

# Environmental and Socioeconomic Analysis of Biofuel Production on Hawaii Island

A Scope for Future Work



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**ECON**Northwest  
ECONOMICS • FINANCE • PLANNING

222 SW Columbia Street  
Suite 1600  
Portland, OR 97201  
Phone: 503-222-6060  
[www.econw.com](http://www.econw.com)

**WPN** Watershed  
Professionals  
Network, LLC

PO Box 1641  
Philomath, OR 97370  
Phone: 541-760-0712  
[www.watershednet.com](http://www.watershednet.com)

**THE KOHALA CENTER**  
education. environment. empowerment.

PO Box 43762  
Kamuela, HI 96743  
Phone: 808-887-6411  
[info@kohalacenter.org](mailto:info@kohalacenter.org)

**Supported by the  
Hawaiian Electric Company**  
P. O. Box 2750  
Honolulu, HI 96840

## CONTACT INFORMATION

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This scope of work is in response to a request from The Kohala Center, which is interested in learning more about the potential socioeconomic impacts of biofuel production on Hawaii Island. The scope was prepared by ECONorthwest (ECONW), Watershed Professionals Network (WPN) and Kohala Center staff. This work was supported with funds from the Hawaiian Electric Company.

ECONW specializes in the economic and financial analysis of public policy and land use decisions. ECONW has analyzed the economics of resource-management, land-use development, and growth-management issues for municipalities, state and federal agencies, and private clients for more than 30 years. Mark Buckley is a senior economist with ECONW and contributed to this scope.

WPN is a natural resource consulting company focused on the assessment, design and implementation of sustainable land-based projects aimed to restore, protect, enhance and soundly manage natural resources in a culturally relevant manner. Since 1998, WPN has served federal, state and local agencies, tribes and private entities in restoration and land management activities in the Pacific Northwest, Pacific Islands and Latin America. Chris Heider is an ecosystem ecologist with WPN and contributed to this scope.

The Kohala Center is an independent, not-for-profit center for research and education *about and for* the environment. The Kohala Center builds teaching and research programs for energy and food self-reliance, as well as ecosystem health, to enhance island environments, serve island communities, and advance the work of the academy.

For more information about this proposal, please contact:

The Kohala Center  
PO Box 437462  
Kamuela, HI 96743  
Phone: 808-887-6411  
[info@kohalacenter.org](mailto:info@kohalacenter.org)

## MACRO-CONSIDERATIONS FOR BIOFUELS MANAGEMENT

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The following represents a summary of macro-considerations for managing biofuels supply, demand, and potential policy decisions.

- Land is a precious resource. Using land for biofuels management should be balanced with increasing needs for locally-sourced food products as well as increasing native forest cover to increase water capture and retention. At the same time, fallow land represents its own challenges including potential run-off of important topsoil and provision of a breeding ground for invasive species.
- Choices of activities on lands should be examined in context of Hawaiian values and traditional use areas.
- There are many potential sources of biofuel feedstocks. Materials may include grown-for-purpose and byproducts from other operations (harvest, restoration activities, etc.). Identifying proper feedstocks that are in line with sound resource management is crucial in developing a biofuels management plan.
- There are tradeoffs associated with cultivating or introducing non-native species for the purposes of biofuels production including their effect on the native species environment. Use of what is native or present is preferable to introducing new species.
- A Risk and Uncertainty Assessment should be made prior to decision-making in evaluating different alternative scenarios, including “no action” scenarios that might have negative consequences.
- Changes in climate are likely to affect the types, viability, production, and costs of different biofuel feedstocks, as well as their potential demand. Climate predictions for wet/dry and differing storm frequencies and intensities should be included in elements of biofuel stock selection.
- Decisions about land use conversion for the purposes of implementing a biofuels policy should involve a careful and thoughtful process, with overarching goals to increase long-term sustainability and viability of food, energy, water, forest, and cultural integrity. Special emphasis should be paid to options which maximize all uses. For example, if biofuel cultivation allows for the use of currently fallow lands which are not otherwise available for food production, biofuel production operators need to be strongly encouraged to make available all unused acreage for the production of food and/or forest.

