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Combined Heat and Power Baseline Assessment and Action Plan for the Hawaii Market

Final Project Report

June 30, 2007

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Executive Summary

The purpose of this report is to provide a baseline assessment and action plan for combined heat and power (CHP) in Hawaii and to identify the hurdles that prevent the expanded use of CHP systems. This report has been prepared by the Pacific Region CHP Application Center (PRAC). The PRAC is a United States Department of Energy (DOE) and California Energy Commission[1] sponsored center to provide education and outreach assistance for CHP in the Pacific region of California, Nevada, and Hawaii. The PRAC is operated by the University of California – Berkeley (UCB), the University of California – Irvine (UCI), and San Diego State University (SDSU).

The information presented in this report is intended to provide:

- an overview of the current installed base of CHP systems in Hawaii;
- a summary of the technical and economic status of key CHP system technologies;
- a summary of the utility interconnection and policy environment for CHP in Hawaii;
- an assessment of the remaining market potential for CHP systems in Hawaii;
- an "action plan" to further promote CHP as a strategy for improving energy efficiency and reducing emissions from Hawaii's energy system; and
- an appendix of contacts for key organizations involved in the Hawaii CHP market.

<u>The Hawaii CHP Landscape</u>

Hawaii currently has approximately 500 MW of installed CHP capacity, or 24% of total electricity generating capacity in the state. The Pacific region of California, Hawaii and Nevada has over 9 GW of CHP capacity, most of which is in California. The average capacity of Pacific region CHP installations is 10.7 MW, and 55% of the CHP capacity is in large industrial systems of 50 MW or greater (Hedman, 2006). CHP systems in the western states of California, Hawaii, Nevada, and Arizona are estimated to be saving more than 370 trillion BTUs of fuel and 50 billion tons of CO_2 emissions per year, compared with the conventional generation they have replaced (Hedman, 2006).

Hawaii's electrical services are provided by one investor-owned utility company (known as an "IOU") and one island cooperative. There is currently one provider of electric services on each island that supplies power to the vast majority of homes and businesses. Hawaii Electric Light Company (HELCO) is the provider of electric utility services on the island of Hawaii. Maui Electric Company (MECO) is the provider of electric utility services on the islands of Maui, Lanai, and Molokai. Hawaiian Electric Company (HECO) is the provider of electric utility services on Oahu and is the parent company of MECO and HELCO. Kauai Island Utility Cooperative (KIUC) is the

[1] Hereafter, the California Energy Commission is referred to as "the Energy Commission."

provider of electric utility service on the island of Kauai. The Gas Company provides utility gas services throughout the state of Hawaii.

Technical and Economic Status of Key CHP Technologies

The various types of CHP systems have different capital and maintenance costs, different fuel costs based on fuel type (e.g. natural gas, landfill gas, etc.) and efficiency levels. The main types of CHP system "prime mover" technologies are reciprocating engines, industrial gas turbines, microturbines, and fuel cells. The more efficient systems (in terms of electrical efficiency) tend to have higher capital costs. See Table ES-1 below for a summary of key characteristics of each of the commercially available types of generators. Fuel cell systems are in an early commercial phase at present, with relatively high capital costs and an uncertain "track record" for O&M costs.

Table ES-1: CHP System Characteristics
(From the Combined Heat & Power Resource Guide and adjusted for Hawaii where noted)

Reciprocating IC Engines	**Capacity Range (kW)**	**100 – 500**	**500 – 2,000**
	Electric Generation Efficiency, % of LHV of Fuel	24 – 28	28 – 38+
	Installed Cost, $/kW (with Heat Recovery)	Up to 3,500[a]	Up to 3,000[a]
	O & M Costs, $/kWh	0.025[a]	0.025[a]
Gas Turbines	**Capacity Range (kW)**	**1,000 – 10,000**	**10,000 – 50,000**
	Electric Generation Efficiency, % of LHV of Fuel	24 – 28	31 – 36
	Installed Cost, $/kW (with Heat Recovery)	1,500	1,000
	O & M Costs, $/kWh	0.015	0.012
Micro-turbines	**Capacity Range (kW)**	**100 – 400**	
	Electric Generation Efficiency, % of LHV of Fuel	25 -30	
	Installed Cost, $/kW (with Heat Recovery)	2,000	
	O & M Costs, $/kWh	0.015	

Notes:
[a] Estimate adjusted for Hawaii installations.

Summary and Status of CHP Policy Issues in Hawaii

The policy context for CHP in Hawaii is complex and multi-faceted. Hawaii has simplified interconnection rules for small renewables and other interconnection guidelines that cover all other distributed generation (DG). The state has simplified interconnection rules and allows for net metering of solar, wind, biomass, and hydroelectric unites up to 50 kW. An external disconnect is required. Mutual indemnification requirements exist, but otherwise there are no additional insurance requirements. Rule 14 covers the interconnection of DG systems. An external disconnect is also required for these systems.

