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ENERGY SUSTAINABILITY IN THE PACIFIC BASIN: EMPHASIS ON THE STATE OF HAWAII AND THE ISLAND OF OAHU

Guidry, M.W. and Mackenzie, F.T.
Department of Oceanography and Hawaii Sea Grant
University of Hawaii at Manoa
Contact: mguidry@soest.hawaii.edu 808-956-3679

"… we have a serious problem: America is addicted to oil ..."

President George W. Bush
State of Union Address
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Executive Summary

We conclude that the keys to a sustainable energy future in Hawaii include:

- Continued efforts to maximize renewable energy use, both to replace existing fossil fuel generation, and to offset oil use in daily operations.
- Major efforts by all energy users to reduce demand through adoption of a variety of demand-side management programs and energy efficiency measures.
- Energy emergency preparedness.
- Working with vehicle, equipment, and appliance manufacturers to ensure Hawaii gets access to the latest, highly efficiency products and that Hawaii is not forgotten. Work with government. Industry, dealers, oil companies, shippers, and mainland renewable energy developers to ensure maximum reduction in oil use by changing demand.
- Increasing the focus on environmental consequences of energy use and develop a program to make those consequences clear to consumers, with the hope of favorable changes in demand.
- Although by law 20% of Hawaii's electricity is to be generated from renewable resources by the end of 2020, strategically, economically, and environmentally there is need for a more aggressive plan of action to ensure a sustainable energy future for Hawaii.

Hawaii's roughly 1.3 million total population (900,000 on the island of Oahu) depends on petroleum for its primary energy. It is the most oil-dependent of the 50 states with no natural fossil fuel resources and almost **90%** of its energy derived from imported petroleum products – primarily oil. Hawaii's population pays among the highest costs for electricity and gasoline of any state. The present and future cost of petroleum derived energy is a major threat to Hawaii's economic and environmental sustainability and well-being.

Energy is essential to Hawaii's modern economy. Air, ground and marine transportation (54%) and electricity generation (39%) are the two biggest consumer sectors of Hawaii's imported fossil fuels. Hawaii depends on energy to bring visitors from overseas to sustain its vital tourism

industry and residents and visitors to travel between the islands. Such travel is principally by air. Energy is also needed to bring imports to Hawaii and to send its exports abroad.

Hawaii's economic dependence on petroleum requires large exports of money to pay for importing crude oil and some refined products. These monetary exports have increased significantly over the last few years as oil prices moved up and now seem to have reached a new, higher plateau. Money paid for imports is not used for further development of Hawaii's economy and does not have local economic multiplier effects. Since much of Hawaii's energy demand is inelastic, when energy prices rise more money is used to meet energy needs at the expense of other sectors of the economy.

Hawaii's dependence on oil poses risks to Hawaii's economy from sudden price increases or from supply problems as were experienced in 1973, 1979, 1991, 1992, 2003, and 2005. An oil price spike can produce considerable short-term economic dislocation and reduce personal income and gross state product. Over the long term, fossil fuel energy use, mainly as petroleum, in Hawaii degrades air quality, poses risks of water and land pollution, and is Hawaii's major human-caused contribution to greenhouse gas emissions that contribute to global climate change.

Hawaii's energy future – coupled to its economic and environmental futures - is tied to its ability to wean itself from fossil fuel dependence. There is no single solution and transitioning to a more sustainable (i.e., less oil dependent) economy will require efforts on multiple fronts in the private, commercial, and governmental sectors. The best measure that can be immediately implemented with greatest near- and long-term impact is increased efficiency in every form of energy use with focus on electricity and ground transportation. In parallel, renewable energies already implemented in Hawaii – such as solar, wind, biofuels, geothermal, etc. – need to continue to expand in use and implementation to displace fossil fuel generated energy.

Energy, the Economy, and the Environment – Hawaii's Energy System

The four primary energy sectors that imported oil is used for in Hawaii are: (1) electricity sector with 39%; (2) air transportation at 30%; (3) ground transportation at 18.8%; and (4) marine transportation at 7%. Of these four high use sectors, Hawaii is likely to be able to best manage sustainability in the electricity and ground transportation sectors. Hawaii has no fossil energy resources. Seventy-eight percent of the oil came from foreign sources, and only 22% came from domestic sources, principally Alaska.

Around 6% of Hawaii's primary energy was produced by indigenous renewable energy sources. Biomass, municipal solid waste, geothermal, hydro electricity, solar water heating, solar photovoltaics, and wind were used to produce electricity. Biomass was also used to produce process heat and solar energy was used for food drying and to heat water.

The challenge to be faced in creating a sustainable energy system in Hawaii is how to balance energy needs, economic growth, and environmental protection. A reliable energy system is essential to economic growth. In general, efforts to improve energy efficiency can reduce energy costs and permit businesses and consumers to spend their money in ways more productive to the local economy. In addition, by investing in efficiency measures and alternative energy resources

within the state, expenses may not necessarily be reduced, but more of the money spent will remain in the State's economy, more jobs will be created, while protecting the environment.