## INTRODUCTION AND OBJECTIVES

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The Kohala Center is seeking a better understanding of the potential production and use of biofuel-based energy sources on Hawaii Island. The Kohala Center recognizes that there are a number of potential direct costs and benefits from increased biofuel production on Hawaii Island, as well as ancillary costs and benefits such as implications for food production opportunities and associated public health, and effects on natural resources and ecosystems. This complex and widespread set of potential effects of large-scale<sup>1</sup> biofuel production demands a thoughtful and complete decision process to be sure to avoid unintended consequences. Within an economic framework, such an analysis entails consideration of supply options and sources of demand. Upon identifying these factors, various possible scenarios can be considered, and compared by their costs and benefits. Understanding the real potential impact on the community requires consideration of costs and benefits directly to producers and consumers as well as others in society, the risks and uncertainties, and the distribution of these effects. In this document, we outline the appropriate research questions and a framework to answer them.

The remainder of this document is split into five sections. Each section describes a particular set of questions related to the larger effort to understand the environmental, economic and social effects of biofuel production on Hawaii Island. Briefly, the five sections address:

- Biofuel crop alternatives (the types of source materials available for the production of biofuel)
- Tradeoffs between existing land-use practices and biofuel production
- Biofuel production alternatives (the types of processing required by different biofuel production techniques)
- Demand for biofuel on Hawaii Island in the context of the island's existing energy conditions
- Potential policy tools and distributional issues associated with biofuel production

In each section, we describe why the particular analysis is important to the overall objectives, we provide steps to conduct the analysis, and we list several related questions that, if the analysis is sufficiently conducted, should be answered in the project's conclusions.

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<sup>1</sup> For purposes of this analysis, "large scale" is defined by industrial-level production (e.g., >5,000 acres), in many different areas. This differs from a "pilot", in that the production is scalable to potentially tens or hundreds of thousands of acres.

## ANALYTICAL QUESTIONS AND SCOPING

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### 1. Identify and Describe Biofuel Supply Alternatives

The first step in framing the context for an analysis of biofuel production on Hawaii Island requires an assessment of the different biofuel technologies to determine which technologies may be best suited for the island. In general, there are three groups of biofuel technologies:

- **First Generation Biofuels.** These are the most common biofuels in the biofuel market. Ethanol is typically derived from food crops such as corn and sugar cane. Biodiesel is typically derived from oils from seed crops such as soy bean, used cooking oil, and waste animal fat. Other types of biofuels also fit into this group such as biogas, syngas, and solid, non-food biofuels (e.g. wood, charcoal, other organic waste materials).
- **Second Generation Biofuels.** These biofuels are typically generated from the residual non-food parts of current crops, such as stems, leaves and husks that are left behind once the food crop has been extracted, as well as other crops that are not used for food purposes, such as switch grass, and waste such as wood chips, skins and pulp from fruit pressing. Second generation biofuels rely primarily on the breakdown of cellulose to produce the biofuel or a thermo-catalytic process whereby the biomass is gasified and then liquefied.
- **Third Generation Biofuels.** This form of production is still in the research and development phase and has not been used on a commercial scale. For example, a number of efforts are under way across the world to develop a commercially viable technique for using algae to produce biofuel.

In addition to understanding the technologies available for processing feedstock into biofuel, it is important to understand the variables on which the viability of biomass supply is dependent (e.g., source location, access to the material, labor in handling, portability of supply, transportation costs). In general, the costs of biofuel production are dependent on the pathway of obtaining and transporting materials:

- **Production of biofuels on site.** Some biofuels can be made at or near the location where the biomass is sourced (e.g., biofuel products from methane digestion). These biofuels can then be transported as a final or interim product to a local hub or consumed locally.
- **Consolidation and transport of biofuel source materials to a central processing facility.** Some fuel sources require transport of the raw materials to a centralized facility with the capacity to process them into biofuels. Transportation involves material handling from the source location to the processing facility, where finished biofuel products are then transported to their final destinations, or utilized at the central facility (e.g., power generation to the grid).

## Questions for Analysis

Below are a series of questions to guide the identification and description of biofuel supply alternatives.

