

# Current State of Hawaii's Energy Resource and Utilization

## Terry Surles and Milton Staackmann

### 1. Introduction

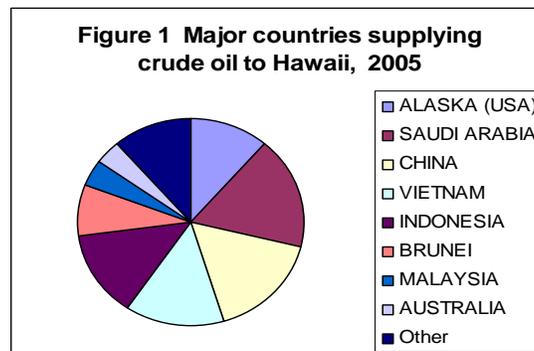
The United States Department of Energy (DOE) and the State of Hawaii Department of Business, Economic Development, and Tourism (DBEDT) have requested that the Hawaii Natural Energy Institute (HNEI) address the topic of the economic implications of continued large-scale reliance of the state on petroleum for electricity generation and transportation. This request explicitly refers to the Energy Policy Act of 2005 Section 355 and the language contained therein. The analyses to be performed as part of this study will focus on the state's economy and the impacts associated with the various possible scenarios outlined under Section 355. Since all of these scenarios require some change in the energy resource mix for the state, it is important to set a baseline and comment on certain important trends in energy resource availability and use. This chapter is designed to perform this function.

### 2. Overall Petroleum Demand for the State

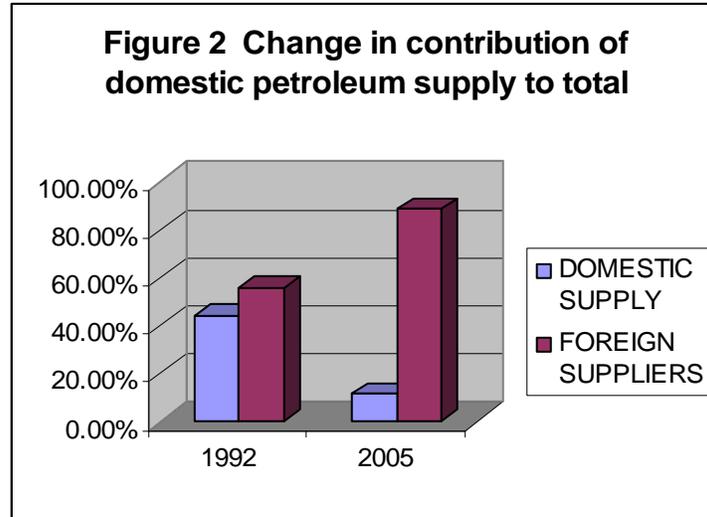
#### 2.1 State Imports of Petroleum

The following discussions will provide for a more disaggregated review of state energy consumption characteristics. To provide context, it is important to examine the broader state requirements for petroleum use.

The two refineries in Hawaii, Chevron and Tesoro, currently (2005) import over 50 million barrels of oil per year (50,892,000 according to DBEDT). These supplies come from a number of countries. In order of descending amounts, the top ten suppliers in 2005 were Saudi Arabia, China, Vietnam, Indonesia, Alaska, Brunei, Malaysia, Australia, Yemen, and United Arab Emirates. Figure 1 below shows the contributions from the major countries supplying crude oil to Hawaii.



Some trends are a bit disturbing. Domestic levels of petroleum importation have gone from 44% in 1992 to 11% in 2005 (see Figure 2 on the next page). By country, imports from Middle East sources increased from 0.4% in 1992 to 21.5% in 2005. The biggest increases during that time came from Vietnam, China, and Saudi Arabia, with a significant percentage decrease from Indonesia.

