

SECTION 5: ELECTRICITY SECTOR ENERGY ANALYSIS

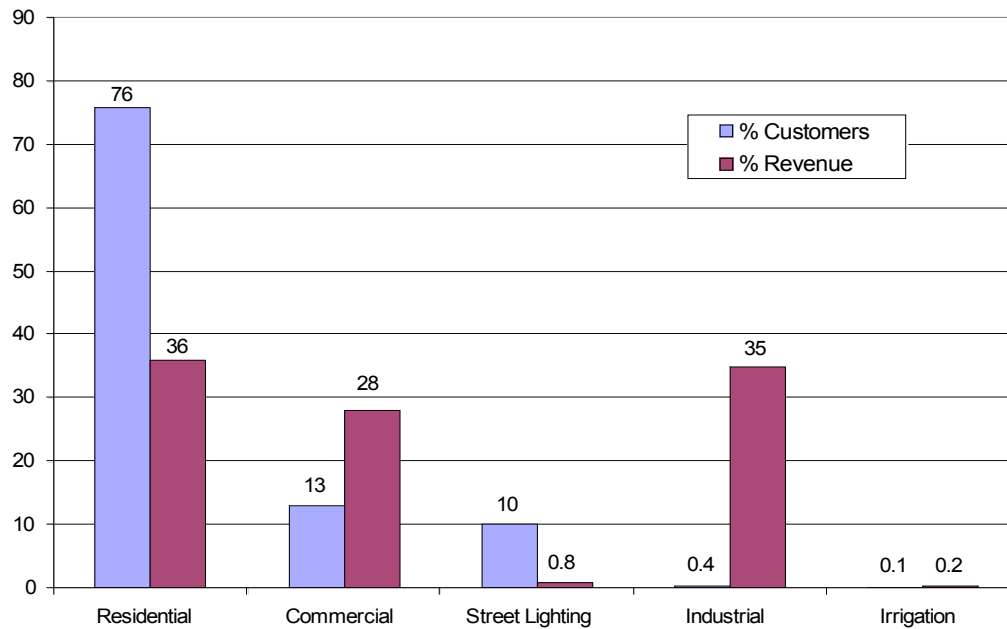
The results of energy analysis of the electricity sector performed in conjunction with community engagement are presented in detail below to add data and a greater understanding of the sector on Kauaʻi. This understanding adds technical merit to the recommendations that are made in following sections.

A. Current Demand Situation

1. Customers

The KESP Energy Analysis Summary primarily uses 2007 data for analysis. The reason for this is that the following year saw extreme price fluctuations in the cost of energy in 2008. At the end of 2007, KIUC had over 35,000 customers divided as shown in Figure 5-1. These percentages did not change from 2006 to 2007.¹

Figure 5-1: KIUC Customer and Revenue Base (2007)



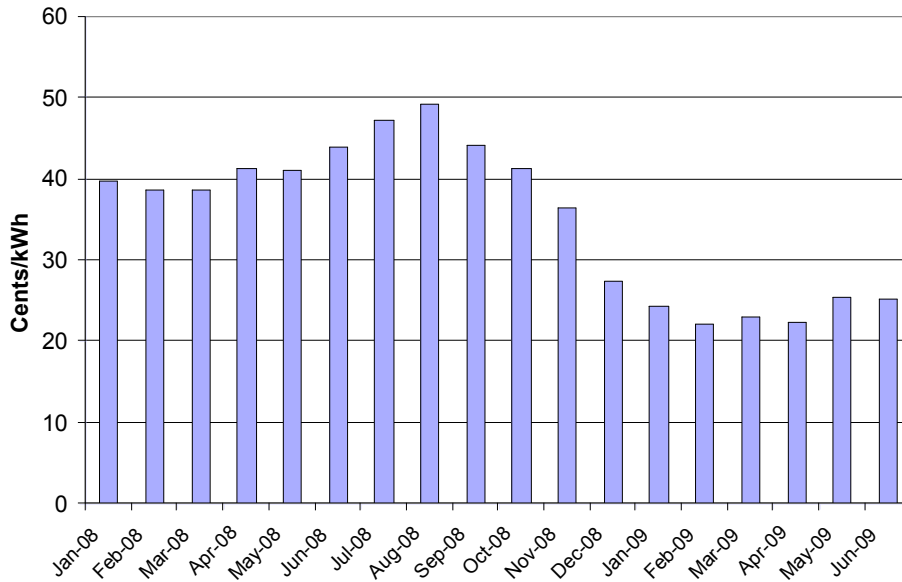
In 2007 the average KIUC residential rate was 35.6 cents/kWh, while that of Hawaiʻi Electric Light Company (HELCO) was 32.8 cents/kWh, Maui Electric Company (MECO) was 28.1

¹ [KIUC] Kauaʻi Island Utility Cooperative (November 2007, Updated October 2008). *Strategic Plan 2008-2023*. Retrieved on 8/3/10 from <http://www.kiuc.coop/pdf/SP2023%202008%20Update%20Approved-2008-10.pdf>.

cents/kWh, and Hawaiian Electric Company (HECO) was 20.5 cents/kWh.² Historical data of KIUC's residential rates from January 2008 to June 2009 is shown in

Figure 5-2.³

Figure 5-2: KIUC Schedule "D" Residential Rates



2. Demand Reduction Opportunities

Codes and Standards

Currently, the County follows ASHRAE 90.1-1999 for commercial buildings. Kaua'i County does not have specific residential energy code requirements; the State requires Honolulu and Maui County to follow Hawai'i Model Energy Code (HMEC), but this code is voluntary in Kaua'i.⁴

Demand-Side Management and Energy Efficiency Programs

KIUC offers a number of demand-side management (DSM) programs to encourage conservation and the use of energy efficient products in the commercial sector. Since 69% of the electricity that KIUC generates is consumed by the commercial rate class, it offers the best opportunity for large scale efficiency impacts and the only opportunity for "cost-effective" DSM. The residential market is served by "energy efficiency programs". These programs differ from DSM as they are

² [HCEI] Hawai'i Clean Energy Initiative (2010). *Hawai'i Renewable Energy Permits and Approvals Guidebooks: Federal and State Approvals for Geothermal*. Page 17. Retrieved on 7/27/10 from http://www.hawaiicleanenergyinitiative.org/pdfs/geothermal_guidebook.pdf.

³ KIUC Website (2009). *Energy Information*. Retrieved on 8/3/10 from <http://www.kiuc.coop/indexenergy.htm>.

⁴ [DSIRE] Database of State Incentives for Renewables & Efficiency Website (June 2009), Retrieved on 8/3/10 from <http://www.dsireusa.org/incentives/index.cfm?re=1&ee=1&spv=0&st=0&srp=1&state=HI>.

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not intended to be resource acquisition programs. They go beyond the scope of DSM by providing energy efficiency opportunities in residential markets for both cost-effective and non cost-effective applications.⁵ In 2007, KIUC achieved 6.0% of net electricity sales through DSM-derived conservation.⁶ This decrease in energy use is due in part to the DSM program hosted by KIUC, which aims to achieve the following five objectives:

1. Reduce energy consumption and peak demand use by encouraging members to adopt the measures included in the programs;
2. Educate members and trade allies about the benefits of energy efficiency;
3. Assist KIUC members in receiving the maximum possible value from the energy dollars they spend;
4. Minimize rate increases by keeping incentive levels as low as possible; and
5. Transform markets over the next five years to increase the availability of energy-efficient equipment.⁷

Current DSM programs at KIUC exist for residential and commercial programs as described in Table 5-1.⁸

Table 5-1: KIUC DSM and Energy Efficiency Program

Sector	Incentive	Description
Commercial	Commercial Energy Efficiency Program	All commercial customers are offered a survey provided by KIUC, which results in a report that identifies energy-saving measures. Financial incentives are available after installing the energy efficient equipment from the report and having a KIUC representative verify that all equipment is operating properly.
	Enhanced Services Program (ESP)	Technical assistance services are offered, including: providing energy cost estimates for proposed new equipment, troubleshooting high energy consumption, training on energy efficient motor principles, providing energy efficiency training to employees, auditing central plan operations and Energy Management System effectiveness, providing load and power quality monitoring, providing energy efficiency implementation plans for large facilities, and more.
Residential	Solar Rebate	Fixed rebate of \$800 for residential customers with existing electric water heaters that convert to solar water heating using a participating contractor.
	Solar Loan	Qualified residential customers are offered a zero interest loan to pay qualified contractors to convert an existing electric water heater to a solar water heater.
	Efficient Appliance Rebate	Residential customers are encouraged to replace less efficient appliances with qualified energy efficient models that have been purchased on Kaua'i. Specific appliances change multiple times per year, while the rebate amounts remain fixed, as described on the KIUC website.