- What are the source materials (food and non-food) associated with biofuel production?
- How are these materials distributed on Hawaii Island (by district, by major service area)?
- How much biofuel can be produced (per ton and per acre under current land uses) by each form of feedstock material?
- What are the growing conditions and geographic ranges required by the feedstock materials?
- What is the optimum growth and yield of different feedstock materials on Hawaii Island?
- How are growth, yield, productivity, and viability likely to change with climate change scenarios (wet, dry, and altered storm frequencies and intensities)?
- Are there any potential byproducts in the island's existing agricultural and agroforestry system that could be used in biofuel production (e.g., culled fruit, slash, etc.)?
- Are there any biofuel sources that yield co-benefits, such as biofuel materials that also produce inputs to other production processes (e.g., methane digestion, syngas, biochar), or source materials that may enhance ecological benefits (e.g., invasive species feedstock)?

## Analytical Approach

In order to address the questions above, the following series of tasks are proposed:

### Task 1 Supply Alternatives Analysis

#### Task 1.1 Biofuel Source Suitability Assessment

The objective of this task is to identify the set of potential source materials that are viable options that fit within Hawaii Island's cultural and biological context. Work would include 1) identification and description of the source materials currently used in biofuel production elsewhere, with a focus in the tropics, as well as other emerging sources that are not yet used commercially; 2) review of existing literature on biofuel production, paying particular attention to literature focused on source material capacities and yields for producing biofuels; 3) compiling of a thorough list of biofuel efforts around the world with an initial matrix describing these biofuel efforts.

#### Task 1.2 Characterization of Suitable Source Materials

Once the crops are identified in Task 1.1, an assessment of them would be made for basic characteristics under the range of growing conditions on Hawaii Island including:

- Growth/accumulation rates and volumes

- Generalized land, resource, and labor requirements
- Harvest and processing requirements
- Energy content potentials
- Cultural importance and value
- Known environmental and social effects of biofuels sources and processing requirements

The objective of this task is to compile descriptions and data for each of the potential source materials for comparison in a Hawaiian context. Most of the data and information for this task would be collected from existing literature as well as from interviews with experts in the relevant fields and would be compiled in their natural metrics (e.g., tons per acre, available acres, geographic zones). Subsequent steps would be taken to consider the different variables uniformly. Information and data collected and calculated in this task would complete the source materials matrix from Task 1.1.

### Task 1.3 Initial Prioritization and Alignment of Source Materials

The matrix completed in Task 1.2 would then be used to conduct a multi-criteria analysis in order to develop an initial prioritization of the most promising biofuel sources for Hawaii Island. The matrix would allow for a straightforward comparison of the characteristics of the different source materials. In comparing the different materials, available feedstock, locations, transportation pathways, energy yield and other physical parameters would be examined to determine overall cost and viability. In addition, discussions with relevant stakeholders would be held to gauge the relative social and cultural importance of potential source materials. The results of the analysis and stakeholder discussions will allow for creation of a weighted scale prioritizing the most important source material characteristics (in a culturally significant context). The data in the matrix and the weights for each characteristic will assist in ranking the potential source materials. The specific ranking methodology will depend on the data available from the literature, available spatial data, and interviews with experts and stakeholders, but will ultimately shed light on which source materials are best suited for biofuel production in a Hawaiian context. Stakeholders could include state and federal agencies, watershed partnerships, user groups, Hawaiian traditional knowledge practitioners and other organizations.

This matrix would not be the final ranking for each of the candidate source materials, but only an initial ranking structure to further populate and narrow options under Tasks 2 and 3, which include compilation of a more complete range of costs and benefits to society by source type. The objective of this task is to develop initial rules-of-thumb for suitability of each identified source material specific to the range of conditions on Hawaii Island. If there are some materials that are technically or socially infeasible for Hawaii Island, they would be dropped from further analysis.

### Deliverables

- Report sections describing existing biofuel technologies, characteristics of biofuel supply materials applicable to Hawaii Island, and a Hawaii-specific ranking of biofuel technologies.

## Literature and Data Sources

- World Soil Information. 2011. *ISRIC – World Soil Information Database*. Available at: <http://library.wur.nl/isric/>
- U.S. Department of Energy. 2011. *Alternative Fuels & Advanced Vehicles Data Center*. Available at: <http://www.afdc.energy.gov/afdc/>.
- European Biofuels Technology Platform. 2011. Available at: <http://www.biofuelstp.eu/>
- University of Hawaii, Hawaii Natural Energy Institute. 2002. *Analysis of Hawaii Biomass Energy Resources for Distributed Energy Applications*. December.

