonstration, or commercial facilities that might be constructed at scales on the order of <10, 100, and 1000 tons per day. All of the technologies identified in the table were deemed appropriate for Hawaii.

A number of recommendations have been developed based on stakeholder input and information collected in preparing this task and include:

1. The State should continue a bioenergy technology assessment activity that can provide updated information on the status of bioenergy conversion pathways and estimates of energy return on investment (EROI) for bioenergy value chain components.

2. Mechanized harvesting is a common theme across bioenergy crops. The State should fund a faculty position(s) in this area to work with the industry, conduct research as needed, and evaluate harvesting technologies for applications in Hawaii.

3. Support demonstration project development along the bioenergy value chain including energy crop production, transportation and logistics, and processing and conversion technologies. The State should develop funding mechanisms to leverage federal and private funds and support demonstration projects.

4. The State should provide support to the industry for preliminary feasibility studies of selected energy crop conversion alternatives to identify the most promising technology pathways and the resource requirements for those pathways.

5. The State should provide low-or-no cost land leases and expedited permitting to support pre-commercial bioenergy demonstration projects.
6. Hawaii should establish a bioenergy/biofuel development fund to support research, and technology development and demonstration where the University of Hawaii, other research organizations, and Hawaii-based industries should be encouraged to jointly participate.

7. Funds should be allocated to support training manpower in the field of bioenergy/biofuel technology.

Table E.1. Characterization of the development status of biomass conversion technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Pilot</th>
<th>Demonstration</th>
<th>Commercial</th>
<th>Appropriate for HI?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol from Biochemical Route</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sugar</td>
<td>X</td>
<td></td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Starch</td>
<td>X</td>
<td></td>
<td>Y</td>
<td></td>
</tr>
<tr>
<td>Fiber(^1)</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Gasification</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat</td>
<td></td>
<td></td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>Power</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Combined Cycle</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>IC Engine</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Steam based</td>
<td></td>
<td></td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>Synfuels</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Pyrolysis(^2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bio-oil production</td>
<td></td>
<td></td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>Charcoal production</td>
<td></td>
<td></td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>Bio-oil production for fuels</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Combustion</td>
<td></td>
<td></td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>Renewable diesel via transesterification of vegetable oil</td>
<td></td>
<td></td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>Renewable diesel via hydrotreating of vegetable oil</td>
<td>X</td>
<td>X</td>
<td></td>
<td>Y</td>
</tr>
<tr>
<td>Anaerobic Digestion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat</td>
<td></td>
<td></td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>Power</td>
<td></td>
<td></td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>Biogas production via cracking of fats, oil, and grease</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\) Demonstration projects for cellulosic ethanol production currently underway
\(^2\) Pyrolysis for bio-oil production as food ingredient is at commercial scale but use of bio-oil for energy other than combustion applications remains at pilot scale
2.5 Permitting

EXECUTIVE SUMMARY

Hawaii’s bold and far reaching visions for a secure and sustainable energy future require an expeditious and broad implementation of clean and renewable energy applications including biofuels. Stakeholders in Hawaii’s bioenergy industry, however, have identified Hawaii’s permitting regime as a main obstacle to capital investment in the sector and successful implementation of promising bioenergy projects in the state. To meet its clean energy goals, Hawaii cannot afford the perception that investment and green energy initiatives are hindered by a lack of support from State and County permitting agencies.

To mitigate this problem, state leadership has called for swift improvements in permitting processes with passage of legislative measures affecting State and County permitting agencies. Several of these agencies have commenced implementation of process improvements, examples of which are provided in this report that show utilization of innovative online tools.

With the passage of HB 1464, HD 3, SD2, CD1, the 2009 State Legislature provided for expansion of the scope of the Renewable Energy Facility Siting Process, which regulates permitting of renewable energy facilities above certain thresholds for electricity generation and biofuel production capacities. The Renewable Energy Facility Siting Process prescribes process facilitation and establishes a maximum time period for government agencies to review a permit application. This should provide potential investors in renewable energy projects some assurance that their permit applications will be processed in a timely manner and with a maximum guaranteed time for processing the permit request.