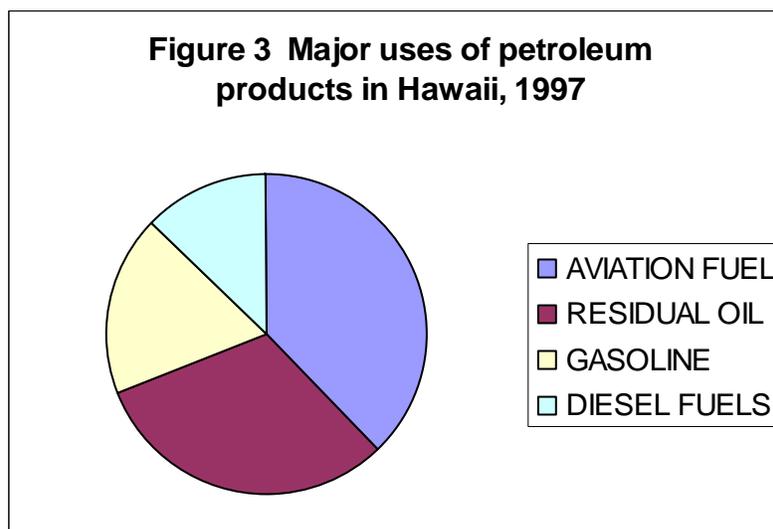


Between 6 and 8 million barrels of refined oil products were also shipped to Hawaii in recent years (2003/2004). Of these imports, between 30 and 40% comes from the continental United States, with the majority of the remainder coming from Asian sources. The majority of these imports are for jet fuel.

### 2.2 Petroleum Use by Sector

Petroleum products provided 88.9% of total energy use in the state in 2004. The most recent, highly accurate information available for energy use is provided in the State of Hawaii Data Book 2005, produced by DBEDT. The values for primary energy by source for the years 1989-2004 are provided in Table 1 on the next page. The energy resources reported include petroleum, coal, geothermal, and renewable energy sources.

As reported in DBEDT's Hawaii Energy Strategy 2000 report, with values for 1997, the major uses for petroleum (using million Btu as the metric), in descending order, are aviation fuel (103 MBtu/yr), residual oil primarily for electricity generation (84 MBtu/yr), gasoline (50 MBtu/yr), and diesel fuels (35 MBtu/yr) – see Figure 3 below.



**Table 1 Primary Energy Consumption in Hawaii by Source, 1989 to 2004 (trillion BTUs)**

Year	Total	Petroleum	Biomass	Solar hot water	Hydroelectric	Coal	Wind	Geothermal	Solid waste
1989	315.0842	289.2301	20.8020	2.3310	1.0183	0.8715	0.4189	0.1435	0.2689
1990	312.1304	284.4906	18.1200	2.3400	1.0700	0.8900	0.2900	-	4.9298
1991	322.9524	294.6222	17.9000	2.3000	1.0000	0.8000	0.3060	-	6.0242
1992	339.0912	305.7758	16.9840	2.3000	0.7226	6.9207	0.2573	0.0168	6.1140
1993	307.7465	266.9516	16.8310	2.3000	0.8024	13.2237	0.2352	1.5988	5.8038
1994	327.4778	285.5010	16.3660	2.3000	1.5300	13.5599	0.2251	1.8060	6.1898
1995	315.1186	273.9590	11.8232	2.8386	1.0632	16.5249	0.2364	2.3045	6.3688
1996	315.9492	277.1298	10.3994	3.1225	1.1332	16.9294	0.2244	2.3566	4.6539
1997	315.9927	278.3480	8.9527	3.1225	0.9544	16.7772	0.1796	2.3633	5.2950
1998	302.8773	269.1272	7.5220	3.1225	0.7654	14.7665	0.2159	2.2782	5.0796
1999	308.4009	272.4720	9.2784	3.5483	1.2410	14.5187	0.1738	2.0255	5.1432
2000	325.2151	290.2354	7.1331	3.5483	0.9481	15.4724	0.1794	2.5855	5.1086
2001	304.6372	273.7797	3.4243	3.6792	1.0439	15.7719	0.1809	2.1356	4.6107
2002	306.2823	272.8375	5.5584	4.0214	1.0318	17.1440	0.1354	0.7637	4.7791
2003	320.3960	284.4207	6.0847	4.0687	0.7962	18.2279	0.1137	1.8181	4.8467
2004*	324.0634	287.7538	6.1256	4.3053	0.9034	17.8472	0.0788	2.1765	4.8533