## 2. Identify Land Use Potentials and Describe Tradeoffs with Existing Land-Use Practices

First generation biofuels require that inputs be sourced specifically for the production of biofuel. Second generation biofuels can be produced with byproducts of existing production (agricultural waste, timber slash, etc.). Third generation biofuels do not require land-based production directly, but do require land insofar as the production facilities will take up space (e.g., algae-growing facilities). One step in comparing the different biofuel supply alternatives is to consider the competing demands of existing and potential future land-use practices and the land use.

Currently, landowners are using their land in a particular manner based on the current condition of the lands and on their own assessment of the costs and benefits associated with a particular land use. This analysis should evaluate how the costs and benefits associated with these existing land-use practices (and land use potentials) compare to the costs and benefits associated with growing feedstock for biofuel production.

### Questions for Analysis

Below are a series of questions to guide the identification and description of tradeoffs with existing land-use practices.

- Where could biofuel materials be sourced on Hawaii Island under current land use scenarios?
- What types of lands will support the identified potential biofuel source materials? Where are they? How are they currently used?
  - What are the general economic costs and benefits associated with the existing land uses?
  - What are the environmental effects of existing land-use practices on Hawaii Island?
  - What are the potential costs and benefits associated with land-use conversion to support biofuel source materials?

- What are the environmental and social effects of sourcing biofuel supply?
- What are the non-agricultural land-use practices on Hawaii Island that may be impacted by feedstock growth for biofuel production?
- How will a commitment to biofuel generation impact a potential future scenario with increased demand for the production of food crops on Hawaii Island?

## **Analytical Approach**

In order to address the questions above, we propose the following series of tasks:

### **Task 2 Land-use Tradeoff Assessment**

#### **Task 2.1 Current Land-use Assessment**

Under this task, the areas on Hawaii Island that could potentially support the growth of source materials for biofuel production or facilities for higher-generation biofuel production (e.g., algae-growing facilities) would be spatially identified, including their locations, area totals, and current land uses. This assessment would have a spatial component (using GIS and spatial data) identifying where each land use currently exists. The costs associated with current land uses, including direct onsite expenditures to land owners and stewards, as well as external costs to neighbors and others would be identified. Some of the data needed to understand the costs associated with current land uses are available through the Agriculture Census conducted by the US Department of Agriculture every five years. Other information associated with land cover, ownership, road networks, topography, and conservation objectives would be examined in the assessment of potential source areas. Additional information would be collected through interviews and personal communications with relevant stakeholders on the island.

This assessment would also characterize the current services provided by these areas, including any non-market benefits such as ecosystem goods and services (e.g., water, biodiversity, cultural Hawaiian significance). In general, the assessment of non-market benefits would take place in three steps. First, the ecosystem services impacted, either positively or negatively, by existing land-use practices would be identified. Next, the magnitude of the impact on ecosystem services in biophysical metrics (e.g., acre-feet of water supplied, tons of carbon sequestered) would be estimated, to the extent possible. Finally, identification and the application of values from existing markets, relevant literature, and other sources of demand to the quantity of ecosystem services would be provided to calculate an estimate of ecosystem services by type of existing land-use practice.

#### **Task 2.2 Potential Land-use Assessment**

Under this task, the potential future uses of areas and resources that could support biofuel production would be considered. This would entail consideration of current, emerging, and likely trends in demand for the goods and services of the general land uses on Hawaii Island. historical data describing the changes in land-use practices over the past several years would be looked at to identify trends which may shed light on the geographic extent of land-use practices in the future without biofuel production. State and county land-policy experts, traditional ecological knowledge practitioners,

watershed partnerships, large landowners, recreational groups (e.g., hunters), and community organizations would be interviewed and mid- to long-range planning targets for land use on Hawaii Island reviewed. The potential extent of land use for biofuel production identified in Task 2.1 would then be considered.