While the changes in permitting of renewable energy facilities should provide significant improvements, the permitting regime could and probably must be further improved in the future to accommodate the large scope of renewable energy development required to move Hawaii closer to the Hawaii Clean Energy Initiative goal of 70 percent clean energy by 2030. The report suggests additional project management measures and the extensive use of online systems as means of further improvements.

RECOMMENDATIONS

(See Vol. II, Issue Report 2.5, Permitting, Section 4.)
(Note: The underlined items are reflected in Table 4, Issue Report Recommendations.)

While the efforts of streamlining permitting are applicable to a broad range of economic development projects, renewable energy development projects are generally receiving a prominent status. A web search conducted in April and May of 2009 has revealed the following elements of expedited and streamlined permitting, which could also be implemented in Hawaii:

- Expedited permitting is a major goal for many agencies but substantial time will be required by agencies to change their permitting processes towards a new permitting
paradigm. Since pressing economic development and renewable energy implementation needs cannot wait until new permitting is universally accepted and implemented thoroughly by the organizations, certain projects should qualify for preferential permitting treatment. The decision whether a project qualifies for expedited permitting might be based on general procedural qualifiers or on case-by-case decisions.

- The permitting procedures should be defined as an efficient work process that encompasses work schemes of all participating agencies and stresses proactive cooperation between the agencies and the applicant. Where present permitting processes might already lead to efficient permitting within individual agencies, it is paramount to facilitate the cooperation between agencies to remove redundancies in permits and information required for individual permits.

- The creation of a central contact point is seen as advantageous in order to efficiently communicate between applicants and permit awarding agencies. The central contact point would act as a facilitator who can help the applicant to reduce the burden of providing redundant information and keep the permitting project on a tight schedule.

- Each permit awarding agency should assign a point of contact that communicates between the central point of contact and the agencies that are part of the permitting process. The points of contacts within the agencies should also be responsible to establish and maintain efficient intra-agency communication for all permitting.

- There should be a pooled information repository where the applicant can deposit information that could then be used by different permits. This information repository would reduce the burden of the applicant to provide similar information to different agencies and for different permits.

- The permitting process should be accomplished within a certain time period. All agencies should endeavor to finish their permitting work within that timeframe. A range from 90 to 180 days has been identified by different state and county agencies for certain permit types. Certain unforeseen circumstances (i.e. non availability of information) might preclude the targeted permitting period but permitting should be completed as expeditiously as possible

- The use of e-permitting is encouraged. The use of an online self-application for certain permits may be justified.

- Another venue for an expanded use of the Internet is an online permitting process with progress tracking and online exchange of information. Such an e-permitting process would define permitting milestones and would process milestone tracking. The applicant and all other process participants could get real time information about the status of the project and if the project permitting is on schedule.

- There should be a mechanism to inform applicants about what steps and in what order these steps need to be carried out in the permitting process.
• Agencies should continuously train existing and new staff in the expedited permitting.

(See Vol. II, Issue Report 2.5, Permitting, Section 8)
The development and implementation of renewable energy projects, and specifically renewable biofuels, is of utmost importance to Hawaii. Presently Hawaii relies on petroleum for about 90% of its energy needs and has one of the highest per capita oil consumption rates in the world. The global oil market has been volatile for the past several years and sobering predictions by mainstream oil analysts warn of possible increasingly tight global oil supplies and high future oil prices starting as soon as in the next 2 to 5 years. Therefore time is of the essence to transform Hawaii’s energy system towards more diversity of the state’s energy supply.

Hawaii’s leadership has developed bold visions of fundamentally transforming Hawaii’s energy in the next two decades to provide up to 70 percent clean energy by 2030. Innovation at this staggering implementation scope and speed requires changes in the way governmental agencies work with developers of renewable energy facilities in the permitting of such projects.

The present permitting regime in Hawaii is seen by investors as the main hindrance to investment in Hawaii. Measures to streamline the permitting regime in Hawaii are therefore crucial to improve the attractiveness of Hawaii as a good place to invest in clean energy.