Hawaii's largest utility, HECO, has a set of simple interconnection guidelines. Hawaii's other primary utility -- KIUC -- currently has no interconnection standard. A proposed standard is under review by the PUC and intervenors in an open docket 2006-0498. The Public Utility Commission (PUC), created a docket (No. 03-0371) to review and improve the state's DG regulations in 2003. The PUC released its Decision and Order on 03-0371 on January 27, 2006.

Utility rates and standby fees are important and controversial aspects of CHP, and ones that are constantly changing. Recognizing that the current proposed standby costs seem extraordinarily high, the PUC has opened a new docket to study HECO's proposed standby tariff. A separate docket has also been opened on KIUC's tariff. Together these dockets will allow the PUC, the state's "consumer advocate," and all other parties to examine the assumptions and methodologies used to determine these costs and its impact to the deployment of beneficial and economic CHP generation in Hawaii. This is explained in detail in Section 6 of this report.

On May 3, 2007, Hawaii passed House Bill 226 (Thielen) the "Global Warming Solutions Act of 2007." The bill requires the state to identify all sources of greenhouse gases, regulate greenhouse gases as a pollutant, and reduce emissions to 1990 levels by 2020 (and further thereafter). While the details of this legislation have yet to be worked out, the goal of reducing emissions of greenhouse gases may provide an incentive for advancing the CHP market in the state because of the greater energy efficiency and reduced emissions that CHP systems can provide relative to conventional grid power.

<u>The Market Potential of CHP Systems in Hawaii</u>

Hawaii is an exciting and economically attractive market opportunity for CHP. In general, the economic conditions for CHP in Hawaii are aided by high prevailing electricity prices, but hindered by relatively high gas prices. All of Hawaii's natural gas is synthetic natural gas (SNG)[2] derived from naphtha. The SNG is provided through The Gas Company's utility business, which is regulated in its rate offerings by the state PUC. The Gas Company also sells regulated and non-regulated propane to those customers without access to SNG. Propane prices in Hawaii are determined by The Gas Company's procurement costs, and are closely tied to the price of oil that is imported into the state. The Gas Company purchases its propane or "liquefied petroleum gas" (LPG) from two local refineries as well as offshore suppliers. This LPG, along with SNG, is used to meet the needs of their customers. There are no naturally occurring sources of petroleum products or natural gas in Hawaii.

In order to support the adoption of CHP, The Gas Company offers its non-utility and utility propane customers who install CHP dedicated propane gas rates. These rates are

[2] The Gas Company's SNG consists of 80% methane, 10% hydrogen, 5% butane, and 5% carbon dioxide.

specifically designed to assist CHP customers by lowering operating costs and managing pricing risk

Summary of CHP System Financial Assistance Programs

There are limited financial assistance programs available for CHP system installation in Hawaii. These include federal tax programs and CHP project screening services that are available on a limited basis from the PRAC and the U.S. Environmental Protection Agency. These programs are discussed in Section 8 of the main text of this report.

Action Plan for Advancing the CHP Market in Hawaii

The final section of this report presents a series of ideas for further advancing the CHP market in Hawaii. Key recommendations include:

1. Issue HPUC policy directives to reject the proposed tariffs in their entirety and require the utilities to resubmit tariffs that are fair, balanced, and non-discriminatory to both those who do and who do not choose to self-generate their electrical power.
2. Enact legislation that provides relief from regulatory hurdles that add difficulty and cost to developing and interconnecting projects.
3. Institute a more even playing field, that recognizes and incentives the environmental and grid benefits of DG/CHP.
4. Encourage standards, codes, permitting, and zoning rules that are not biased toward central power station generation.
5. Adapt the most successful of the CHP policies from other states to Hawaii's unique market.
6. Examine and consider implementing a research, development, and demonstration (RD&D) program for clean DG/CHP in Hawaii

See Section 9 of the main text of this report for further elaboration of these "action plan" concepts.

Conclusions

Hawaii represents an attractive market opportunity for CHP due to a combination of economic conditions, strong growth in demand for energy services, and energy and environmental concerns. There currently is approximately 500 MW of CHP capacity in the state, although some of this capacity is represented by relatively old projects of which some may no longer be operational.

CHP economics in Hawaii are both island and site specific. On Oahu, projects can be attractive where there is a good use for thermal energy that matches the profile of electrical output. On the other major islands of Hawaii, Maui, and Kauai, economics are more attractive due to the very high cost of electrical power. Efficiently designed projects can easily be attractive on these islands.

The greatest immediate threat to the CHP market in Hawaii is the large increase in standby charges for CHP projects that are being proposed by the major island utilities.

If these charges are implemented, CHP economics will be dramatically affected and may no longer be attractive except possibly in the very best settings. We hope that moving forward, changes in electricity tariff structures are made carefully and fairly, and in ways that do not preclude the important principle of customer choice with regard to the provision of electrical services for commercial and industrial sites in the state.