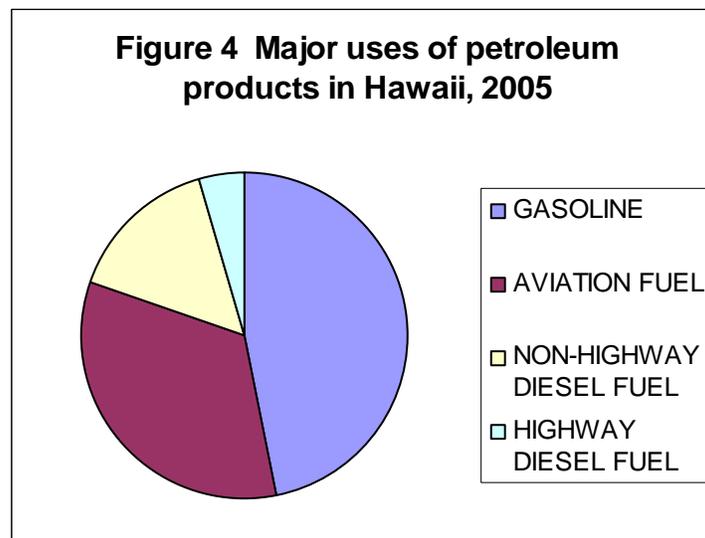
\* Preliminary

Source: DBEDT 2005 Data Book

Of these amounts, a considerable amount of the jet fuel (53%), residual (10%), and diesel (20%) are used either for international transportation or for sale and use by the military forces in the state. In terms of “in-state” use (subtracting out the use for international travel and for the military), petroleum amounts to 84% of total energy use. It is also reasonable to examine total energy use, since most of the military and international travel utilization of petroleum products occurs in the state as well. Using this metric, the total energy use in the state from petroleum utilization is 88%, which is consistent with the value listed for the year 2004 (89%).

Sectoral end use of petroleum products can also be summarized for 1997. Petroleum end use as a percentage of total energy use was as follows: air transportation (32%), electricity (26%), ground transportation (17%), marine transportation (7%), and other uses (6%). It should be noted that these percentage values appear to be inconsistent with values for other, more recent years, such as 2000.

As reported in the State of Hawaii Data Book 2005, the major uses for petroleum (using million gallons as the metric), in descending order, are gasoline (454), aviation fuel (325), non-highway diesel oil (147), and highway diesel oil (43) – see Figure 4 below.



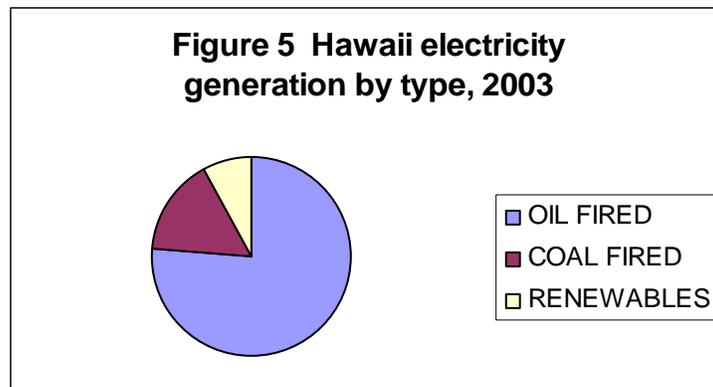
The information in the most recent Data Book that is available appears to be inconsistent with that of the Energy Strategy Report. For example, the Data Book does not provide any breakdowns for petroleum use by the military, for producing residual oil, for international aviation, or for marine transportation (except for small boats). One significant reason for this inconsistency is that the liquid fuel tax base table in the Data Book does not report residual oil because it is not taxed. Thus, the Data Book does not provide the necessary data for expressing sectoral end use of petroleum products as done in the Hawaii Energy Strategy 2000 report. There also appears to be data inconsistencies between some of the tables within the 2005 Data Book. (The lack of reporting of residual oil has been pointed out to DBEDT.)