Improvements in Hawaii’s permitting regime should involve new workflow processes within State and County permitting agencies as well as efficient interagency cooperation. While internal agency process improvements are ongoing and have resulted in numerous noticeable improvements, Hawaii’s legislature has recently established the Renewable Energy Facility Siting Process that provides an overall permitting framework for renewable energy facilities above a certain capacity. Projects that qualify for the Renewable Energy Facility Siting Process will have a prescribed maximum time for permitting of 18 months, excluding the EIS process. An enforceable maximum time for permitting should provide investors some certainty that their permitting applications will be processed in a timely manner.

Innovative permitting approaches, such as the Renewable Energy Facility Siting Process, are laying important administrative foundations for expeditious development of a strong renewable energy industry in Hawaii.

While these new approaches to permitting of renewable energy facilities are timely and very important for Hawaii’s secure and clean energy future, it is to be expected that Hawaii’s permitting regime will require further changes in the years to come, in order to correct processes that lack efficiency improvements.

This report proposes possible further improvements to permitting for renewable energy facilities. The proposed further improvement of permitting processes would build on past accomplishments and recent legislative actions and would emphasize interagency cooperation in permitting project management and innovative online management tools.
It is felt that a structured and transparent interagency permitting framework working in concert with Hawaii’s permitting agencies’ own internal efficiency standards, is an appropriate administrative support to ensure the healthy growth of a strong renewable energy and bioenergy industry in Hawaii.

While progressive procedures and policies are the foundations to transform the permitting regime, human aspects in the organizations are the drivers that make re-engineering efforts successful and ensure that effective permitting strategies will become institutionalized.
2.6 Financial Incentives and Barriers and Other Funding

EXECUTIVE SUMMARY

The goal of this section of the Hawaii Bioenergy Master Plan (HBMP) is to identify and evaluate financial incentives and barriers at points along the bioenergy industry value chain (feedstock production, feedstock logistics, conversion, distribution, and end use) and their potential impact on the production of biofuels at levels sufficient to contribute a significant renewable energy resource to the State of Hawaii.

This section provides a comprehensive list of the financial barriers and incentives to entry and operation in the biofuel industry in the State of Hawaii. The scope covers both Federal and State financial instruments, including the American Recovery and Reinvestment Act of 2009. It includes discussion of innovative public and private financing vehicles for alternative energy and greenhouse gas (GHG) emissions reductions. The analysis was conducted through a legislative scan, stakeholder interviews, and surveys. Appendices summarize existing State and federal biofuel incentives, legislation proposed during the 2009 Hawaii legislative session, and policies for other Pacific region states and for selected countries.

A historic overview of biofuels legislation and industry activity provides a backdrop for the understanding of Hawaii’s present landscape. Hawaii biofuels initiatives date back to the mid-1970s, following a period of rapid fossil fuel price inflation. While biofuels have been used for electricity generation and transportation fuels, the development of a Hawaii industry has been slow. There does not currently exist local production or refining of Hawaii grown feedstock other than the long-established use of bagasse for electricity production.

This study analyzes the key threats to bioenergy across the value chain. Briefly, biofuels investors appear not to be confident in long-run profitability given challenges that they face in land acquisition, competition from energy substitutes (e.g. electric vehicles), highly concentrated purchasers, and fragmented State support.

The following recommendations are provided:

- Frame Hawaii’s bioenergy strategy around vital State interests. Energy security and greenhouse gas emissions reduction targets could provide justification for bioenergy support.
- Design a priori measurement and monitoring mechanisms to evaluate alternative individual projects based on State interests, particularly for the distribution of land leases.
- Act swiftly to capture funding made available through the American Recovery and Reinvestment Act of 2009, though recognize the funding would need to be balanced by sustained sources to carry the operation year after year.
- Consider House Concurrent Resolution 195 (HCR 195) and the subsequent recommendations of the Hawaii Energy Policy Forum (HEPF). Further study is
required to determine the most appropriate incentives at each part of the biofuels value chain. In particular, analysis is needed to determine: Locations for biomass project; Options for leasing State land for fuel crop development; Opportunities for state and county governments and private investors to secure federal grants to support the development of fuel crops and the conversion of fuel crops to generate electricity; and feasibility of setting up a revolving fund as a mechanism to provide incentives necessary to stimulate investment in fuel crops and the conversion of fuel crops to generate electricity.