1. Introduction

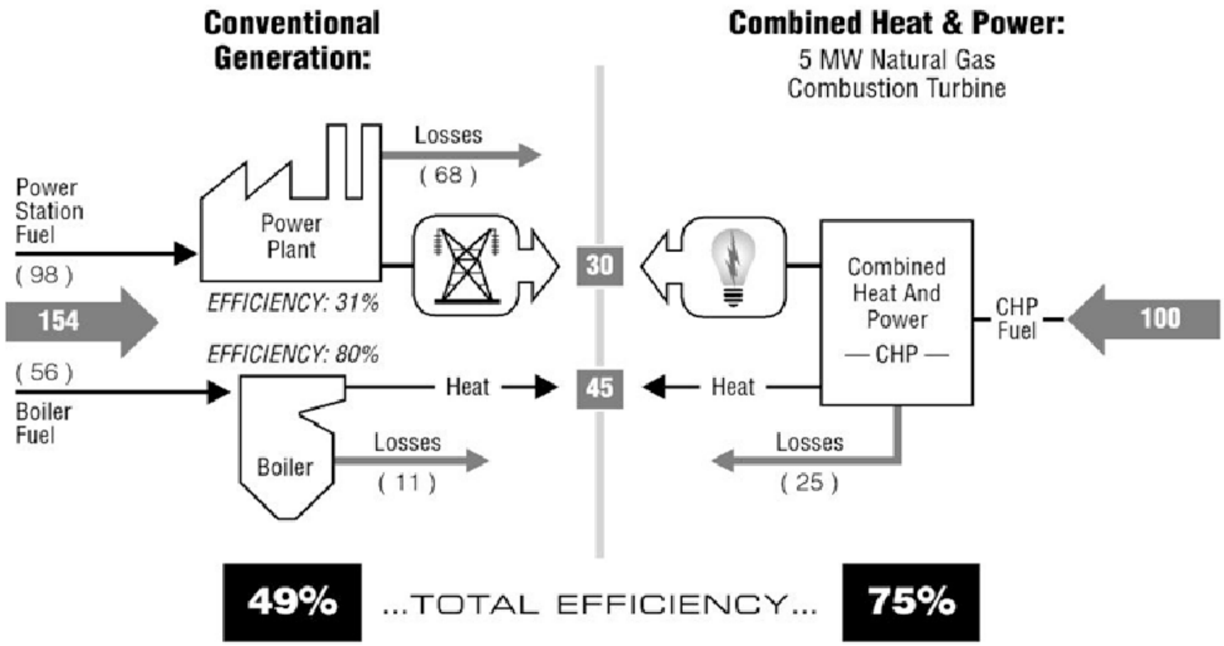
The purpose of this report is to assess the current status of combined heat and power (CHP) in Hawaii and to identify the hurdles that prevent the expanded use of CHP systems. This report has been prepared by the Pacific Region CHP Application Center (PRAC). The PRAC is a United States Department of Energy (DOE) and California Energy Commission sponsored center providing education and outreach assistance for CHP in the Pacific region of California, Nevada, and Hawaii. The PRAC is operated by the University of California – Berkeley (UCB), the University of California – Irvine (UCI), and San Diego State University (SDSU).

The information presented in this report is intended to provide:

- an overview of the current installed base of CHP systems in Hawaii;
- a summary of the economic status and conditions for CHP systems in Hawaii;
- a summary of the utility interconnection and policy environment for CHP in Hawaii;
- an assessment of the remaining market potential for CHP systems in Hawaii;
- an "action plan" to further promote CHP as a strategy for improving energy efficiency and reducing emissions from Hawaii's energy system; and
- an appendix of contacts for key organizations involved in the Pacific Region CHP market.

As a general introduction, CHP is the concept of producing electrical power onsite at industrial, commercial, and residential settings while at the same time capturing and using waste heat from electricity production for beneficial purposes. CHP is a form of distributed generation (DG) that offers the potential for highly efficient use of fuel (much more efficient than current central station power generation) and concomitant reduction of pollutants and greenhouse gases. CHP can also consist of producing electricity from waste heat or a waste fuel from industrial processes.

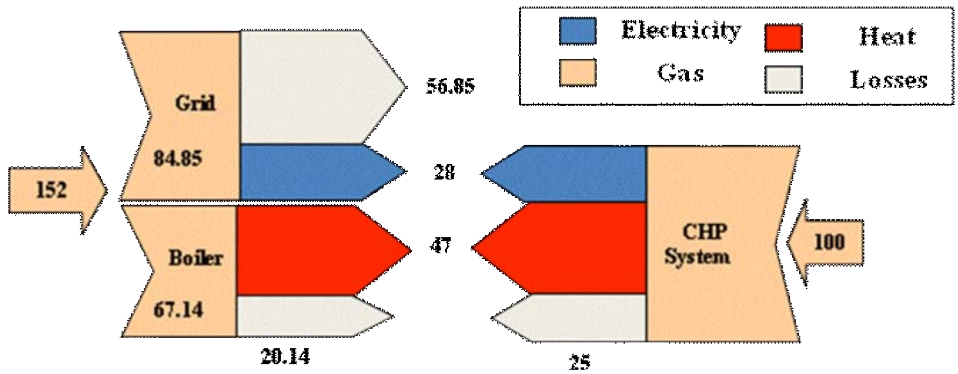
The following figures depict the manner in which CHP systems can provide the same energy services as separate electrical and thermal systems, with significantly less energy input. As shown in Figure 1, to provide 30 units of electricity and 45 units of heat using conventional generation would require energy input of 154 units. A typical CHP system using a 5 MW combustion turbine could provide these same energy services with only 100 units of energy input, thereby saving net energy, cost, and greenhouse gas emissions. Somewhat smaller systems in the 500 kW to 1 MW range, which would be more typical for the Hawaii market, could offer similar energy savings as their energy efficiency ratings would be similar to those of the 5 MW case shown below.