### 3. Electricity Use

This section will describe the generation capacity within the state on both a statewide and county-by-county basis. These data will be presented as total capacity and capacity by generation type. Lastly, electricity usage will also be presented on a statewide and county-by-county basis.

#### 3.1 Generating Capacity

The statewide electrical generating capacity is over 2300 MW (2003). About 76.4% is oil-fired generation, 15.5% is coal-fired, and approximately 8.1% is derived from renewable energy systems, such as wind, photovoltaic systems, geothermal, municipal solid waste (MSW), biomass combustion, and hydro (see Figure 5 below). While solar hot water heating is not necessarily considered part of the electric generation system, it is listed here as a renewable resource, since the data are presented in this manner and most water heating devices in the state are electric.

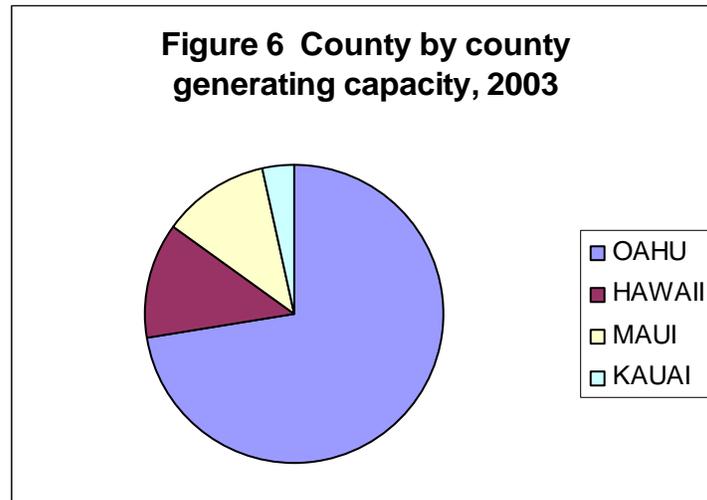


By far the county requiring the most electricity is the City and County of Honolulu (island of Oahu). The capacity for Oahu is 1669 MW-gross. Independent power producers (IPPs) provide 41% of the capacity, while Hawaiian Electric Company (HECO) facilities provide 59%. Of this capacity, 76% is oil-fired generation, 19% is coal-fired, and 5% is from other resources, primarily from the MSW facility.

The county of Maui is served by Maui Electric Company (MECO). MECO facilities are located on three islands that comprise Maui County: Lanai, Molokai, and Maui. There is also one IPP facility on the island of Maui. The total capacity is 267 MW-net. 94% of the capacity belongs to MECO, while 6% belongs to the IPP. Of this capacity, 94% is oil-fired generation and 6% is biomass-fired (bagasse). It should be noted that these values represent the system in 2003. There has recently been the installation and start-up of a 30 MW wind farm by an IPP in 2006.

The county of Hawaii is served by Hawaii Electric Light Company (HELCO). The total capacity for this county is 288 MW-net. Unlike the first two counties, over half of the generating capacity comes from IPPs (64%), while 36% is from HELCO. Of this capacity, 74% is oil-fired generation, 7% is coal-fired, and 19% is from renewable technologies. These include geothermal, wind energy systems, and run-of-the-river hydro. Similar to Maui, since 2003, there has been the installation of a new wind farm rated at 10.56 MW at Hawi and the repowering plus expansion of the South Point wind farm from 7 MW to 20.5 MW.

The county of Kauai is the only county that does not have a utility which is a subsidiary of Hawaiian Electric Industries. Rather, electricity is provided by Kauai Island Utility Cooperative (KIUC). The current capacity is 77 MW. 92% is fired by petroleum-based products (naphtha and diesel) and 8% is fired by renewable energy systems, primarily bagasse. See Figure 6 for the county by county distribution of electricity generating capacity.