- Establish a sub-committee of people with a mix of public and private experience raising capital for infrastructure and energy projects to put together the specific financial incentives to support HBMP. The sub-committee should, at a bare minimum, evaluate the incentive concepts proposed by HEPF in their response to HCR 195 (Appendix G).

- Create a dedicated office that will maintain an up-to-date list of State and Federal incentives, and provide guidance for prospective biofuel business owners on how to apply for incentives (grants, loans, tax credits, etc.). This office could also be the resource that guides business owners on the steps needed to value the environmental credits from the project. Perhaps this office could even provide business planning guidance. For example, a biomass power plant will likely be eligible for a waiver from the competitive bid process to provide HECO electricity. However, the waiver is for a period of four months. That is a prohibitively short period of time to get all the aspects of a plant’s operations lined up for negotiation of a power purchase agreement with the utility.

- Coordinate and make transparent the process for land acquisition for biofuel feedstock producers. Bioenergy and land use policy involves multiple State agencies (DLNR, DHHL, DOA, DBEDT). Biofuels may be perceived as competing with other land uses, such as food production and residential development. The State interest in bioenergy should be articulated relative to competing interests.

- Reconcile investor’s concern for exit strategies with biofuels incentives. “What are the business options if ethanol demand falls?” “What are my exit strategies?” “What other outlets exist for large ethanol stocks if transportation demand tanks?” Biofuels investors’ decisions are typically based on 10-20 years for biofuel refinery plants.

- Align a flex fuel ethanol-based transportation strategy with the emergence of potential new transportation modes, including rail, and vehicle technologies, such as electric and hybrid vehicles. The State and counties are committed to alternative transportation strategies, and the role of biofuels should be assessed in that context.

- Synergize the biofuels master plan with the Hawaii Clean Energy Initiative goals. A higher profile for both will likely lead to more Federal dollars.

- Investigate Renewable Identification Number (RIN) market opportunities stemming from the Federal Renewable Fuel Standard (RFS). At present, Hawaii is opted-in to the Federal RFS. (Anon. 2008d) While further study is required, opportunities may exist to establish a complete, localized bioenergy value chain in Hawaii’s using the Federal
RFS. One resource we suggest to investigate is the RINMARK exchange (http://www.rinxchange.com/).

- Facilitate the measurement and monitoring of greenhouse gas emissions. An approach might include mandatory reporting through The Climate Registry (TCR). TCR sets consistent and transparent standards to calculate, verify and publicly report greenhouse gas emissions.

- Coordinate biofuels policy with State goals to reduced GHG emissions. GHG emission reductions have actualized and perceived economic value in current and proposed initiatives to mitigate anthropogenic climate change. Provide research, education, and outreach on the role that biofuels might play relative to other strategies.
2.7 Business Partnering

EXECUTIVE SUMMARY

In order for Hawaii to have a productive bioenergy industry, successful partnering amongst industry “players” is essential. This section of the Hawaii Bioenergy Master Plan specifically evaluates facilitating the bioenergy industry through partnerships across and between sectors of the bioenergy value chain, and partnership with other organizations that control access to critical resources such as land and water.

Hawaii’s bioenergy industry is in its infancy. Research found that a significant number of Partners demonstrate interest and intent—especially in the area of bioenergy conversion/processing—but most Partners have not yet reached the stage of commercial production. From a business partnership perspective, the following was noted:

- Partnering between various processes within the value chain is required for the vast majority of models identified.

  For the purposes of this report, a model is an example of the bioenergy production value chain that has differing partnership-handoff points/roles.

- More Partners are needed to fulfill identified functions. Many of the Partners are not necessarily associated with the bioenergy industry and thus the industry would benefit from a facilitator who can identify and match potential partners in the process chain.

- A greater number of Partners is needed in the Growing Processes area. Independent producers of bioenergy feedstock (biostock) are rare. Among the models with nearer term biostock production capability, a vertical integration was commonly found whereby the organization controls the processing and develops the biostock.

- Facilitative partnerships should be viewed on a per-island basis due to the economic obstacles of interisland shipping. One notable exception is in the transportation and distribution of liquid biofuels where there may be existing infrastructure.