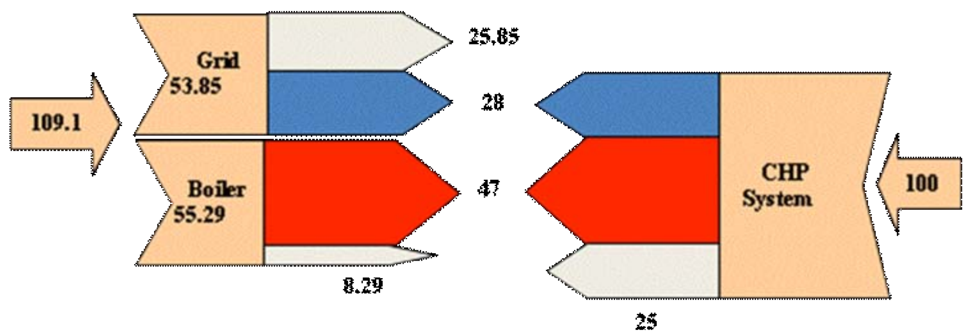
Source: Hedman, 2006

Figure 1: CHP Flow Diagram Based on 5 MW Combustion Turbine (generic energy units)

Figure 2 shows a more generalized depiction of the same concept. Compared with typical conventional generation, a present-day CHP system could provide the same electrical and thermal energy services with approximately two-thirds of the energy input. Even compared with a much advanced and more efficient combination of utility grid power and boiler technology in the future, the CHP system can still compete favorably. And of course the efficiencies of CHP "prime mover" technologies are also expected to improve over time.



Typical Conventional Generation



Advanced Technology for Grid and Boiler Technology

Figure 2: Generic CHP Flow Diagrams Compared with Typical and Advanced Conventional Generating Systems (generic energy units)

In addition to improving energy efficiency by capturing waste heat for thermal energy uses, CHP systems eliminate transmission and distribution (T&D) losses inherent in power produced from conventional centralized generation. These T&D losses are typically in the range of 7-11% of the amount of power delivered (Borbely and Kreider, 2001). CHP systems can also provide important grid "ancillary services" such as local voltage and frequency support and reactive power correction (i.e. "VARs"), and emergency backup power when coupled with additional electrical equipment to allow for power "islands" when the main utility grid fails.

Recognizing the potential of CHP to improve energy efficiency in the U.S., the DOE established a "CHP Challenge" goal of doubling CHP capacity from 46 GW in 1998 to 92 GW by 2010 (U.S. CHPA, 2001). As of 2006, there were an estimated 83 GW of CHP installed at 3,168 sites in the U.S., representing about 9% of total generating capacity in the country (Bautista et al., 2006). This suggests that the nation is generally on track to meet the DOE goal of 92 GW by 2010. However, new capacity additions appear to have slowed in recent years, with less than 2 GW installed in 2005 compared with about 4 GW in 2003 and 2004, and over 6 GW in 2001 (Bautista et al., 2006).

2. Report Purpose

As noted above, the purpose of this report is to assess the current status of combined heat and power (CHP) in Hawaii and to identify the hurdles that prevent the expanded use of CHP systems. The report summarizes the CHP "landscape" in Hawaii, including the current installed base of CHP systems, the potential future CHP market, and the status of key regulatory and policy issues. The report also suggests some key action areas to further expand the market penetration of CHP in Hawaii as an energy efficiency, cost containment, and environmental strategy for the state.

An additional purpose of the report is to alert stakeholders in Hawaii of the creation of the U.S. DOE "regional application centers" (or "RACs") for CHP. The PRAC serves the states of California, Hawaii, and Nevada by:

- providing CHP education and outreach services (e.g. with the PRAC website at http://www.chpcenterpr.org and through conferences and workshops);
- conducting "level 1" CHP project screenings for promising potential projects;
- developing CHP baseline assessment and action plan reports for each state in the region, to be periodically updated and improved; and
- developing example project profile "case studies" for CHP system projects in the Pacific region.

For the Hawaii CHP market specifically, the PRAC would like to work with CHP stakeholders and potential "end-users" in the state to further develop CHP resources for the state. As this report makes clear, Hawaii is a unique state with special conditions and concerns related to its energy sector. The PRAC hopes to work with local groups among the islands to develop energy strategies for Hawaii that are technically and economically sound, and also environmentally and culturally appropriate.