⁵ Ray Mierta (KIUC). Personal Communication with Doug Hinrichs (SENTECH Hawai'i Team). July 16, 2009.

⁶ KIUC (November 2007, Updated October 2008). *Strategic Plan 2008-2023*. Retrieved on 8/3/10 from <http://www.kiuc.coop/pdf/SP2023%202008%20Update%20Approved-2008-10.pdf>.

⁷ Black & Veatch (November, 2008). "Integrated Resource Plan." http://www.kiuc.coop/IRP/Tariff/IRP2008_2008%20KIUC%20IRP.PDF.

⁸ Kaua'i Island Utility Cooperative Website (2009). Retrieved on 8/3/10 from <http://www.kiuc.coop/co-opportunities/>.

B. Projected Demand Situation

1. Customers

There are many ways to project energy demand into the future, including basing projections on historical energy demand rates, on population growth, on limitations to growth based on carrying capacity, to flat-lining for zero net growth.

2. Demand Reduction Opportunities

One of the first steps of Integrated Resource Planning (IRP) development was to construct a load forecast for Kaua'i. The adopted base case forecast was developed using an econometric model in which energy requirements were modeled as a function of Kaua'i population, income, and visitor population. These variables have historically shown a very strong correlation to load growth. The base case forecast predicts that energy requirements will increase at a 2.3% average annual growth rate, rising from 515 GWh of generation in 2009 to 789 GWh in 2028. Peak demand is projected to increase from 82.0 MW in 2009 to 126.0 MW in 2028.⁹

The KIUC IRP system load forecast was developed by LCG Consulting. The model that was provided in 2003 was reviewed and updated in 2008, with both results shown in

⁹ Black & Veatch (November, 2008). *Integrated Resource Plan*. Retrieved on 8/3/10 from http://www.kiuc.coop/IRP/Tariff/IRP2008_2008%20KIUC%20IRP.PDF.

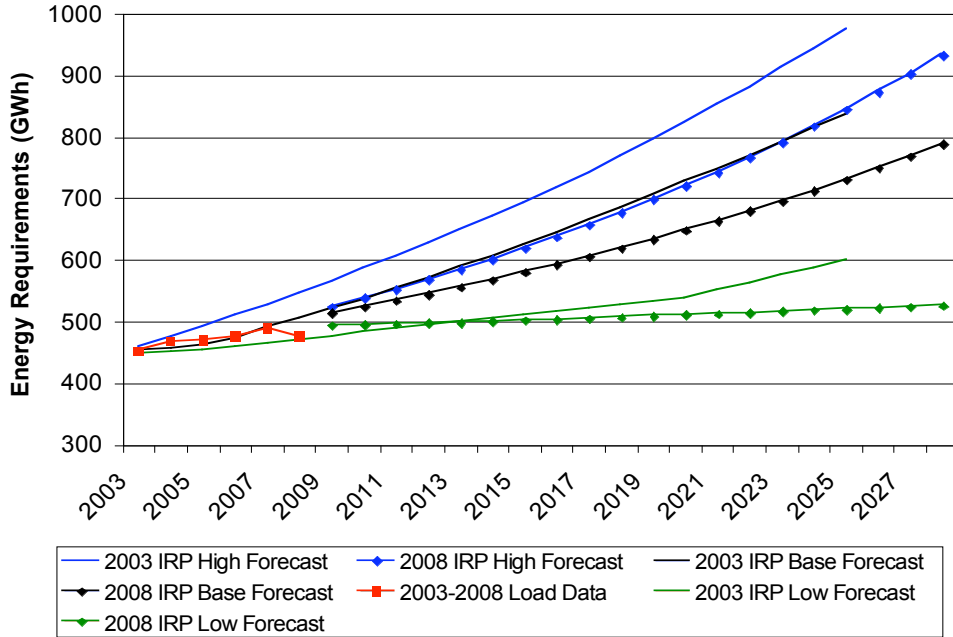
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Figure 5-3. Under the updated base case forecast, total energy requirements were projected to increase at a slower rate than previously forecasted. The updated forecast projects an annual growth rate of 2.3%, from 515 GWh in 2008 to 789 GWh in 2028. Under the high growth scenario, the annual average growth rate (AAGR) for energy requirements was projected to be 3.1%, increasing from 525 GWh in 2009 to 934 GWh in 2028. Under the low growth scenario, the AAGR of energy requirements was projected to be 0.3%, increasing from 495 GWh in 2009 to 527 GWh in 2028.¹⁰

Data for 2008 is now available and shows that a key assumption to the IRP projections, Kaua'i's 2008 energy requirements, is low. The assumption for 2008 energy requirements was 515 GWh, however the actual 2008 KIUC gross generation was 476 GWh, a 2.6% decrease from the 2007 gross generation of 489.2 GWh.¹¹ The significant decrease in Kaua'i's energy requirements will likely affect the IRP forecasted numbers.

¹⁰ Ibid. Page 4-19.

¹¹ KIUC (June 1, 2009). *Annual Fuel Mix Disclosure*. Retrieved on 8/3/10 from <http://www.kiuc.coop/pdf/FuelMix2008.pdf>.

Figure 5-3: IRP Forecast of Total Energy Requirements on the KIUC System

The following tools and approaches can potentially reduce demand.

Technologies and Practices

In order to better understand energy efficiency opportunities and the associated costs and benefits, KIUC commissioned an energy efficiency potential study that was completed by KEMA Inc., a California-based company, in April of 2005. This study assessed the technical, economic, and achievable potential of a wide range of end-use efficiency measures in order to direct KIUC toward immediate program implementation needs, as well as for integration into the 2008 IRP.

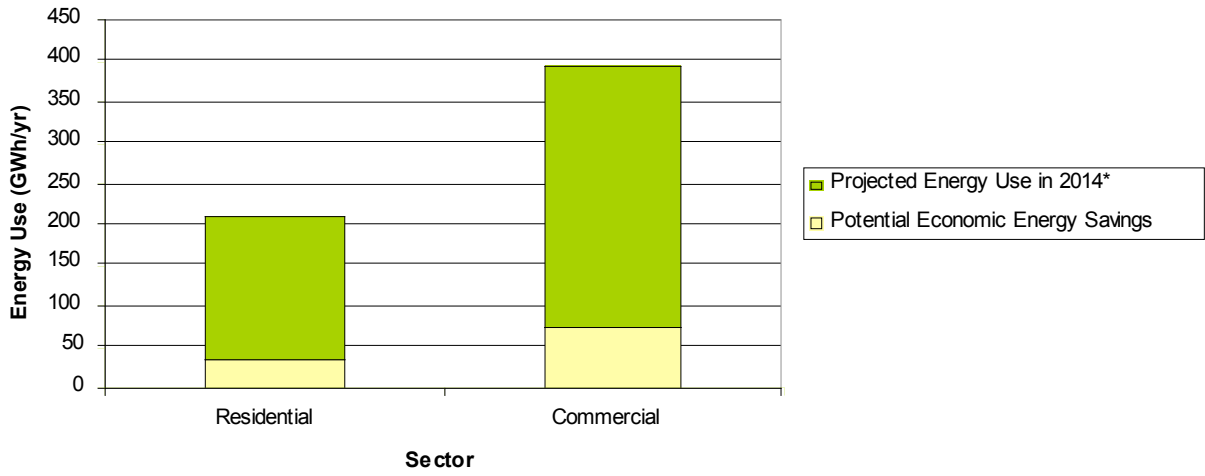
The KEMA report projected that approximately 25% energy savings in the commercial and residential sector was economically viable by 2014.¹²

¹² KEMA, Inc. (April 26, 2005). *Energy Efficiency Potential Study, Final Report prepared for KIUC*. Retrieved on 8/3/10 from <http://www.kiuc.coop/pdf/Kaua`i%20EE%20Report%20Final.pdf>.

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Figure 5-4 shows the potential energy savings (based on the KEMA report) and the projected energy use by 2014 (based on the KIUC IRP base forecast).

Figure 5-4: Projected Energy Use and Savings in 2014 by Sector



*Projected energy use in 2014 is based on the KIUC IRP base forecast.