The overall trends for reducing dependence on oil as related to electricity generation are not positive. Over the past ten years, there has been little change in the percentage of electricity generated by oil. Some change may be occurring due to the passage of a Renewable Portfolio Standard by Hawaii. As a result, there is now a push to install more wind and biomass-fired facilities, as well as expanding the potential for the use of geothermal resources.

### 3.2. Electricity Use

Electricity use grew faster between 1990 and 1997 than any other form of energy use. Electricity sales were 13% greater in 1997 than for 1990. This reflects an increase in population of 1.1% and an increase in Gross State Product of 3.8%. Electricity sales per capita increased by 11.3%. On a county-by-county basis, MECO sales grew by 32%, HELCO sales by 25%, KIUC grew by 11% and HECO by 9%. It is important to note that the use of electricity is not as inelastic as supposed by planners. For example, increases in the cost of petroleum (a cost passed through to electricity consumers) led to a slight decline in electricity sales during the first six months of 2006. This is in the face of planners' projections of a 3.4% increase over the same period of time.

Energy intensity on a statewide basis has declined over the past thirty years and in 2000 was approximately 80% of the energy use per capita reported in 1970. Electricity use per capita, however, has risen substantially over the same period. By 2000, per capita use of electricity had risen to approximately 150% of the per capita use in 1970.

## 4. Transportation

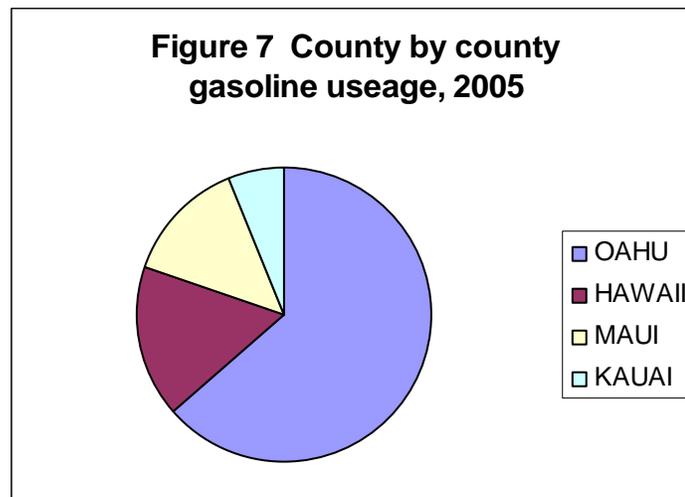
This section is in two parts. The first is gasoline use on a state and on a county-by-county basis. The second part is a review of transportation fuel use for aviation,

shipping, and other surface vehicles (such as construction and road building vehicles) that use diesel fuel. Instead, this will provide a summary of jet fuel, diesel, and bunker fuel use on a state and on a county-by-county basis. It is worth noting that, despite the rhetoric to reduce oil consumption for the state of Hawaii on an overall basis, much of the past focus has been on electricity generation with less analysis on the transportation sector. In recent years, more attention has been given to alternate transportation fuels.

#### 4.1. Gasoline Usage

Gasoline use has grown considerably over the past ten years. In 1983, slightly more than 300 million gallons of gasoline were used in the state. By 2005, that amount had increased to over 450 million gallons, an increase of 50%. Thus, despite concerns on resource availability and price, there has been a considerable increase in transportation fuel needs in the preceding decade.

On a county-by-county basis in 2005, Oahu (Honolulu County) had approximately 64% of the gasoline demand in the state. Gasoline use for the county in 2005 was slightly over 290 million gallons. Hawaii County, owing to the longer driving distances on the island, had a demand of almost 75 million gallons in 2005. Maui County (Lanai, Molokai, and Maui) had a demand of 62 million gallons, while Kauai's gasoline consumption was 28 million gallons in 2005. See Figure 7 for the county by county distribution of gasoline usage.



#### 4.2. Other Petroleum Products for Transportation

Unlike practically all other states in the country, Hawaii has a substantively different usage mix for transportation fuels. In particular, the percentage of fuel used for air travel is significantly greater than that for other states. Similarly, its location in the middle of the Pacific Ocean requires a considerable amount of materials to be shipped in and out of the state via marine transportation. Thus, bunker fuel usage on a state per capita or GSP basis is greater than for most other states, including coastal states.