These two scenarios along with results from previous tasks will allow the comparison of the tradeoffs associated with each of these land uses and, ultimately, the presentation of a series of maps demonstrating the potential extent of land use for biofuel production or sourcing biofuel materials from planned or ongoing land-use practices. Furthermore, the potential land-use tradeoffs would be described assuming a future in which demand for specific land might change based on these investigations, such as increased demand for food crops from Hawaii Island. This part of the analysis would describe potential thresholds of biofuel production as well as types of biofuel commitments and how they would impact the capacity of the island to generate other beneficial goods and services.

## Deliverables

- Spatial representation of existing and projected land-use practices.
- Spatial analysis of areas suited for production of biofuels through (first generation) or through sourcing through other ongoing activities (second generation), with potential quantities assigned.
- Spatial analysis of culturally significant areas and constraints for potential biofuel operations, sourcing, etc.
- Report sections describing historical, existing, and projected future land-use practices, the economic costs and benefits associated with those land-use practices, the potential geographic extent of biofuel source crop production, and the tradeoffs for other beneficial land uses.

## Literature and Data Sources

- U.S. Department of Agriculture. National Agricultural Statistics Service. 2007, 2002, 1997, 1992. Census of Agriculture. (County-level data available).
- State of Hawaii, Department of Agriculture. Hawaii Agricultural Statistics Service.
- Rocky Mountain Institute. 2007. *Island of Hawaii Whole System Project Phase I Report*. March.
- National Renewable Energy Laboratory. 2011. *Biofuel Atlas*. Available at: <http://maps.nrel.gov/biomass>.
- Smith, B. and R. Bruins. 2010. "Evaluating Ecosystem Service Trade-offs Associated with Biofuel Feedstock Production in the Midwest." National Exposure Research Laboratory.

- Koh, L., and J. Ghazoul. 2008. "Biofuels, Biodiversity, and People: Understanding the Conflicts and Finding Opportunities." *Biological Conservation*. 141(10):2450-2460.
- Nelson, E., G. Mendoza, J. Regetz, S. Polasky, H. Tallis, et al. 2009. "Modeling Multiple Ecosystem Services, Biodiversity Conservation, Commodity Production, and Tradeoffs at Landscape Scales." *Frontiers in Ecology and the Environment*. 7(1):4-11.
- DeFries, R., J. Joley, and G. Asner. 2004. "Land-use Choices: Balancing Human Needs and Ecosystem Function." *Frontiers in Ecology and the Environment*. 2(5):249-257.

### 3. Identify and Describe Biofuel Production Alternatives

So far, the tasks described above have focused on the biomass, source materials, and land needed to produce biofuels primarily in the form of first generation biofuels, as well as second and third generation biofuels. An additional step in the analysis is to identify and describe the alternatives for biofuel production (the process of converting biomass inputs into biofuel outputs). This analysis would focus on facility-level questions and pertain to first, second, and third generation biofuels.

#### Questions for Analysis

Below are a series of questions to guide the identification and description of biofuel production alternatives.

- What are the relevant characteristics of existing facilities that produce biofuel from the previously identified (and relevant) biomass sources?
- At what scales are these facilities profitable?
- Are the facilities portable?
- How sensitive are transportation costs to profitability?
- What are the fixed and variable costs associated with these facilities? What are their revenues and profits? How will tax revenues change?
- What types of environmental effects are associated with these facilities? What are the economic costs and benefits of these environmental effects?
- How many individuals may be employed by the facility? What types of jobs are they? Could the local labor force fill the positions?

#### Analytical Approach

In order to address the questions above, we propose the following series of tasks:

## **Task 3 Biofuel Production Assessment**

### **Task 3.1 Characterization of Biofuel Production Facility**

Under this task, all relevant biofuel production technologies would be identified as would existing facilities around the world applying these technologies for case studies. For each case study, several general characteristics such as the amount of biofuel produced, the number of employees, and the revenues, profits, and tax revenues associated with facility operation would be identified. The pre-operation characteristics of each facility such as initial construction costs, sources of funding, and pre-facility land uses would be described. The construction and operations data associated with existing biofuel production facilities would serve as the basis for assessment of the potential impacts of a production facility on Hawaii Island.