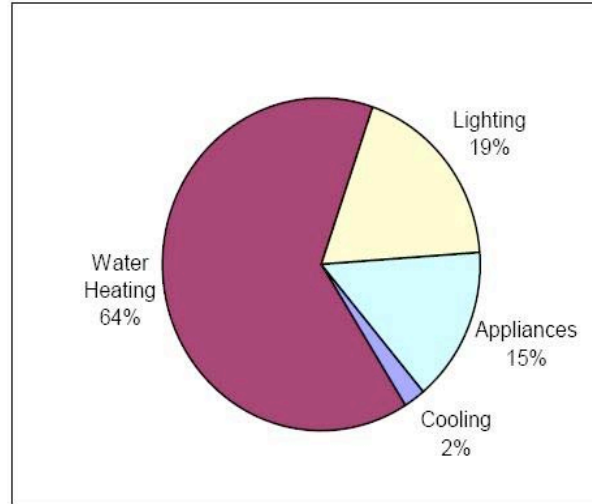
Achieving the energy savings illustrated in

Figure 5-4 is further described in the residential and commercial sections of the report below.

Residential

Figure 5-5, from the KEMA report, breaks down the end uses that offer energy efficiency savings in the residential sector.¹³

Figure 5-5: Residential Economic Energy Savings Potential by End Use (2014)



Residential energy savings potential is most attainable in water heating. The 64% water heating potential shown above can be achieved through solar hot water heating systems and efficient clothes washers. Solar water heating systems include solar collectors, such as flat-plates or evacuated tubes, and often storage tanks. This “low-tech” technology has been proven to be a cost-effective way to heat water for domestic hot water purposes with a very short payback period. There are two types of solar water heating systems: active, which have circulating pumps and controls, and passive, which don't. Solar thermal hot water heating is considered to be an energy offset technology, since it does not produce electricity. Rather, solar thermal systems use the sun's energy to heat water directly, therefore saving energy and reducing utility costs. Anecdotally, Kaua'i has achieved a 33% market penetration of solar water.

According to analysis performed by the National Renewable Energy Laboratory, solar water heating is cost effective at any location in Hawai'i. An estimated 80,000 single family homes, multi-unit dwellings, and institutional facilities in Hawai'i are served by solar water heaters.¹⁴ On Kaua'i, one-third of the single family homes use solar thermal energy to heat domestic hot water. There is still a large technical potential for residential energy savings from solar water heating specific to the island.¹⁵

Lighting efficiency may be improved by replacing incandescent light bulbs with compact florescent light bulbs (CFLs). Replacing older appliances, refrigerators and dishwashers will also

¹³ Ibid.

¹⁴ Department of Business, Economic Development & Tourism Website (2009). Retrieved on 8/3/10 from <http://www.gov/dbedt/>.

¹⁵ Ray Mierta (KIUC). Personal Communication with Doug Hinrichs (SENTECH Hawai'i Team). July 16, 2009.

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have a substantial impact on residential energy use, as the energy savings potential is estimated at 15%, as shown above.

The KEMA study recommended 40 residential DSM measures to be evaluated and developed by KIUC. No new residential DSM measures will be adopted by KIUC, partly due to the lack of market penetration of existing residential programs.¹⁶

Commercial

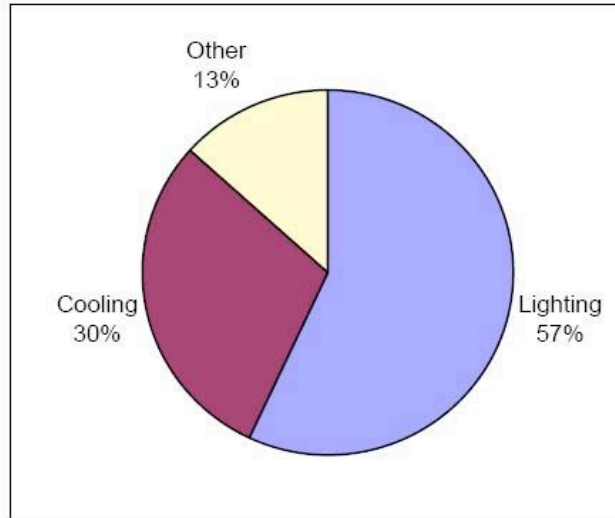
¹⁶ Black & Veatch (November, 2008). *Integrated Resource Plan*. Retrieved on 8/3/10 from http://www.kiuc.coop/IRP/Tariff/IRP2008_2008%20KIUC%20IRP.PDF.

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Figure 5-6 breaks down the end uses that offer energy efficiency savings in the commercial sector.¹⁷

¹⁷ KEMA, Inc. (April 26, 2005). *Energy Efficiency Potential Study, Final Report prepared for KIUC*. Retrieved on 8/3/10 from <http://www.kiuc.coop/pdf/Kauai%20EE%20Report%20Final.pdf>.

Figure 5-6: Commercial Economic Energy Savings Potential by End Use (2014)



The most energy-saving opportunity can be achieved by altering lighting. The KEMA study suggested that the 57% energy savings potential detailed in

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Figure 5-6 can be achieved in part by replacing the standard T-12 florescent lamps with T-8's, where the upgrade has not yet been performed.¹⁸ T-8's have a smaller diameter and provide more lumens per watt than T-12 lamps. Since the release of the KEMA report, third generation T-5 lighting (which has a smaller diameter and is even more efficient than T-8's) is being used in commercial lighting.¹⁹ Additionally, light-emitting diode (LED) lighting is currently available for commercial applications, and holds great promise to revolutionize lighting over the next decade as research increases performance and reduces cost. The lighting energy efficiency potential is also achieved by installing lighting controls such as occupancy sensors that turn lights off when no one is in the room, as well as continuous dimming, which uses photocells to reduce power consumption and light output when daylight is available.

There is a major (30%) potential to reduce energy use in cooling of commercial buildings; this can be accomplished by installing efficient equipment/controls and routinely performing operations and maintenance. There is potential for new technologies, such as absorption chiller air conditioning or desiccant dehumidification. Absorption chillers have been integral parts of cogeneration systems for decades, using recovered heat from onsite engines and turbines to drive chillers. An alternative source of heat is from modern evacuated-tube and concentrating parabolic collectors. The chillers turn the recovered heat into chilled water, which is then used in loop systems to cool down buildings. This load-following, peak-shaving technology suite essentially provides renewable air conditioning for buildings, with only minimal electric use, at the same time that the grid is most vulnerable to congestion and outages on hot afternoons. Another heat-driven technology is desiccant dehumidifiers, which remove humidity from the air being used to cool buildings. Desiccants are used to remove moisture from intake air in advance of a chiller, making the chiller more efficient since it only has to cool down air and not water.

The KEMA study recommended 79 commercial DSM measures to be evaluated and developed by KIUC.²⁰ According to the 2008 IRP, KIUC has a total of 33 commercial DSM measures that will result in a cumulative energy savings of 30,000 MWh and a cumulative peak reduction of 4.34 MW after 20 years of implementation.²¹

Public Buildings Benchmarking

On June 25, 2009, Governor Lingle signed Act 155 into law, which requires every existing public building that is over 5,000 square feet and/or uses more than 8,000 kWh of electricity/year will be benchmarked by the end of calendar year 2010, then retro-commissioned at least once every five years thereafter. Information acquired during benchmarking will influence investments in retrofits and renovations to improve the efficiency of the public building stock, and will often lead to departments entering into energy savings performance contracts to cover the capital costs of energy-efficiency measures and distributed generation.²²

¹⁸ Ibid.

¹⁹ Electrical and Mechanical Services Department (Hong Kong). "Guidelines on Energy Efficient Equipment: T5 Fluorescent Lamps." Retrieved on 8/3/10 from http://www.emsd.gov.hk/emsd/e_download/pee/t5guide.pdf.

²⁰ KEMA, Inc. (April 26, 2005). *Energy Efficiency Potential Study, Final Report prepared for KIUC*. Retrieved on 8/3/10 from <http://www.kiuc.coop/pdf/Kaua`i%20EE%20Report%20Final.pdf>.

²¹ Black & Veatch (November, 2008). *Integrated Resource Plan*. Retrieved on 8/3/10 from http://www.kiuc.coop/IRP/Tariff/IRP2008_2008%20KIUC%20IRP.PDF.

²² Renewable Energy; Energy Efficiency, House Bill 1464 (2009). http://www.capitol.hawaii.gov/session2009/bills/HB1464_CD1_.pdf.

In the summer of 2008, KIUC performed energy audits on 16 County facilities, which resulted in specific recommendations for each building. General suggestions included removing unnecessary lamps and appliances, replacing current lighting with more efficient (T-8) lamps, installing occupancy sensors for lights, and installing window tinting. At this time, it is unknown if the County has instituted the changes recommended by KIUC.