- More information on production capacity (growing and processing) is needed and would greatly facilitate partnership identification and Partner planning.

The following represent key recommendations for advancing the bioenergy industry in Hawaii:

- **Provide “first-mover” incentives**
  In order to motivate the industry and build capacity in functions supporting the bioenergy industry, the State can provide incentives for early implementation of bioenergy production.

- **Develop and maintain a bioenergy Partner database**
A database of Partners, similar to the Bioenergy Partner Catalog in this report, would facilitate identification of partners for organizations without complete vertical integration, and assist with the identification of opportunities to fill the gaps in the bioenergy industry. This would benefit the State, in its industry facilitation efforts, as well as the private sector Partners.

- **Provide incentives to growers**
  Qualitative and quantitative information collected for this report indicates a need for greater capacity in bioenergy feedstock production. The objective of encouraging greater growing capacity can be approached from either end of the bioenergy value chain, but the authors believe that incentivizing growers directly is more effective for this objective.

- **Facilitate partnerships through a matchmaker**
  The State can significantly encourage necessary bioenergy partnerships through the creation of a position or program that facilitates such partnerships by identifying and encouraging needed Partners, introducing appropriate Partners, and acting as an industry advocate and government liaison.
2.8 Economic Impacts

EXECUTIVE SUMMARY

The objective of this study is to identify and evaluate potential economic impacts from the production of biofuels at points along the value chain. The “value chain” is here defined as: feedstock production, feedstock logistics, conversion, distribution, and end use. To accomplish this task, a macroeconomic model of Hawaii’s economy, representing macro and sector-level inter-linkages, has been created. The model utilizes the 2005 State Input-Output Study for Hawaii, prepared by the Department of Business, Economic Development, and Tourism (DBEDT), as the primary data source. The 2005 Input-Output table is an excellent year in which to calibrate for this analysis because the recent price of world oil was similar: averaging $49/barrel.

Although there are several avenues by which a local bioenergy industry could develop, from biomass combustion for electricity to biomass for liquid fuel, this study focuses on sugarcane-to-ethanol. This scenario is chosen because 1) Hawaii has considerable experience with growing sugarcane as a feedstock and ethanol conversion is a currently commercially available technology, 2) a 10% ethanol-blending mandate for motor fuel was made effective and a 20% by 2020 Alternative Fuel Standard (AFS) was adopted in 2006, 3) ethanol blending facilities have been established within the state. Although the impetus of the 2006 mandate implementation, amongst other federal and state-level incentives, was to prompt a local bioenergy industry, the mandate has been met with imported ethanol sources.

To produce 93.7 million gallons of sugarcane derived ethanol in order to meet the AFS, 91,500 acres of irrigated agricultural land would need to be in sugarcane production. Assuming the industry is viable, it would be a $312 million sector and could produce ethanol at $3.33 per gallon – although costs may be brought down through the integration of byproducts with the electric sector. Roughly 1,200 jobs would be created with an average annual salary of $45,000. This results in an increase in gross state product of $272 million annually (+0.5%).

The creation of a local ethanol industry could serve to revitalize currently fallow agricultural lands as well as provide jobs in agriculturally oriented areas of Hawaii. On the other hand, it will take significant State support to make locally produced ethanol competitive with imported sources. The benefit stream must be assessed in relation to alternative agricultural activities, water consumption, community suitability and labor availability.

Ethanol is only one biofuel product that may be utilized within the state and findings about ethanol may not be applicable to other feedstock or conversion technologies. As bioenergy technologies become commercially available, both in Hawaii and elsewhere, there will be increasingly reliable information on their impacts and costs. Thus further study of biofuels for electricity generation and alternative liquid fuel products like biodiesel are needed to provide a more comprehensive view of the future of biofuels and their impacts to Hawaii’s economy.
Information needs identified during this study:

Thus further study of biofuels for electricity generation and alternative liquid fuel products like biodiesel are needed to provide a more comprehensive view of the future of biofuels and their impacts to Hawaii’s economy.

Biomass-to-electricity is another likely scenario for Hawaii’s bioenergy future, given technological viability of current feedstock production. A comprehensive assessment of cost estimates, however, is outside the scope of this study and merits further analysis.