3. The Hawaii CHP Landscape

Key organizations for the Pacific Region CHP market include equipment suppliers and vendors, engineering and design firms, energy service companies, electric and gas utility companies (both "investor owned" and "cooperative"), research organizations, government agencies, and other non-governmental organizations. Appendix A of this report includes a database of contact information for key organizations involved in the CHP market. The organizations listed in the appendix are those that have responded to requests for contact information. As subsequent revisions of this report are made, the PRAC expects the contact database to become more complete and comprehensive.

Hawaii's electrical services are provided by one investor-owned utility company (known as an "IOU") and one island cooperative. There is currently one provider of electric services on each island that supplies power to the majority of homes and businesses. Hawaii Electric Light Company (HELCO) is the provider of electric utility services on the island of Hawaii. Maui Electric Company (MECO) is the provider of electric utility services on the islands of Maui, Lanai, and Molokai. Hawaiian Electric Company (HECO) is the provider of electric utility services on Oahu and is the parent company of MECO and HELCO. Kauai Island Utility Cooperative (KIUC) is the provider of electric utility service on the island of Kauai. The Gas Company provides utility gas services throughout the state of Hawaii.

There are many challenges facing Hawaii's electricity system that may prove to be addressable with CHP, but the most important is the need to diversify sources of generation. The majority of Hawaii's economy is based on military and tourism. This makes electricity reliability critical, and the need to quickly recover from an electrical outage essential.

Historical experience has shown that the most vulnerable part of Hawaii's electric power system is the distribution system, followed by the generation system that also introduces key vulnerabilities. In 1992, Hurricane Iniki devastated the electricity distribution system on the island of Kauai, which slowed their economy's ability to recover from the devastating storm. In 2006, a large earthquake disrupted power on all of the islands. It took nearly 19 hours for power to be restored for all but 2,200 of HECO's 291,000 customers on Oahu (Segal, 2006). Significant facilities, such as Honolulu International Airport, were forced to remain inoperable until electricity was restored. HECO uses diesel generators to start larger steam-generating units that power up the grid in the event of a blackout, a process that can take four to eight hours with the current generators. Additional generating units could save several hours in the first phase of a blackout restoration by bringing an initial increment of power online faster (Segal, 2006).

Table 1: Electricity Generation Fuel Mix Among the Islands (2005 Calendar Year)

Fuel Sources	**HECO (Oahu)**	**HELCO (Hawaii)**	**MECO (Maui, Molokai, and Lanai)**	**All HECO (HECO, HELCO, and MECO)**	**KIUC (Kauai)**
Oil	77.30%	78.10%	92.80%	79.30%	88%
Coal	18.60%		1.60%	14.30%	
Biomass (includes waste-to-energy)	4.10%		4.50%	3.70%	10%
Geothermal		18.10%		2.10%	
Hydro		3.30%	1.20%	0.50%	2%
Wind		0.50%		0.10%	
Total	100%	100%	100%	100%	100%

Sources: DBEDT, 2000; HECO, 2007

Table 1 presents the fuel mix for the major Hawaiian islands by utility service territory, and for HECO as a whole. For HECO, the percentage of fuels used to produce electricity is based on the amount of electricity generated by the HECO family of companies and the amount of purchased from independent power producers in 2005. As shown in the table, the islands are strongly dependent on oil for electricity production, with approximately 80% of the electricity generated from oil. Coal supplies an additional 13-14%, making fossil fuels responsible for over 90% of electricity generation. Geothermal is significant on the Big Island of Hawaii, but only amounts to a few percent of overall generation for the state.

Hawaii's electricity system is unique in that it is made up of six small, isolated electricity systems rather than a vast grid spanning thousands of miles as is common on the mainland. While this setup does have some advantages it also means that line losses are high because of transmission and distribution constraints. Additionally, the price paid by utility customers for electricity has been trending upward in Hawaii, as it has elsewhere. The heavy reliance on imported oil for electricity generation (and for transportation) makes Hawaii's economy highly vulnerable to the fluctuations in the world oil market. In recent years, oil prices have risen significantly due to rising demand, interruptions in supply (e.g. from Iraq), and other factors. The rise in petroleum prices is a major contributor to the rise in electricity costs, since fuel cost adjustments are added to the rate set periodically by the Public Utilities Commission.

Growing demand in Hawaii continues to require additional generation. Since there are no naturally occurring sources of petroleum or natural gas, the state has been forced to continue to import all of its oil and coal, with synthesis gas and LPG produced locally, for the most part, from refineries in the state. This is the primary reason Hawaii has the highest statewide average cost of electricity in the U.S.