Codes and Standards

Building codes and standards could be passed to ensure that new buildings meet strict energy utilization standards across all sectors. The State is currently in the process of developing a “Tropical Energy Code” which will draw from the Guam Energy Code, and provide customization for the local climate that differentiates Hawai`i from the other U.S. states.²³ In the 2009 State Legislature, the bill creating a state-wide building code modeled after the International Energy Conservation Code (IECC) of 2006 did not pass. However, the state expects to integrate the “Tropical Energy Code” into the International Energy Conservation Code (IECC) of 2006 pending next year’s legislative session. The County of Kaua`i may pass local legislation that adopts the IECC 2009 building codes before the State, as legislation is currently on its way to the County Council. If Kaua`i adopts these changes, the new building energy efficiency standards will remove the more antiquated building codes that Kaua`i currently uses, and result in major energy savings for the County.

While building codes are a mandatory measure that must be followed, builders and architects may volunteer to design and build to minimize environmental impact and energy use while achieving a certification for the building. For example, the U.S. Green Building Council’s *Leadership in Energy and Environmental Design* (LEED) is a third-party certification program that promotes a whole-building approach to sustainability. It does this by recognizing performance in five key areas of human and environmental health: sustainable site development, water savings, energy efficiency, materials selection and indoor environmental quality. This certification is available for residential, commercial, new construction, and existing buildings. The U.S. Green Building Council estimates that green buildings typically save 30-50% on energy use, 35% on carbon emissions, 40% on water use, and 70% on solid waste.²⁴ Honolulu requires new publicly owned buildings to be LEED certified.²⁵ The first LEED –certified building on Kaua`i was the education center at the National Tropical Botanical Gardens in Kalaheo.

C. Current Generation Situation

Electricity generation on Kaua`i is primarily centralized, meaning that the majority of electricity is generated in large facilities and then transmitted long distances to end-users. In contrast, distributed generation generates electricity from small-scale (typically 3 kW up to 10,000 kW) power generation technologies.

Distributed power production is expected to continue to grow through independent power producers (IPPs) as well as residential and commercial consumers that install their own systems.

²³ Department of Energy Website (2009). *Building Energy Codes Program*. Retrieved on 8/3/10 from http://www.energycodes.gov/states/state_info.php?stateAB=HI.

²⁴ U.S. Green Building Council Website (2009). Retrieved on 8/3/10 from <http://www.usgbc.org/>.

²⁵ Slavin, M. (July 8, 2009). *Leading by Example: Hawai`i’s Clean Energy Initiative*. Retrieved on 8/3/10 from <http://www.renewableenergyworld.com/rea/news/article/2009/07/leading-by-example-hawaiiis-clean-energy-initiative?cmpid=WNL-Friday-July10-2009>.

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There are a number of variables that may impact the growth of distributed electricity generation, including legislative policies, changes to KIUC's 1% cap on net-metering, energy prices, the cost of distributed technologies, etc.

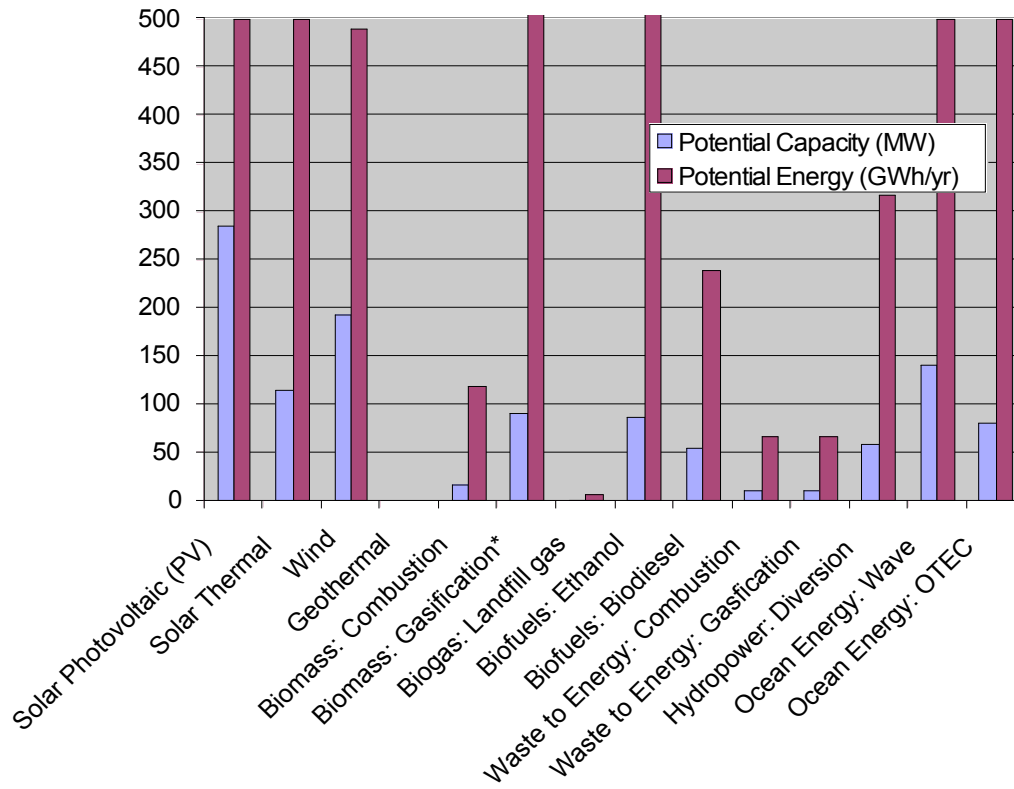
In March of 2005, Black & Veatch completed a "Renewable Energy Technology Assessments" (Renewable Technologies) report for KIUC.²⁶ The report assessed 26 renewable and advanced energy technologies, in the following categories: solid biomass, biogas, biofuels, waste to energy, hydroelectric, ocean energy, solar, wind, geothermal and multi-fuel generation technologies (engines, turbines, and fuel cells). The theoretical potentials of renewable energy resources are shown in

²⁶ Black & Veatch (March 2005). *KIUC Renewable Energy Technology Assessments*. Retrieved on 8/3/10 from <http://www.kiuc.coop/pdf/KIUC%20RE%20Final%20Report%201%20-%20Executive%20Summary.pdf>.

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Figure 5-7.²⁷ These potentials are “theoretical” in that they don’t include any technical, economic, land-use, environmental or other limitations on the resource. For reference, Kaua’i’s current energy requirement is less than 500 GWh/year.

²⁷ Ibid.

Figure 5-7: Theoretical Kaua'i Renewable Energy Resources

It is obvious that Kaua'i has many potential renewable energy resources to meet its energy needs. These include biomass and biofuels, hydroelectric, ocean, solar, waste-to-energy and wind. There are other energy resources that are not currently technically or economically feasible, such as ocean power (wave, current, or tidal), ocean thermal energy conversion, enhanced geothermal systems, etc. These resources will need to be evaluated in the future as their potential becomes better defined over time.

The 2005 Black & Veatch Renewable Technologies report commissioned by KIUC scored 26 renewable energy technologies by 7 criteria, narrowing down their final recommendations to five technologies [municipal solid waste (MSW), hydro, wind, landfill gas (LFG), and biomass]. Summary assumptions, size, and cost results for the five recommended technologies are shown in

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Table 5-2.²⁸

²⁸ Ibid.

Table 5-2: Summary Results from KIUC Renewable Technologies Report

Technology	Assumptions	Size	Capital Cost (\$/kW)	Fixed O&M (\$/kW-yr)	Variable O&M (\$/MWh)	Capacity Factor (%)	Cost of Energy (COE, \$/MWh)
Biomass	Stoker boiler - Direct fired	20 MW	4,556	150	8	80	179.5 - 204.6
MSW	Mass burn Current \$56/ton, future \$90/ton tipping fee	300 tpd	11,343	286	23	70	20.4 - 108.7
Hydro	4 new sites, 2 upgraded sites	Varies	1,200 - 7,200	28 - 102	0	15 - 69	58 - 86
Wind	7 areas studied	2 - 6.6 MW	1,628 - 2,250	39 - 75	1.68 - 1.95	31 - 36	64 - 96
LFG	Kekaha Landfill	0.8 MW	3,965	111	16	86	99

The Renewable Technologies report did not review energy storage technologies (pumped hydro, compressed air, batteries, hydrogen, etc.), which could have significant potential for “firming” renewable energy resources to allow them to fit to KIUC’s (i.e. the electrical grid) needs. Also, the report determined that solar thermal and ocean power were considered “not yet fully commercial.”²⁹ While this remains true for ocean power technologies, solar thermal has advanced steadily in the past few years and could be a very applicable technology for Kaua`i’s current situation. In fact, despite the immaturity of the technology, solar thermal was the sixth technology in line for recommendation within the report, indicating it could have good promise as a resource.