### **Task 3.2 Assessment of Social Costs and Benefits of Production**

Under this task, the social costs and benefits imposed on residents of and visitors to Hawaii Island of the different production alternatives identified would be assessed. This would include a general assessment of food supply effects, public health effects, transportation system effects, and public hazard effects. It would not include environmental effects, considered separately under Task 3.3. It is anticipated that the level of analysis for this task would include qualitative characterizations where there is evidence of likely effects, and readily available quantification. We recognize that a full assessment of these effects could each require full focused studies on their own, which should be considered as potential follow-up studies where substantial likely effects are identified.

### **Task 3.3 Assessment of Environmental Costs and Benefits of Production**

Under this task, the environmental costs and benefits of the different facility options would be assessed. This would entail describing the baseline conditions (the costs and benefits associated with pre-facility land uses estimated in Task 2) and comparing them against a description of the environmental costs and benefits associated with construction and operation of the facility. This assessment, to the extent possible, would rely on existing literature describing the biophysical and economic effects associated with existing facilities around the world, identified in Task 3.1. Where existing data are insufficient, interviews would be conducted with relevant stakeholders and experts to identify potential environmental costs or benefits, estimate the biophysical effect, and estimate or describe the associated economic effect.

### **Task 3.4 Assessment of Labor-based Variables**

Under this task, an assessment would be made of several labor-based variables associated with each of the biofuel production facilities identified and described in previous tasks. The first assessment would be of the demand for labor associated with the case study facilities. This assessment would identify the number of workers required in each type of facility as well as the type of employment (e.g., what expertise will be required to work at the facility). An alignment would be created between this labor demand with the existing labor supply on Hawaii Island. This assessment would describe and quantify the types of jobs demanded at the facility and would describe the

extent to which the local labor force could meet this demand. Some of the data describing the local labor force is available through the Bureau of Economic Analysis. Unfortunately, this source does not provide data specific to Hawaii Island, but it does provide data for the state, which may, in some instances, be enough to extrapolate labor characteristics specific to Hawaii Island.

## Deliverables

- Fact sheet identifying and describing existing biofuel production facilities around the world.
- Report sections describing the economic costs and benefits associated with construction and operations of biofuel production facilities, and an analysis of labor-related issues associated with different types of facilities.

## Literature and Data Sources

- Hill, J., E. Nelson, D. Tilman, S. Polasky, and D. Tiffany. 2006. "Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels." *Proceedings of the National Academy of Sciences of the United State of America*. 103(30):11206-11210.
- de Gorter, H. and D. Just. 2010. "The Social Costs and Benefits of Biofuels: The Intersection of Environmental, Energy, and Agricultural Policy." *Applied Economic Perspectives and Policy*. 32(1):4-32.
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- Searchinger, T., R. Heimlich, R. Houghton, F. Dong, A. Elobeid, et al. 2008. "Use of U.S. Croplands for Biofuels Increases Greenhouse Gases through Emissions from Land Use Change." *Science*. 319(5867):1238-1240.

## 4. Identify and Describe Demand for Biofuel from Hawaii Island

The assessments described above have focused on the supply side of the issue. Another important step is to identify and describe demand characteristics for the biofuel once it is produced. This analysis will include not only the existing and potential demand for biofuel produced on Hawaii Island, but also how biofuel production will potentially change consumer behavior associated with other energy sources. We will consider existing and potential future demand for biofuel in the context of the island's existing and projected future energy composition.

## Questions for Analysis

Below are a series of questions to guide the identification and description of demand for biofuel from Hawaii Island.

- What are the current and projected future baseline energy conditions assuming no biofuel production?
- How much biofuel is currently purchased on Hawaii Island?
- How much fuel is currently purchased on Hawaii Island that could be replaced with biofuel?
- How much will consumers on Hawaii Island be willing to pay to purchase biofuel produced on the island?
- Are there markets for biofuel from Hawaii Island to sister islands? How much will they be willing to pay?
- How does/could biofuel demand vary by biofuel type, and relative to other energy sources?
- What are the long-term goals for biofuels from the largest consumers in Hawaii (e.g., Department of Defense, airline industry, shipping industry)?
- How will biofuel change energy consumption and other consumer behavior?