Total jet fuel consumption was 7.7 million barrels in 2005. As discussed in Section 2.2, this amounted to approximately 30% of the petroleum use in the state. This compares to approximately 10% of petroleum use on a nation-wide basis. This consumption includes jet fuel refined in the state and refined product shipped directly

into the state. Oahu consumed 69% of the jet fuel total, Maui 19%, Hawaii County 8.5%, and Kauai 3.6%. In addition to the mainland and international flights leaving Honolulu, aircraft plying inter-island routes are re-fueled only in Honolulu.

Total diesel use amounted to approximately 4.5 million barrels per year (2005). This is approximately 20% of the total petroleum use in the state. Oahu accounts for 71% of the total diesel fuel usage, Hawaii County 11%, Kauai 11%, and Maui 7%. Approximately 16% of this fuel was being sold to the military (1997).

As described in earlier sections, a considerable amount of refinery capacity is used to produce residual fuel oil. While most of this is utilized for electricity generation, approximately 10% is used as bunker fuel for marine shipping. This is significant in that approximately 25% of petroleum usage in the state is residual fuel oil as compared to the national average of 5%.

A small amount of liquefied petroleum gas (LPG) is used for transportation (some City and County of Honolulu vehicles), but this amounts to less than 0.1% of all petroleum liquids. LPG use in buildings will be discussed in the next section.

## **5. Petroleum Product Usage in Buildings**

This section covers fuels (i.e., LPG and synthetic natural gas -- SNG) that are used in buildings for a variety of purposes, such as water heating, cooking, space heating, and absorption chilling. The total statewide usage of these fuels in 2005 amounted to an equivalent of about 3.1 trillion Btu, with 93% of this total coming from SNG. No county-by-county breakdowns of this total are available. The SNG usage would be equivalent to about 21 million gallons of diesel fuel (using a standard value of 139,000 Btu/gallon of diesel) and this would be equal to just over 2% of all petroleum liquids.

Due to Hawaii's benign climate, these fuel types are used to a much lesser degree as compared to the rest of the country. This is also due to the fact that, since there are no natural gas pipelines as in the continental United States, certain functions that use natural gas on the mainland, such as water heating, frequently use electricity in Hawaii. Further, a considerable number of solar water heating systems have also been deployed in the state. Thus, the percentage of the use of these fuel types is much lower (about 2% of total energy consumption) versus the nation as a whole (over 15%).

## **6. Other Energy-related Activities and Other Products from State-Based Refineries**

The summary of petroleum product usage is not complete unless products that are used for economic activities other than energy systems are included. This section will summarize products and uses not covered in the preceding three sections. Other products are also produced in the state-based refineries that are extremely important to the state's economy. Two of these products are liquid asphalt and lubricants. In fuel-use models employed by the state, two metrics are given for calculating the production of these materials in a manner consistent with that for energy products. The total number of barrels of petroleum used for the production of asphalt and lubricants is almost 450,000 barrels per year. This is slightly less than 1% of overall imports. In a similar manner, calculations done on a Btu basis also show that approximately 1% of the oil usage goes to the production of these materials. While this is a small percentage, closure of the state-based refineries would potentially lead to significant problems in the construction and road-building sectors should these products not be available locally.

## **7. Summary Comments**

The preceding discussions should set the stage for the analyses that follow. Two final comments are important. The numbers presented in the preceding sections represent a compilation from several resources. It should be pointed out that these resources do not necessarily agree with one another in terms of these data. Thus, one of the purposes and goals of this study will be to obtain an improved baseline from which to operate in future analyses.

The second comment is that no attempt was made to value the energy (or non-energy) products as part of this discussion. A substantial amount of literature is available describing the current energy situation in Hawaii in economic terms. One of the purposes of this 355 study and analysis will be to better value the impact of petroleum dependence on the state and the economic consequences of reducing that dependency. Thus, these findings will be discussed in later chapters of the overall report.