The overall technology screening results are shown in Figure 5-8.³⁰ The screening criteria included: cost of energy (weighted 50%), Kaua`i resource potential (10%), fit to KIUC needs (10%), technology maturity (10%), environmental impact (7.5%), socioeconomic impact (7.5%), and incentives/barriers (5%). The technologies were screened on a 100-point scale, with a higher score indicating the technology scored well on the screening criteria. Geothermal, anaerobic digestion and ocean tidal were all determined to have negligible developable resource potential and were excluded from the detailed analysis. Centralized (large-scale) wind was given a relatively high score of 75 on the environmental screening impacts, and came out as number one on the overall technology screening. Since the report was issued, it has become apparent that centralized wind faces major environmental challenges on Kaua`i due to avian concerns. These environmental challenges may significantly impact the ability of wind to be a near-term renewable energy resource.

Distributed (small-scale) wind was not included in the report. On Kaua`i, a handful of homeowners (anecdotally, around eight) have installed distributed wind energy turbines. It is unclear if these homeowners would be exempt from the same avian conservation fines that could be levied against a utility or large developer, but the SENTECH Hawai`i Team believes

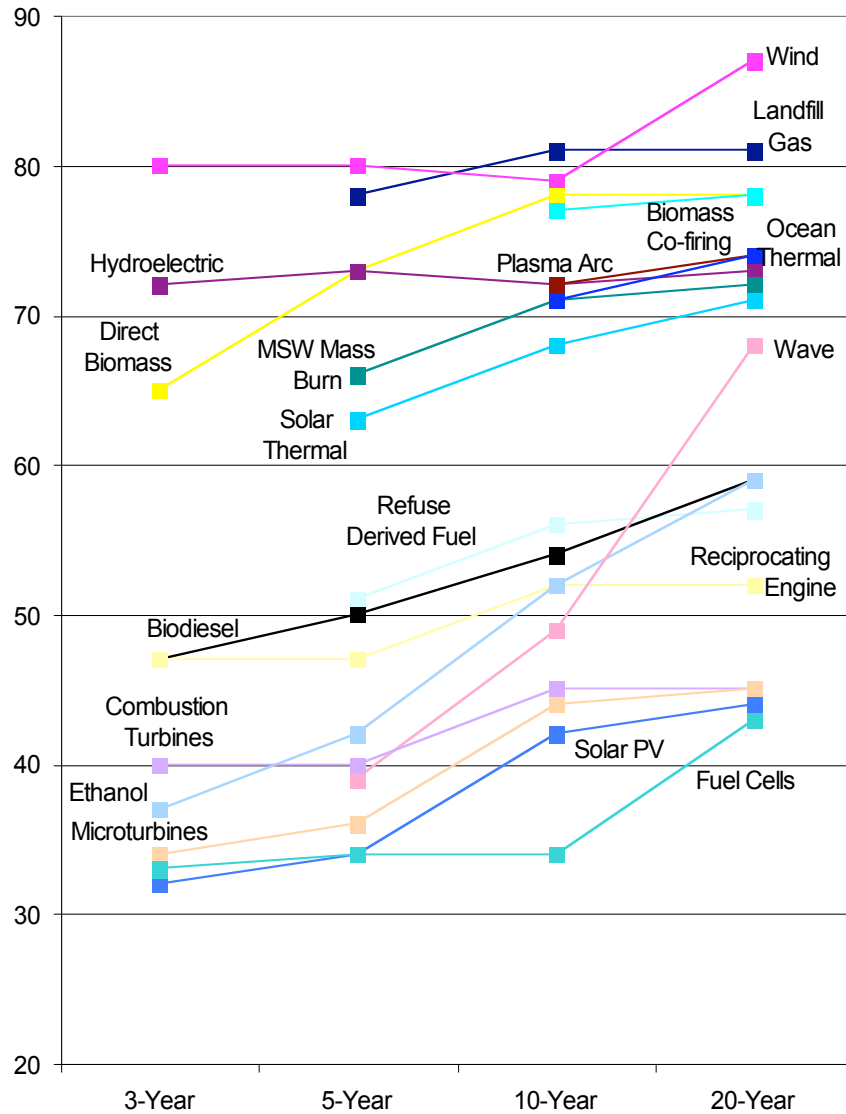
²⁹ Ibid.

³⁰ Ibid.

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homeowners who installed small wind systems would face the same Federal regulations as any large wind developer.³¹

Figure 5-8: Technology Screening Results from KIUC Renewable Technologies Report



The PUC has instructed each state electrical utility to develop an Integrated Resource Plan (IRP). Kaua'i's IRP was written by Black & Veatch and submitted to KIUC on November 17, 2008. The IRP has been rejected by the PUC and will be replaced by a Clean Energy Scenario Plan (CESP), so the 2008 IRP remains a "draft" document.³² The goal of the IRP was the

³¹ According to Paul Conry, State of Hawai'i Department of Fish and Wildlife, in a conversation on October 7, 2009, they are subject to the same rules as large scale developers.

³² Hawai'i Public Utilities Commission (May 2009). *Docket No. 2009-0108 – Instituting a Proceeding to Investigate Proposed Amendments To the Framework for Integrated Resource Planning*. Retrieved on 8/3/10 from <http://puc.hawaii.gov/PUC%20Announcements/Docket%20No.%202009-0108.Opening%20Order.pdf/view>.

identification of resources (or mix of resources) for meeting near-term and long-term customer energy needs in an efficient and reliable manner at the lowest reasonable cost. The CESP framework will revise the previous IRP framework to propose a planning process to develop multiple 20-year planning scenarios. A 5-year Action Plan will also be developed based on the range of resource needs developed in the various planning scenarios. The CESP framework will include the identification of Renewable Energy Zones (REZ) and geographic areas in which resources are of higher value (known as Locational Value Maps).³³

1. Centralized Generation

Fossil

Kaua`i has one electric utility that provides electricity to over 95% of end-users on the island. Kaua`i Island Utility Cooperative (KIUC) is a member-owned cooperative utility, founded in 2002 when ownership of the Kaua`i Electric Division of Citizens Utilities Company was converted to a cooperative from an investor-owned utility.

KIUC currently relies on highly refined oil products (diesel and naphtha) for over 90% of its energy supply. According to testimony before the 2009 Legislature by the Director of the Hawai`i Department of Health, the department encourages the use of naphtha since it is a petroleum-based fuel that has lower sulfur content than other liquid fossil fuels typically used in power generation and is therefore environmentally cleaner.³⁴ In addition, the burning of naphtha emits lower levels of carbon dioxide as compared to distillate or residual fuel oil. The KIUC Kapaia generating station has air pollution control permits which require the burning of naphtha and result in lower stack emissions.

In 2007, KIUC used approximately 15.8 million gallons of naphtha and 18.7 million gallons of diesel.³⁵ A chart showing the 2007 energy usage on Kaua`i is shown below. The percentages are based on the energy content, or Btu's, of the energy (fuel) sources. The 2007 volume and energy content of these fuels are also shown below. "Other" fuels consist of diesel for non-highway and non-KIUC use, small boat fuel and gasoline for agricultural use.

Figure 5-9 shows KIUC's fuel ratios from 2003-2007.³⁶

³³ Hawaiian Electric Company (April 7, 2009). *Vision for Developing the Clean Energy Scenario Planning Framework*. Retrieved on 8/3/10 from

www.heco.com/vcmcontent/CleanEnergy/PDF/CESP_Vision_040709.pdf

³⁴ Senate Committee on Energy and Environment testimony of Chiyome Leinaala Fukino, M.D., Director of Health, February 12, 2009,

http://www.capitol.hawaii.gov/session2009/Testimony/SB447_TESTIMONY_ENE_2-12-09.pdf.

³⁵ Steve Rymsha (KIUC). Personal Communication with Doug Hinrichs (SENTECH Hawai`i Team). July 7th, 2009.

³⁶ KIUC (2009). *Annual Fuel Mix Disclosure: 2003 Through 2007*. Retrieved on 8/3/10 from <http://www.kiuc.coop/pdf/energy/FuelMix2007.pdf>.