## Analytical Approach

In order to address the questions above, we propose the following series of tasks:

### Task 4 Biofuel Demand Assessment

#### Task 4.1 Assess Baseline Energy Conditions

Under this task, current and projected future consumer behavior on Hawaii Island in terms of energy use would be described. Existing sources of energy would be identified along with a description of how consumers use the energy (e.g., in what quantity, for what purpose), the price of energy, and where it is purchased. Current consumer behavior would be projected into the future to create a similar description of energy sources, consumer uses, prices, and distributing locations and institutions. A necessary element of this task would be to identify potential demand for biofuel given existing consumer characteristics. In other words: how much biofuel *could* consumers purchase now if it were available?

This baseline analysis would in part be based on results from efforts, currently underway, to update Hawaii Island's Energy Sustainability Plan. The updated plan will outline the current and potential future composition of energy supply and demand on Hawaii Island. From this plan, data and information would be collected regarding quantities, prices, sources, and descriptions associated with energy-related consumer behavior assuming no future emphasis on biofuel production. The plan will also highlight recent trends in energy consumption (such as potential changes in overall

supply and/or demand, changes in composition of energy supply and/or demand, and other initiatives that may influence future energy supply and demand characteristics.

#### **Task 4.2 Assess Potential Future Energy Conditions Assuming Emphasis on Biofuel Production**

In Task 4.1, the baseline energy conditions would be assessed assuming no emphasis on biofuel production. In this task, the data and information collected in Task 4.1 and the results of the island's updated Energy Sustainability Plan would be used to assess the energy-related conditions assuming initiatives supporting biofuel production on the island are realized. The potential future demand for biofuel produced on Hawaii Island among consumers on the island, and, if relevant, elsewhere would be assessed. Other similarly isolated areas around the world would be identified that have made an effort to increase their biofuel production; changes in their demand for biofuels would be examined to project potential future changes in demand for biofuel on Hawaii Island and changes in future energy composition.

The assessment would extend, however, outside Hawaii Island and identify other potential sources of demand for biofuel produced on the island. The extent to which inter-island demand is considered will be limited beyond other islands in the state of Hawaii. Existing markets would be identified in which the biofuel could be sold, and current and historical prices and quantities traded in those markets. Changes in the overall supply and demand for biofuels outside the island would not be projected because of high levels of uncertainty inherent in projecting changes in future quantities and prices in the energy sector.

#### **Task 4.3 Assessment of Potential Changes in Future Energy-related Consumer Behavior**

Under this task, the results of 4.1 and 4.2 would be brought together to assess and describe the potential change in energy-related consumer behavior on Hawaii Island. Increasing biofuel production on island likely will change energy-related behavior by consumers. This assessment would focus on the costs and benefits associated with changes in the demand for and use of non-biofuel energy sources brought about by supporting an increase in Hawaiian biofuel production. This assessment would also focus on the externalities associated with energy consumption and the change in the value of those externalities as consumers change their energy-related behavior. Central to this assessment would be estimating the change in greenhouse gas emissions stemming from a change in energy-related behavior. Other pollutants, however, would also be important, such as emissions of mercury, particulate matter, and greenhouse gases. The US Environmental Protection Agency estimates emissions from different energy sources at a regional level. This dataset and the conversion factors provided by the US Environmental Protection Agency would be sufficient to estimate preliminary changes in emissions resulting from increased reliance on biofuel. Other literature would provide economic factors (e.g., the social cost of carbon) allowing for the ability to monetize the change in emissions.

## Deliverables

- Report sections describing existing and potential future demand for biofuel on Hawaii Island and in other potential markets, the potential change in energy-related behavior resulting from increased biofuel supply, and a discussion of the economic costs and benefits associated with changes in emissions from energy-related consumption.

## Literature and Data Sources

- Davies, M., C. Gagne, Z. Hausfather, D. Lippert. 2007. *Analysis and Recommendations for the Hawai'i County Energy Sustainability Plan*. October.
- U.S. Energy Information Administration. 2011. *Biodiesel Performance, Costs, and Use*.
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## 5. Identify and Describe Policy Tools, Distributional Issues, and Mitigation Efforts