Residential customers on Oahu paid $0.09 per kilowatt-hour in 1991, but that price has risen to about $0.20 as of January 1, 2007. Maui residential customers are now paying an effective rate of $0.28/kWh. Customers on the island of Hawaii pay $0.31/kWh, while those on Kauai, Lanai, and Molokai pay about $0.33-.34/kWh. Commercial electricity rates are also comparatively high in Hawaii. The following table shows current commercial and residential rates for the HECO companies, including "blended" rates for customer classes where electricity demand and energy charges are billed separately.

Table 2: Commercial and Residential Electricity Rates for the HECO Companies

Rate Schedule	Average Cents per Kilowatt-Hour				
	HECO	**HELCO**	**MECO (Maui)**	**MECO (Molokai)**	**MECO (Lanai)**
Residential	20.06	31.03	27.67	33.95	32.51
"P" Large power use businesses	15.73	25.64	24.47	29.83	28.80
"J" Medium power use businesses	17.50	28.42	27.16	33.96	34.79
"G" Smaller power use businesses	21.20	36.00	30.23	41.70	35.62
"H" Commercial cooking, heating, air conditioning & refrigeration	17.48	29.35	27.27	31.75	31.67
"F" Street lights (City & State)	18.22	29.44	25.30	32.03	31.14

Source: HECO, 2007a

4. Overview of CHP Installations in Hawaii

The Pacific region has several hundred CHP installations at present, with most located in California and in a wide range of industrial and commercial applications. The latest version of the Energy and Environmental Analysis Inc. (EEA) database of CHP installations in Hawaii shows a total of 30 sites. This total is not exactly correct because some of the older installations in the database may not be currently operational, and because the database is not comprehensive with regard to new installations. PRAC is working with EEA to update the database and improve its accuracy.

Table 3 shows a breakdown of the CHP sites by Pacific region state, along with additional data for the overall electricity generation in each state. Hawaii currently has approximately 500 MW of CHP capacity, compared with over 9 GW in California and 300 MW in Nevada. The average capacity of Pacific region CHP installations is 10.7 MW, and 55% of the CHP capacity is in large industrial systems of 50 MW or greater (Hedman, 2006). CHP systems in the western states of California, Hawaii, Nevada, and Arizona are estimated to be saving more than 370 trillion BTUs of fuel and 50 billion tons of CO_2 emissions per year, compared with the conventional generation they have replaced (Hedman, 2006).

Table 3: Electricity Generating Capacity and CHP Installations in the Pacific Region

	Hawaii	California	Nevada
Retail Customers (1000s)	435	13,623	981
Generating Capacity (MW)	2,267	56,663	6,856
Generation (Million MWh)	12	184	32
Retail Sales (Million MWh)	10	235	29
Active CHP (MW)	544	9,121	321
CHP Share of Total Capacity	24.0%	16.1%	4.7%

Source: Hedman, 2006, based mostly on data from EIA, 2002

Recent CHP installations include a CHP unit at the Grand Wailea Resort Hotel and Spa in Wailea, Maui, which became operational in December 2002. This customer-sited installation has helped the utility and its customers assess CHP as an emerging distributed generation technology. The City and County of Honolulu has been involved with landfill gas-to-energy project in Kailua, although the project has been terminated. Requests for proposals are being developed for two wastewater treatment plants that will include CHP utilizing biogas.

5. Current Economic Status of CHP Systems in Hawaii

The various types of CHP systems have different capital and maintenance costs, different fuel costs based on fuel type (e.g. natural gas, landfill gas, etc.) and efficiency levels. The main types of CHP system "prime mover" technologies are reciprocating engines, industrial gas turbines, microturbines, and fuel cells. The more efficient systems (in terms of electrical efficiency) tend to have higher capital costs. Table 4 below presents key characteristics of reciprocating engines, gas turbines, and microturbines. Fuel cells are an emerging CHP technology with higher capital costs but also higher operational efficiencies and very low emissions.

Table 4: CHP System Characteristics
(From the Combined Heat & Power Resource Guide and adjusted for Hawaii where noted)

Reciprocating IC Engines	**Capacity Range (kW)**	**100 – 500**	**500 – 2,000**
	Electric Generation Efficiency, % of LHV of Fuel	24 – 28	28 – 38+
	Installed Cost, $/kW (with Heat Recovery)	Up to 3,500[a]	Up to 3,000[a]
	O & M Costs, $/kWh	0.025[a]	0.025[a]
Gas Turbines	**Capacity Range (kW)**	**1,000 – 10,000**	**10,000 – 50,000**
	Electric Generation Efficiency, % of LHV of Fuel	24 – 28	31 – 36
	Installed Cost, $/kW (with Heat Recovery)	1,500	1,000
	O & M Costs, $/kWh	0.015	0.012
Micro-turbines	**Capacity Range (kW)**	**100 – 400**	
	Electric Generation Efficiency, % of LHV of Fuel	25 -30	
	Installed Cost, $/kW (with Heat Recovery)	2,000	
	O & M Costs, $/kWh	0.015	

Notes:
[a] Estimate adjusted for Hawaii installations.