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Figure 5-9: KIUC Fuel Mix (2003-2007)



Fuel Mix Generation*	2003	2004	2005	2006	2007
Biomass	1,431,000	1,884,000	2,175,000	1,971,638	1,400,362
Fossil Fuel	427,451,988	430,840,756	430,274,405	436,740,493	461,001,302
Hydro	23,813,993	35,493,318	36,895,645	36,888,298	26,300,465
Photovoltaic	66,000	90,315	202,500	373,000	522,769
Total	452,562,981	468,308,389	469,547,550	475,973,429	489,224,897

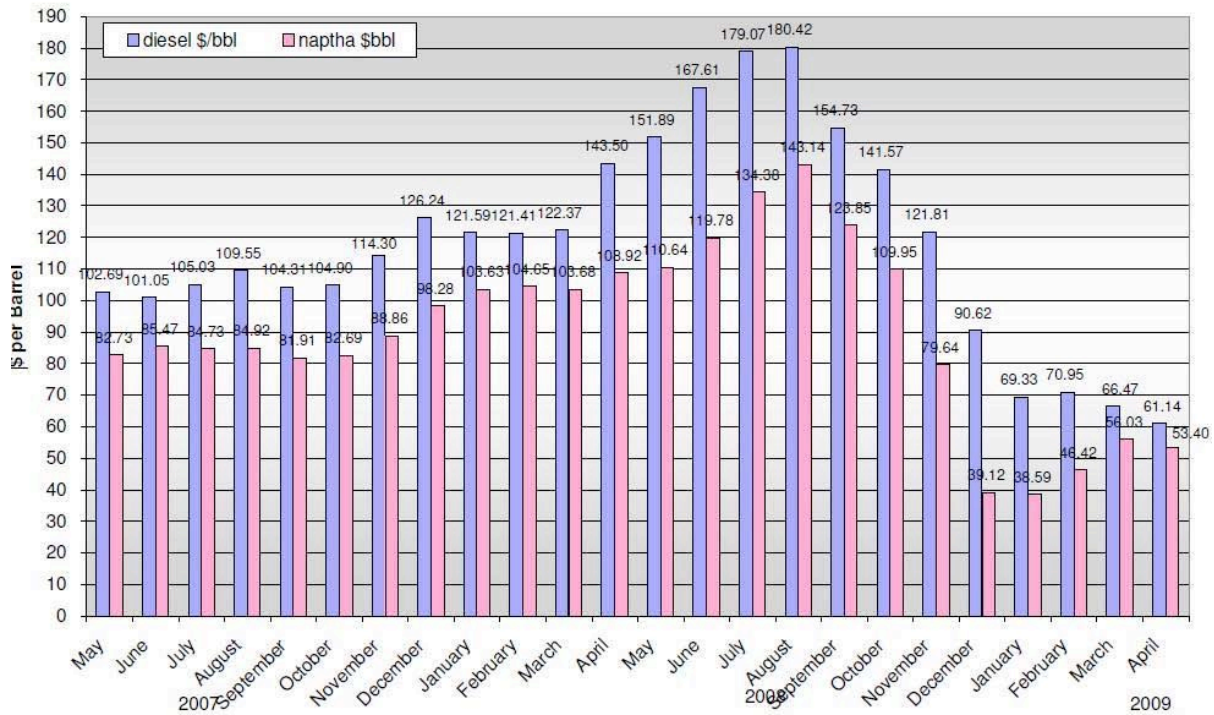
* Gross Generation kWh

Fuel Mix Percentage	2003	2004	2005	2006	2007
Biomass	0.3%	0.4%	0.5%	0.4%	0.3%
Fossil Fuel	94.5%	92.0%	91.6%	91.8%	94.2%
Hydro	5.2%	7.6%	7.9%	7.8%	5.4%
Photovoltaic	0.0%	0.0%	0.0%	0.1%	0.1%
Total	100.0%	100.0%	100.0%	100.0%	100.0%

KIUC is an equal opportunity provider and employer.

The historic rates paid by KIUC for diesel and naphtha are shown in Figure 5-10 below.³⁷

Figure 5-10: KIUC Diesel and Naphtha Prices (2007 to Current)



³⁷ KIUC Website (2009). \$ per barrel. Retrieved on 6/21/09 from <http://www.kiuc.coop/indexenergy.htm>.

SECTION 5: ELECTRICITY SECTOR ENERGY ANALYSIS

KIUC currently operates two fossil fuel power stations, Port Allen (93.75 MW) and Kapaia (27.5 MW), plus two hydroelectric facilities, Upper Waiahi (0.5 MW) and Lower Waiahi (0.8 MW). The maximum generation capability of the KIUC system is 122.55 MW, of which 121.25 MW (all but the hydro units) is considered firm capacity.³⁸ Half of KIUC’s generators were installed over 30 years ago, making them candidates for replacement in the near future. Historically, KIUC has maintained enough firm generating capacity to meet the total peak customer demand with the largest unit out of service, and the morning peak customer demand with the largest and third largest units out of service. The all-time peak demand on the KIUC system is 78 MW, and the largest units are Kapaia’s CT-1 (27.5 MW), Port Allen’s GT-2 (22.6 MW), and Port Allen’s GT-1 (17.5 MW). Plans are currently underway to increase firm generation to ensure adequate supply.³⁹

KIUC recently identified the need to look into a near-term addition of generation capacity due to a projected 2.3% annual increase in energy requirements, rising from 515 GWh of generation in 2009 (projected) to 789 GWh in 2028.⁴⁰ Peak demand is projected to increase from 82.0 MW in 2009 to 126.0 MW in 2028.⁴¹ In addition to increased demand, part of this need is due to reliability issues stemming from the lack of adequate inertia on its system after the Lihue Plantation, with its high inertia steam generator, went out of business. The GenX Option Screening Study provides KIUC with preliminary thermal performance and cost information for seven options to be constructed at the existing Lihue Energy Services Center (LESC) site. The seven options analyzed are shown in Table 5-3.⁴²

Table 5-3: KIUC GenX Options

Option Number	Technology	OEM	Configuration	Total Direct Costs (\$1000)	Total Indirect Costs (\$1000)	Net Plant Output (MW)	Cost (\$1000/kWh)
1	SCCT	GE	LM2500PE STIG 30	45,589	8,935	24	2,247
2	CCCT	Solar	1 x 1 Solar Titan 130	45,830	8,983	17	3,156
3	CCCT	Solar	2 x 1 Solar Titan 130	65,125	12,765	36	2,194
4	CCCT	GE	1 x 1 LM2500PE	65,330	10,779	34	2,244
5	CCCT	GE	1 x 1 LM2000	55,901	9,224	20	3,333
6	CCCT	GE	2 x 1 LM2000	85,879	14,170	40	2,497
7	SCDE	Wärtsilä	18V46 x 2	52,519	10,294	34	1,870
8	CCDE	Wärtsilä	2 x 1 18V46	63,454	12,437	36	2,093

Three options are notable: the 1x1 LM2500, the 1x1 Solar Titan and the 2x1 Solar Titan.

- The 1x1 LM2500 PE option has the lowest busbar (equipment) cost and lowest heat rate among the three.
- The 1x1 and 2x1 Solar Titan options have considerably better grid stability characteristics than the LM 2500, which may outweigh the cost and performance benefits of the LM 2500.

Additional benefits may be discovered that are beyond the busbar cost analysis that was performed for the GenX Option Screening Study. These could include infrastructure requirements, such as availability of transmission or water, or compatibility with forecasted load requirements.

³⁸ Black & Veatch (November, 2008). *Integrated Resource Plan*. Retrieved on 8/3/10 from http://www.kiuc.coop/IRP/Tariff/IRP2008_2008%20KIUC%20IRP.PDF.

³⁹ KIUC (November 2007, Updated October 2008). *Strategic Plan 2008-2023*. Retrieved on 8/3/10 from <http://www.kiuc.coop/pdf/SP2023%202008%20Update%20Approved-2008-10.pdf>

⁴⁰ Black & Veatch (November 2008). *KIUC GenX Option Screening Study Final Report*.

⁴¹ Black & Veatch (November, 2008). *Integrated Resource Plan*. Retrieved on 8/3/10 from http://www.kiuc.coop/IRP/Tariff/IRP2008_2008%20KIUC%20IRP.PDF.

⁴² Black & Veatch (November 2008). *KIUC GenX Option Screening Study Final Report*.

2. Decentralized (or Distributed) Generation

KIUC currently purchases approximately 5% of the total system energy from independent power producers (IPPs), all of which rely on renewable resources and produce energy on an as-available basis. These IPPs are entities that own facilities that generate electric power for sale to utilities and end-users. IPPs may be privately-held facilities, cooperatives such as rural solar or wind energy producers, or non-energy industrial entities capable of feeding excess energy into the system.