Governments oftentimes offer incentives for private individuals and businesses to pursue objectives deemed important to the public. These incentives take many forms such as tax breaks for specific types of spending, low-interest loans for specific types of investments, etc. An important step in the analysis would be to identify the types of policy tools and incentives that are most conducive to widespread benefits from any biofuel production on Hawaii Island. With most policy actions, there are winners (individuals who benefit from a particular action) and losers (individuals who incur costs as a result of a particular action). This analysis would incorporate conclusions from previous assessments outlining the costs and benefits, as well as winners and losers associated with biofuel production on Hawaii Island in order to provide suggestions for mitigating the extent to which natural systems and individuals are adversely affected, and incentives are not well aligned. Under this task, potential environmental and socioeconomic effects associated with the most likely biofuel scenarios on the island would be summarized and potential strategies for mitigating negative effects of biofuel

supply, such as potential road impacts of fuel material transportation would be identified.

## Questions for Analysis

Below are a series of questions to guide the identification and description of policy tools, distributional issues, and potential mitigation efforts associated with biofuel production on Hawaii Island.

- Who are the winners and losers in the production process?
- Are there existing synergies between current restoration efforts and biofuels production (e.g., removal of invasive species, reforestation and tree thinning efforts)?
- Are there any existing state/federal incentives for biofuel production?
- What other policy tools exist to promote appropriate biofuel production?
- What are the costs and benefits of these policy tools?
- Are there any populations of concern affected by biofuel generation?
- What measures can be taken to mitigate the extent to which individuals are adversely affected?
- What are the environmental and socioeconomic effects of the most likely biofuel production scenarios on the community?
- How could some of the potentially negative effects of biofuel production on the island be mitigated?

## Task 5 Policy Tools and Distributional Assessment

### Task 5.1 Assessment of Policy Tools

Under this task, the existing portfolio of policy tools typically associated with spurring an effort such as Hawaii's promotion of biofuel production would be described including a description of how each of these policy tools works along with their strengths and weaknesses (costs and benefits) specifically as they relate to spurring and supporting biofuel production. In some instances, federal policies may be in place that would support efforts to promote biofuel production on Hawaii Island. In these instances, the policy would be identified and a description included of how Hawaii's biofuel program could take advantage of participation. Other, state- and local-level policies seeking to promote biofuel production would be examined and a description made of how those policies could be molded to fit Hawaii's needs.

### Task 5.2 Summary of Costs and Benefits, and Winners and Losers and Mitigation Efforts

Under this task, the relevant costs and benefits from previous tasks associated with different biofuel production options and the different steps in the production process would be compiled. The potential costs and benefits of the different policy tools available for use in promoting the industry would also be incorporated. For these costs and benefits, the types of individuals would be identified that will benefit as well as

those that will incur costs, paying particular attention to costs and benefits associated with populations of concern throughout the area. In all cases, mitigation measures that could be taken to decrease the burden on individuals negatively affected by the policy would be identified and described.

### Task 5.3 Risk and Uncertainty Associated with Biofuel Futures

Under this task the potential for biofuel supply and demand scenarios to generate identifiable and unidentifiable undesirable outcomes would be described, evaluated and to the extent possible, quantified. This section would address the likelihoods of various undesirable effects identified under preceding tasks. Such potential categories of effects are anticipated to include environmental effects, public health effects and transportation system effects. Scenarios involving unprecedented materials for Hawaii, such as non-native species, genetically modified species, or significant levels of chemicals hold the greatest potential for imposing risk and uncertainty on the island community, and would require focused analysis.

### Task 5.4 Identification of Potential Mitigation Efforts

This task focuses on mitigating the distributional issues associated with the most likely biofuel production scenarios on Hawaii Island. By identifying strategies for mitigating these distributional issues, this analysis will summarize other environmental and socioeconomic effects of biofuel production on the island and offer strategies for mitigating those negative effects (e.g., how could negative impacts associated with increased transportation related to the biofuel production process be mitigated?).

## Deliverables

- Fact sheet identifying and describing federal- and other state-level policies aimed at supporting biofuel production or other similar energy-related industries.
- A final report compiling the costs and benefits identified in other tasks, describing distributional issues associated with biofuel production, and suggesting potential mitigation efforts to minimize negative impacts of biofuel production.

## Literature and Data Sources

- Department of Environmental Management, Solid Waste Division. 2004. *Study Relating to Used Cooking Oil Generation and Biodiesel Production Incentives in the County of Hawai'i*. December.
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