Additional CHP system equipment includes electrical controls, switchgear, heat recovery systems, and piping for integration with building heating, ventilation, and air conditioning (HVAC) systems. These systems use waste heat generated by the prime mover directly to provide hot water for commercial buildings and hospitals, assist boilers in producing steam for industrial processes, and/or to drive absorption or adsorption chillers to provide cooling. Piecing these HVAC systems together, however, has high costs associated with buying, shipping, and assembling equipment from a large number of different manufacturers. Hawaii's long distance from mainland manufacturers magnifies this effect in ways not experienced in other states. In order for CHP to become more economically viable, there is a need to integrate HVAC systems with the prime mover to achieve footprint, cost, and reliability advantages over conventional "pieced together" systems.

The early adopters of CHP in Hawaii are in the commercial sector, and especially resort hotels. Commercial buildings have a relatively consistent annual energy use profile associated with the moderate climate in Hawaii, with about a 20% higher energy consumption during the hottest months of July – October (Competitive Energy Insight, Inc. 2004). The relatively low thermal loads for office buildings make at best a marginal economic case for retrofitting a building for CHP, especially on Oahu.

In contrast, the Kauai Marriott CHP system, which will tri-generate electricity, hot water, and cooling, is expected to save the resort about $706,000 per year (PERC, 2006). These cost savings are expected because of three beneficial conditions: more displaceable thermal loads, more electric chiller loads, and higher electricity prices. Resorts have a much higher and more consistent demand for hot water because they have a much higher ratio of showers and washing machines per occupant than typical office buildings. Simultaneously they also have much higher cooling demands than office buildings, which are often sealed much better than resorts.

6. Summary and Status of CHP Policy Issues

Important policy issues for CHP include utility interconnection procedures, utility rate structures including standby charges and exit fees, and economic incentive measures. An overview of these CHP/DG policy areas for the Hawaii market is provided below.

<u>Access and Interconnection Rules (Rule 14)</u>

Distributed generation/interconnection is an evolving, "work in progress" in Hawaii. Hawaii has established both simplified interconnection rules for small renewables and, more recently, separate rules for all other DG. Simplified interconnection and net metering are available for solar, wind, biomass, and hydroelectric systems up to 50 kilowatts (kW) in capacity. This limit was raised from 10 kW to 50 kW in 2005 by SB 1003.

The state's major electric utility, HECO, uses a set of simple "how-to" interconnection guidelines. HECO also uses a simple, two-page net-metering agreement. A manual, lockable disconnect is required for net-metered systems. There are no additional liability-insurance requirements, and a provision for mutual indemnification is included. The state's only other electricity provider, KIUC, has proposed a similar set of interconnection rules. These rules are currently under review by the Hawaii Public Utilities Commission (HPUC).

The interconnection of DG systems in Hawaii is generally governed by Rule 14, which was instituted by HPUC Order No. 19773. This order was issued in 2002 and modified in 2003. Rule 14 includes by reference the utilities' technical interconnection standards (Appendix I), interconnection agreement (Appendix II) and interconnection procedures (Appendix III). The rules cover all DG technologies.

Appendix I of Rule 14 states that a manual disconnect is required for all installations and a dedicated transformer may be required by the utility depending on the short circuit contribution of the DG device. Interconnection with network distribution systems (as opposed to radial systems) is addressed, although it is unclear when additional studies would be needed to address such interconnections.

In October 2003, the HPUC initiated a new proceeding (Docket No. 03-0371) to review and improve the state's DG interconnection rules. The HPUC released its Decision and Order on 03-0371 on January 27, 2006. The decision, numbered 22248, outlines policies for several aspects of distributed power generation in Hawaii. These include conditions under which utilities can participate in DG projects, the role of DG in the state's integrated resource planning process, DG interconnection procedures, and utility rate design including standby charges.

Rates, Standby Charges and Exit Fees

Hawaii PUC Decision and Order No. 22248 states, among other things, that all the parties agree that standby and backup charges should be cost-based. However there was no general agreement on what those costs are, and the record on the subject was not sufficiently developed for the commission to design actual standby rates. Therefore, the PUC requires each utility to establish, by proposed tariff for commission approval, standby rates based on unbundled costs associated with providing each service. In response, the HECO submitted their proposed amendments to Tariff No. 1, which contains the proposed amendments to their existing standby rates and provisions on August 28, 2006. KIUC submitted similar proposed amendments on November 27, 2006.

Unfortunately for the Hawaii CHP market, the proposed tariffs, as currently written, would dramatically raise the costs of operating DG/CHP on the islands. On Kauai, the proposed KIUC rate would raise the standby charge of $5 per kW-month to over $30 per kW-month. Rates proposed by HECO would raise standby charges on all of the islands served by the HECO utilities, including adding standby charges on Oahu and Maui where there currently are no standby charges. If approved, these dramatic rises in standby fees would make most commercial CHP projects in Hawaii all but economically infeasible.