Total power producing capacity from customer-generators is capped at 1% of KIUC's peak system demand. KIUC became fully subscribed shortly after the Hawai'i Public Utility Commission (PUC) approved the 1% cap. Due to the speed in achieving the 1% cap, a significant number of customer-generators were waitlisted and offered an energy purchase by KIUC under the Schedule Q Modified Tariff ("Schedule Q"). Schedule Q offers the same physical interconnection opportunities as net metering, but imposes a more significant monthly metering charge. Also, instead of selling electricity back to KIUC for a retail rate, Schedule Q customers receive a wholesale rate. As of November 2008, 203 applications for Schedule Q were received and 17 customers had interconnected to provide a total generation capacity of 152 kW. There are approximately 160 metered systems on Kaua'i, of which about 89% are residential and 11% are commercial systems.⁴³

D. Projected Generation Situation

1. Centralized Generation

Several large-scale (Independent Power Producer or utility-scale) technologies could play a role in achieving Kaua'i's energy sustainability goals, including:

- Biomass and Biofuels
- Hydroelectric
- Concentrating Solar Power and Solar Photovoltaic

Further detail is provided below for each of these technologies..

Biomass and Biofuels

Power from the combustion of biomass is a proven commercial electricity generation option in the United States with about 9,733 MW in 2002 of installed capacity; in 2002 that was the equivalent of about 70% of nonhydroelectric renewable electricity generation, or 1.6% of total U.S. energy supply.⁴⁴ Most of today's biomass power plants are direct-fired systems that are similar to most fossil-fuel fired power plants. The biomass fuel is burned in a boiler to produce high-pressure steam which is introduced into a steam turbine connected to an electricity

⁴³ Black & Veatch (November, 2008). *Integrated Resource Plan*. Retrieved on 8/3/10 from http://www.kiuc.coop/IRP/Tariff/IRP2008_2008%20KIUC%20IRP.PDF.

⁴⁴ [Garman](#), David (April 27, 2004). Testimony of David K. Garman: *Administration's Views on the Role that Renewable Energy Technologies Can Play in Sustainable Electricity Generation*. Retrieved on 8/3/10 from http://www1.eere.energy.gov/office_eere/congressional_test_042704.html.

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generator. Many modern turbines and generators can operate on some biodiesel blend, usually capped at B20, or 20% biodiesel, on the engine side.

Until recently, Kaua`i generated a significant portion of its power from the combustion of bagasse, which is the fibrous residue left over from the processing of sugarcane. However, there is only one remaining sugar plantation on Kaua`i. The output from this remaining plantation is limited to about 8.6 MW, or 1.095 GWh in 2008.^{45,46} This amount of energy is equal to approximately 0.2% of KIUC's total fuel mix generation in 2008. This plant is scheduled to shut down in October 2009, leaving Kaua`i without any operating sugar plantations.⁴⁷ Before the Lihue Plantation sugar mill closed, renewables generated 18% of the total fuel mix generation.⁴⁸ In 2008, the total of all renewable fuels was about 8%.

KIUC currently lists two potential biomass projects. One project is a 90,280 MWh plant owned by PacWest and the second is a gasification plant utilizing Albizia tree chips with Green Energy Hawai`i.

Figure 5-11 is a map indicating Kaua`i's potential for biofuel crops.⁴⁹ Biomass can be used to generate electricity via combustion or converted to biofuels for multiple applications in the ground transportation and electricity sectors.

The State Department of Business, Economic Development, and Tourism (DBEDT) is currently working on a Bioenergy Master Plan, which will set the course for the coordination and implementation of policies and procedures to develop a bioenergy industry in Hawai`i. The draft Master Plan is scheduled to be completed October 15, 2009.

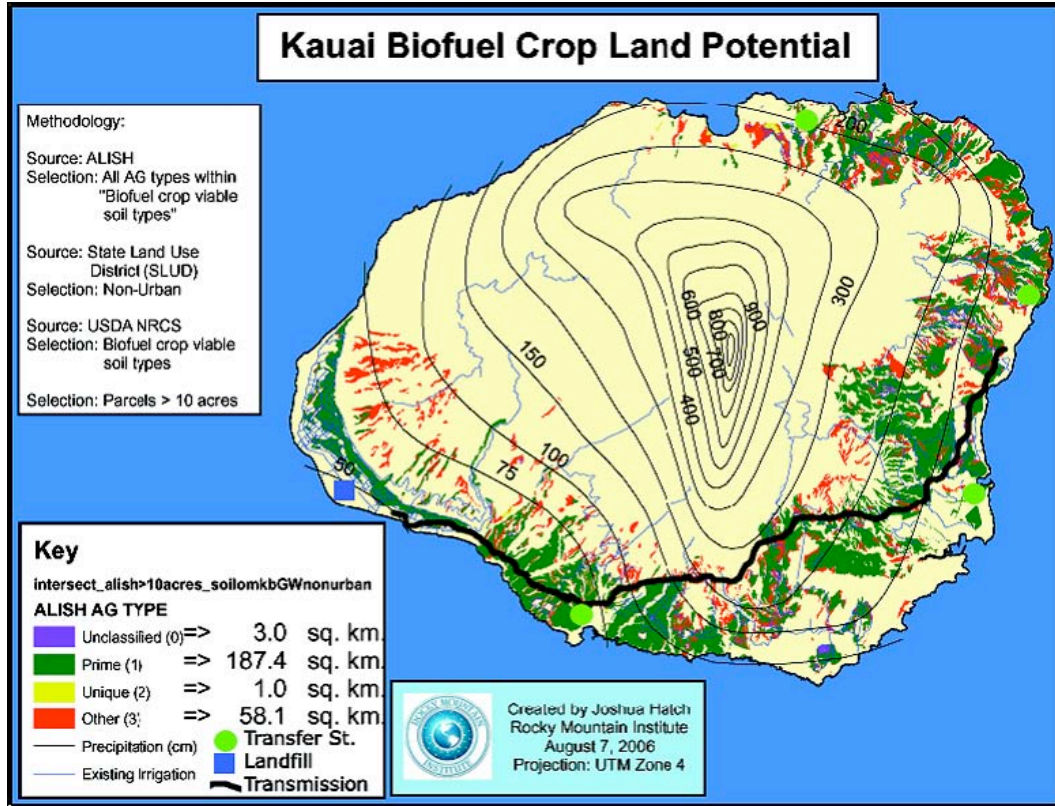
⁴⁵ KIUC, Co-opportunities Energy Services Plus Website (n.d.). *Biomass and Municipal Solid Waste*. Retrieved on 8/3/10 from <http://www.kiuc.coop/co-opportunities/links/plan/biomass.htm>.

⁴⁶ KIUC, Co-opportunities Energy Services Plus Website (n.d.) *Annual Fuel Mix Disclosure, 2003 through 2008*. Retrieved in July 2009 from <http://www.kiuc.coop/pdf/FuelMix2008.pdf>.

⁴⁷ Hawaii News Now (October 30, 2009). *Pictures: Last day of sugar production on Kaua`i*. Retrieved on 8/3/10 from <http://www.hawaiinewsnow.com/Global/story.asp?S=11418530>.

⁴⁸ Kaua`i Planning & Action Alliance (2009). *Measuring What Matters for Kaua`i - Community Indicators Report 2008*. Retrieved on 8/3/10 from <http://www.kauainetwork.org/library/documents/publicationsrep/indicatorsfinalreport2008.pdf>.

⁴⁹ Rocky Mountain Institute (October 26, 2006), draft report, "Biomass- and Biofuels-to-Power."

Figure 5-11: Biofuel Crop Land Potential for Kaua'i

Hydroelectric

There are three types of hydropower facilities: impoundment, diversion, and pumped storage; some hydropower plants use dams and some do not. There are two main types of hydro turbines that convert hydropower to electricity: impulse and reaction. The type of hydropower turbine selected for a project is based on the height of standing water, referred to as "head", and the flow, or volume of water, at the site.

KIUC currently operates two hydroelectric facilities, Upper Waipahu (0.5 MW) and Lower Waipahu (0.8 MW). The 2005 KIUC Renewable Technologies report screened 49 potential project sites and selected 6 sites to recommend (4 new sites and 2 upgrades).⁵⁰ These sites are: 1,800 MWh upgrade to Upper Lihue (Upper Waiahi), 13,666 MWh at Puu Lau Kitano, 21,400 MWh at Waimea Kitano, a 3,900 MWh upgrade at Waimea Mauka, 23,000 MWh at Upper Wainiha, and 16,000 MWh at Wailua Falls.⁵¹ In addition to the 6 sites, KIUC has identified a potential 35,000 MWh project owned by Gay & Robinson located at Olokele Ditch.