Although the energy-balance for ethanol from sugarcane is shown to be positive elsewhere, a Hawaii-specific analysis of total energy inputs versus energy output may be illustrative in order to better understand the full life-cycle costs of ethanol production in Hawaii.¹

Community suitability and assessment studies will be needed in order to determine region-specific impacts, including impacts to food production (including crops and livestock).

The question of tradeoffs between labor and capital nonetheless is an important consideration in assessing the benefits of local biofuels, particularly for crops with longer periods between harvests.

The pressure on agricultural lands to be rezoned for urban use or made into “gentleman estates” is sizeable and merits further analysis.

In general, the impacts to the refineries of rising world oil prices and increasing local production of energy are not well understood and merit further analysis.

The costs of production for other feedstock for electricity are not addressed in this report. For tree crops, costs can vary widely depending on management practices such as coppicing versus replanting and is an area of future inquiry.

¹ The question of net energy balance is crucial to understanding whether policy outcomes are achieving their stated goals. For example, a 2002 USDA report on the energy balance for corn ethanol estimates that corn ethanol produces 34% more energy than it takes to produce it (USDA, 2002). Sugarcane is thought to be quite a bit more energy positive, estimated to increase energy output by nearly 80%.
2.9 Environmental Impacts

EXECUTIVE SUMMARY

An evaluation of the potential environmental impacts associated with bioenergy development in Hawaii was conducted as part of the Hawaii Bioenergy Master Plan mandated by Act 253 of the Hawaii State Legislature in 2007. This effort included the characterization of the general environmental impacts and issues associated with bioenergy development, the identification of potential environmental impacts in Hawaii for each portion of the biofuels value chain, and recommendations for State action.

Despite the obvious potential benefits of reduced greenhouse gas (GHG) emissions and energy self-sufficiency offered to Hawaii by bioenergy development, there are many potential environmental impacts that need to be considered when developing bioenergy policy and projects in Hawaii. The following is a summary list of the potential environmental impacts and issues associated with bioenergy development in Hawaii.

- Reduction in greenhouse gas emissions and use of fossil fuels
- Invasive species management
- Agricultural land use conflicts
- Water use and water rights
- Water pollution/quality
- Soil quality
- Air quality
- Residue management
- Socio-economic community impacts
- Cultural impacts
- Transnational environmental issues

The following list of recommendations has been developed based on stakeholder input and information collected in the preparation of this study.

1. Environmental Impact Assessment – As specific proposals are put forward for development of aspects of the bioenergy value chain, environmental assessments or environmental impact statements should be completed pursuant to the State of Hawaii environmental review law (Chapter 343, HRS) and the Department of Health Title 11-200 administrative rules governing the review process. It should be noted that not all bioenergy projects may trigger Chapter 343, HRS due to their proposed locations, land ownership, and/or funding.

   Environmental assessments and impact statements should include evaluations of the potential social, economic, and cultural impacts associated with the proposed projects, as required in the Title 11-200 administrative rules for the environmental review process. Assessments should strive to include analysis of how specific proposed projects for bioenergy development in Hawaii will effect and be affected by international market conditions. This analysis will give transparency to the potential indirect and direct environmental impacts of biofuels development in Hawaii.
2. **Life-Cycle Analysis (LCA)** – Life-Cycle Analysis (LCA) is the cradle to grave systems approach for examining technology and systems. LCA should be used to examine the specific technical aspects of any proposed biofuels value chain, the crops, energy requirements, emissions, land use changes, water use requirements, wastes, logistics, conversion technology, distribution, and end use to determine the net energy and greenhouse gas balances of the biofuel. This process is being used nationally and internationally to evaluate bioenergy development and could be employed for analysis of local conditions and permitting.

The State should establish requirements for LCA based on Hawaii’s specific environmental conditions, goals and needs. The State should establish guidelines for LCA, including certification of LCA methodologies, and the minimum attainment of positive net energy and greenhouse gas balances. LCA should be used as an integral component in a biofuels certification process.

3. **Conservation Agriculture** – Since most environmental impacts from bioenergy development are found in the feedstock production phase, the State should require appropriate conservation agriculture practices for biofuels feedstock production. This would help reduce water consumption, use of pesticides and fertilizers, and pollution.