Electricity for Hawaii

Hawaii has four electric utilities serving the six major islands – Oahu, Big Island of Hawaii, Maui, Kauai, Molokai, and Lanai. These utilities operate six independent systems (one system per island). This presents a special challenge, in that they are not interconnected. If a generator fails on one of the systems, it must be backed up by available reserves on the island. Accordingly, each of the utilities (except for Oahu's) typically maintains a high reserve margin. Generally, the minimum load service criteria is to have enough reserve for the largest unit to be on maintenance and for the next largest unit to have an unscheduled outage, and still be able to meet peak demand. If there is renewable energy from intermittent sources, such as wind, solar, and run-of-the-river hydro, each island system must provide its own reserves. If the wind is not blowing, or the sun is not shining, or river flow is decreased due to lack of rain, and a renewable energy system is not producing on one island, replacement generation cannot be provided from another island. In addition, as documented in the aftermath of the recent earthquake occurring off the Big Island, power generation is vulnerable to events like earthquakes, hurricanes, etc.

Improving End-Use Efficiency in Hawaii's Electricity Sector

In Hawaii, most electricity is used in buildings. This information is useful in terms of understanding the sources of electricity demand. The residential sector has the largest number of customers with diverse, individual needs, who present a challenge in designing measures and taking action to reduce demand. It is very important sector because it drives peak demand, which occurs generally between 6 p.m. and 8 p.m.

To date, most residential sector demand-side management measures and state tax incentives in Hawaii have focused on converting electric water heater to solar water heaters. These efforts have enjoyed some considerable success, with approximately 80,000 solar water heaters operating statewide. While solar water heating is generally considered to be a demand-side measure since it is owned by the customer and produces heat rather than electricity, electricity displaced by solar water heating is also counted as renewable energy.

Distribution of samples to encourage purchase of compact fluorescent lighting is another measure that shows promise. At various times, there have been campaigns to encourage customers to get rid of their second refrigerators, which are typically far less efficient than their newer, primary refrigerators and are generally only used to keep beverages cold. Almost all houses in Hawaii are not air-conditioned, but the use of air conditioning is on the increase. In response, local utilities have distributed rebate coupons to encourage purchase of more efficient room air conditioners.

While lighting is the largest commercial sector end-use, it is closely related to ventilation and interior lighting. Typically, if interior lighting can be made more efficient, temperatures are reduced in the building, reducing cooling and ventilation requirements. Thus it is more

important in commercial buildings to treat the building as a system in planning energy efficiency measures.

Renewable Energy for Hawaii

It is widely recognized in Hawaii that there are significant untapped renewable energy resources. These include wind to power wind generators, sunshine for solar water heaters and solar thermal or photovoltaic electricity generation, streams capable of providing run-of-the-river hydroelectricity, volcanic areas producing superheated underground steam useable for geothermal power, waves and tides capable of producing wave and tidal energy, municipal solid wastes and wastewater treatment by products capable of fueling generators, excellent growing conditions to produce biomass for generation or conversion into liquid fuels, and a significant difference between ocean surface temperatures and deep water capable of being used for ocean thermal energy conversion or for seawater air conditioning.

Virtually all renewable energy use is in the electricity sector. The exceptions are some solar drying of agricultural products and some generation or process heat production for agricultural uses that do not sell to the utility. Although the State generally classifies solar water heating as a contribution of energy to the electricity sector, it actually offsets electricity that would otherwise be used for water heating by directly heating the water.

An additional challenge is the pattern of use of electricity in Hawaii. The peak demand is generally in the evenings between 6 and 8 p.m., which reduces the value of photovoltaic power, which is no longer available at that time. In contrast, on the Mainland, peak demand is generally in the mid-afternoon, coincident with peak photovoltaic production. In addition, nighttime energy demand on most of the islands is very low. For example, on the Big Island, it is typically less than half of the peak demand. This can result in the curtailment of available renewable energy and certain steam units must be run constantly.

Improving the Sustainability of Fossil Fueled Electricity Generation

Due to the extent of the existing fossil fuel infrastructure, and the advantages of fossil fueled generation as a source of base load, firm power, and other factors, we expect that Hawaii will depend upon significant amounts of fossil fuel generation for the foreseeable future. There are options that could make Hawaii's existing and future fossil fuel infrastructure more sustainable. These options include increasing the efficiency of the existing generators, adding distributed generation, fuel switching, clean coal technologies, and eventually moving to biofuels and/or hydrogen fuels.

Possible Futures for Energy Sustainability for Hawaii

It appears that a combination of varied policies, policy measures, and technologies will be needed to move Hawaii toward a sustainable energy system. These include energy efficiency measures, using affordable, indigenous, efficient, non-fossil fuel, and non-greenhouse gas emitting energy options.