⁵⁰ Black & Veatch (March 2005). *KIUC Renewable Energy Technology Assessments*. Retrieved on 8/3/10 from <http://www.kiuc.coop/pdf/KIUC%20RE%20Final%20Report%201%20-%20Executive%20Summary.pdf>.

⁵¹ Ibid.

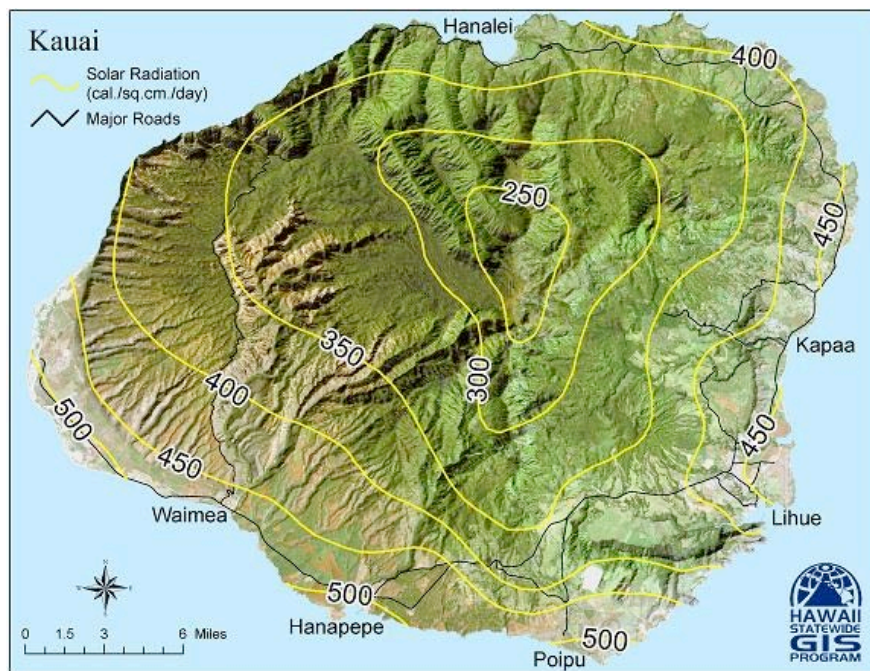
Concentrating Solar Power and Solar PV

Concentrating Solar Power (CSP) technologies use the sun's heat to generate electricity from heat or steam. CSP plants concentrate sunlight onto receivers that collect the solar thermal energy and convert it to heat. The receiver typically contains oil or molten salt as the heat-transfer medium, allowing the thermal energy to be stored for later use. This thermal energy can then be used to produce electricity via a steam turbine, typically in the 20-100 MW range. Solar thermal energy can also drive a smaller-scale Organic Rankine Cycle (ORC) generator, in the 1 - 20 MW range. Arizona Public Service and Solargenix installed a 1-MW solar thermal ORC generator a few years ago; some Hawai'i-based companies are offering similar products in 2009.

KIUC currently lists three potential solar projects, two of which are near-term (anticipated operation dates before 2012). The projects use parabolic trough (CSP) technology with 4 hours of thermal storage or PV technology and would be selected through a RFP process.

Figure 5-12 is a map indicating Kaua'i's potential for solar energy technologies.⁵²

Figure 5-12: Solar Potential for Kaua'i



⁵² Hawai'i Statewide Geographic Information System (GIS) Program (2000). *Solar Radiation Maps, Kaua'i*. Retrieved on 8/3/10 from <http://hawaii.gov/dbedt/gis/miscmaps.htm>.

2. Decentralized (or Distributed) Generation

Photovoltaic

Photovoltaic (PV) devices can be made from various types of semiconductor materials, deposited or arranged in various structures, to produce solar cells that have optimal performance. There are three main types of materials used for solar cells: silicon, polycrystalline thin films, and single-crystalline thin films.

KIUC is working with several developers to bring 5 MW of PV online in 2010.

Small Wind

A handful of homeowners have installed small wind energy systems across Kaua`i. The County Council is currently considering ways to encourage Small Wind Energy Conversion Systems (SWECS). Section 8 of this report is dedicated to the consideration of wind energy systems.

E. Current Energy Delivery Situation

KIUC has 161 miles of 69 kV transmission lines, and 1,226 miles of 12 kV distribution lines. Approximately 237 miles of distribution lines are underground. While under-grounding lines may provide improved aesthetics and resistance to wind and falling trees, they come with higher cost and potential for longer power outages upon failure due to the difficulty in locating and repairing faults.⁵³

KIUC is implementing a hardening plan that will improve service reliability for the island's critical infrastructure. This plan includes under-grounding portions of the distribution circuits.⁵⁴ KIUC has also begun to implement an Advanced Metering Infrastructure (AMI) initiative.

F. Projected Energy Delivery Situation

Transmission reliability is an area of concern for KIUC. Generating capacity is expected to shift from Port Allen to Kapaia and elsewhere. The entire island is served by at least two transmission lines with the exceptions of the far west side [Mana and the Pacific Missile Range Facility (PMRF)] and the north shore (Kilauea to Ha`ena), which rely on one transmission line each. In order to improve reliability for the north shore, KIUC is actively planning to complete a coastal transmission line route from Kapa`a to Princeville that was begun in the early 1990s. Also, future renewable energy projects may be sited at locations that require transmission line upgrades or additions.⁵⁵

Meeting Kaua`i's reliability and sustainable energy goals will depend to a large degree on the interconnection and operational integration of renewable generation to the power grid. Peaking

⁵³ KIUC (November 2007, Updated October 2008). *Strategic Plan 2008-2023*. Retrieved on 8/3/10 from <http://www.kiuc.coop/pdf/SP2023%202008%20Update%20Approved-2008-10.pdf>

⁵⁴ Ibid

⁵⁵ Ibid.

generation that runs only a small number of hours every year, primarily during the summer months, is typically less efficient than most base load power plants. This means that peaking units contribute disproportionately not only to greenhouse gas emissions but to local air pollution because they operate during hot summer afternoons when local air quality can be poor.

Across America, just like on Kaua'i, power grids are increasingly operating at their limit, facing shortcomings in capacity, reliability, security and power quality. Smart investments must occur to replace aging infrastructure and expand capacity where necessary to meet increasing electricity demand. This investment represents a once-in-a-century opportunity to apply new technologies and systems rather than the antiquated designs and technologies of the 1960s and earlier. Throughout the 20th century, the U.S. electric power delivery infrastructure served our nation well, providing adequate, affordable energy to homes, businesses and factories.

New advances in power delivery, communications and information technology have laid the groundwork for a modern grid. Proven effective in lab tests and field trials, these cutting-edge solutions offer dramatic improvements in power quality, service and cost savings. Advanced metering infrastructure (AMI), for example, provides two-way communication between customers and their electric utility, giving utilities detailed information about electrical loads and power outages while giving customers the option to adjust their energy use in response to real-time utility rates. AMI is a necessary underpinning for more sophisticated approaches to demand response. AMI is a step toward "Smart Grid", which is a concept that involves adding internet-like communication technologies and control technologies to the nation's electrical grid. KIUC has begun its AMI initiative.

According to a recent study, analysis of comprehensive smart grid technology applications at 200 of the largest U.S. utilities shows potential smart grid savings of 115,145 MW with avoided costs of more than \$120 billion and net savings after smart grid costs of \$48 billion. This study is the first to apply individual utility customer end-use hourly electric loads to evaluate smart grid costs and benefits. Data for more than 800,000 residential and commercial utility customers in the 200 largest US utilities were applied in the study. The total savings of 115.1 GW, as broken down in Table 5-4 below, represents 20.8% of peak demand.⁵⁶

Table 5-4: Total Smart Grid Savings

Peak Savings (GW)		115.1
Residential Savings	84.8	
Residential Savings	30.3	
Reduction in Peak (%)		20.8
Residential	28.0	
Commercial	12.0	

KIUC could explore the technical and economic feasibility of smart grid/vehicle integration. As discussed earlier in this paper, plug-in hybrid vehicles, or electric vehicles, could be charged at night using the output of off-peak wind or other energy sources.

⁵⁶ Jackson, Jerry (June 24, 2009). *Are Smart Grids a Smart Investment? Hourly Load Analysis of 800,000 Utility Customers at 200 of the Largest US Utilities*. Retrieved on 8/3/10 from <http://ourenergypolicy.org/docs/27/AreSmartGridsASmartInvestments.pdf>.