4. **Weed Risk Assessment (WRA)** – Weed Risk Assessment (WRA) should be required for all candidate crops for biofuel production. Since Hawaii has sensitive natural resources that are susceptible to invasive species, the State should establish criteria for restricting certain candidate crops that may have the greatest potential for harm. It may also want to limit introduction of certain crops from areas near sensitive habitats depending on the individual characteristics of the candidate crop.

5. **Examine the Issue of Agricultural Land Use and Biofuels** – The State should commission a study to examine the potential issues related to agricultural land use and biofuels. The potential impacts to local agriculture from an introduction of large-scale biofuel development may be significant. Of particular importance is the potential loss of local food-crop production as prime agricultural lands are shifted to biofuels and non-agricultural uses.

The study should examine how existing agricultural practices and uses of land, including small farming and ranching, may be impacted by the introduction of incentives and subsidies for biofuels. This should include an analysis of food security and fuel security issues in Hawaii. The study should also examine how the conversion of prime agricultural lands to non-agricultural uses may affect biofuels development and long-term viability.

6. **Encourage Use of Existing Infrastructure** – To minimize the potential environmental impacts from the development of new infrastructure needed to support bioenergy, the State should encourage the use of existing conversion facilities, pipelines, and other infrastructure where applicable.
7. **Community-Based Bioenergy Working Group** – Many stakeholders expressed concern about the lack of information regarding environmental issues and the State’s plan for bioenergy development. Many requested a forum to exchange information. The State should establish a community-based working group with representatives from various stakeholders including, but not limited to, representatives from State of Hawaii Departments of Agriculture; Business, Economic Development and Tourism; Land and Natural Resources; Attorney General; bioenergy entrepreneurs; large landowners; small farmers; environmentalists; Native Hawaiian groups; the power industry; etc.

This forum would be useful for creating community dialogue and understanding about bioenergy development and environmental issues in Hawaii. It could also be used as a tool for gathering information for social and cultural impact assessment.

8. **Biofuel Certification Program** – To safeguard Hawaii’s unique native eco-systems and culture, and support sustainable biofuels development, the State should explore the possible development of a certification program for biofuels. Many countries are proposing that biofuels meet certain mandated targets or minimum goals to receive subsidies and government recognition. A certification program in Hawaii could include various sustainability requirements related to net energy and greenhouse gas balances, invasive species protection, water and land conservation, protection of local food supplies and farming, and other social and cultural issues.

It should be noted that certification programs are difficult to employ and may, if too unwieldy or burdensome, constrain the development of the local biofuel industry in Hawaii. If employed, certification should be targeted at specific local problems and tailored to meet specific sustainability goals established by the Legislature.

Due to the complexity of the issues, the State should commission a separate study to examine biofuels certification for Hawaii. The study should include analysis and recommendations for sustainability requirements, implementation and timing guidelines, and the specification of departmental permitting responsibilities. A central component of the study also should be the analysis of the various certifying methods including government run certification programs, preliminary certification for “First-Movers”, voluntary certification, and third-party certification. Optimally, certification of any sort should not add to the duration of the overall permitting process. Efforts should be made to coordinate existing permitting and disclosure processes and reduce or eliminate redundancies.

Optimally, a certification program should be established prior to the development of new subsidies for biofuels in Hawaii. However, due to the State’s desire to encourage rapid development of bioenergy there may need to be some discussion about creating initial screening processes and preliminary certification to help first movers with “shovel-ready” projects or demonstration projects. If a “First-Movers Program” for preliminary certification was established, any participating programs should be required to complete a full and timely certification and LCA as part of their final permitting/compliance. Strict precautions would need to be taken in a preliminary certification process to safe-guard
against invasive species and any other irreversible commitment of resources that may be proposed by a project under a “First-Movers Program”.
2.10 State, County, and Federal Plans, Policies, Statutes, and Regulations

This is a compilation of State, County, and Federal Plans, Policies, Statutes, and Regulations based on information available as of April 28, 2009. No Executive Summary is provided. The reader is referred directly to the report section in Vol. II.