Comparing the demand charges alone from the proposed tariffs on a per kilowatt-hour basis to the existing average rates advertised by HECO on its web site for the same customer classes J and P, no customer could reasonably afford to pay for standby service as proposed and pay its own system costs on self-generation and interconnection. This is because the monthly billing demand charge would be determined by multiplying the applicable rate schedule billing demand rate ($/kW) by the standby "monthly billing demand." The standby "monthly billing demand" would be determined by the lower of either the actual metered demand during the current billing period, or the highest metered demand during the previous 11-month period (if the customer's peak metered demand during the previous 11-month period is greater than the contracted standby demand).

If, however, the customer's peak metered demand during the previous 11-month period is less than or equal to the contracted "standby demand," the standby "monthly billing demand" would be zero. This "demand ratchet" method of determining standby rates is both onerous and punitive to customers who install CHP. Additionally, a six-month reservation demand charge is applied for early termination of the standby contract by a customer. Taken together these provisions are designed to be so punitive that no one would enter such a contract.

Recognizing that the proposed standby costs seem extraordinarily high, the PUC has opened a new docket to study HECO's proposed standby tariff. A separate docket has also been opened on KIUC's tariff. Together these dockets will allow the PUC, the state's "consumer advocate," and all other parties to examine the assumptions and methodologies used to determine these costs and its impact to the deployment of beneficial and economic CHP generation in Hawaii.

Greenhouse Gas Emissions Legislation

On May 3, 2007, Hawaii passed *House Bill 226* (Thielen) the "Global Warming Solutions Act of 2007." The bill requires the state to identify all sources of greenhouse gases, regulate greenhouse gases as a pollutant, and reduce emissions to 1990 levels by 2020 (and further thereafter). The legislation requires the state to establish a task force to prepare a regulatory scheme and work plan "for implementing the maximum practically and technically feasible and cost-effective reductions in greenhouse gas emissions from sources or categories of sources of greenhouse gases to achieve the statewide greenhouse gas emissions limits by 2020" (*HB 226*). Depending on the details of the regulatory scheme that gets developed, this legislation may provide an incentive for advancing the CHP market in the state because of the greater energy efficiency and reduced emissions that CHP systems can provide relative to conventional grid power.

Economic Incentive Policies

Hawaii currently does not have a buy-down incentive or state tax incentive for CHP system installation or operation. The available incentives are those available at the federal level, including the investment tax credit that is currently available for the installation of microturbine systems (see Section 8 below).

7. The Market Potential of CHP Systems in Hawaii

Hawaii is an exciting and economically attractive market opportunity for CHP. In general, the economic conditions for CHP in Hawaii are aided by high prevailing electricity prices, but hindered by relatively high gas prices. All of Hawaii's natural gas is synthetic natural gas (SNG)[3] derived from naphtha. The SNG is provided through The Gas Company's utility business, which is regulated in its rate offerings by the state PUC.

The Gas Company also sells regulated and non-regulated propane to those customers without access to SNG. Propane prices in Hawaii are determined by The Gas Company's procurement costs, and are closely tied to the price of oil that is imported into the state. The Gas Company purchases its propane or "liquefied petroleum gas" (LPG) from two local refineries as well as offshore suppliers. This LPG, along with SNG, is used to meet the needs of their customers. There are no naturally occurring sources of petroleum products or natural gas in Hawaii.

In order to support the adoption of CHP, The Gas Company offers its non-utility and utility propane customers who install CHP dedicated propane gas rates. These rates are specifically designed to assist CHP customers by lowering operating costs and managing pricing risk

The economics of CHP are island and site specific. The economics of "third party ownership" are stronger on outer islands where electricity costs are higher than on Oahu. On Oahu, there is a strong preference for sites with substantial thermal uses. On

[3] The Gas Company's SNG consists of 80% methane, 10% hydrogen, 5% butane, and 5% carbon dioxide.

Maui and the Island of Hawaii, the economics appear to be very attractive subject to system optimization, efficient design, and risk management. On Kauai, the economics appear to be compelling due to the very high costs of electric energy on the island.

In many instances diesel appears to be the most economic fuel for CHP on the outer islands, where SNG is not available. However, this conclusion is subject to the important considerations of transportation, storage, permitting and environmental benefits offered by gaseous/liquefied gas fuels such as SNG or propane, which for many sites may prevail over the fuel cost difference. It is important to note that both diesel and gaseous/liquefied gas fuels can exhibit attractive returns for host, third party, or utility investment in power projects, especially on the outer islands (Competitive Energy Insight Inc., 2004).

The major Hawaii utilities have made projections regarding the potential market penetration of CHP in Hawaii over the period of 2003 through 2012. For the HECO group of companies, over 80 MW of CHP potential were forecast over that ten-year period (Competitive Energy Insight Inc., 2004).

We note, however, that the PUC has recently placed restrictions on utility ownership of CHP, causing HECO to withdraw their ownership program application. This means that HECO will probably only look at ownership on a rare case-by-case basis that meets the PUC guidelines. With these new PUC restrictions, future CHP developments in Hawaii are expected to be performed primarily by non-utility entities. Approximately half of the 80 MW of CHP potential forecast by HECO was in the form of utility-owned projects, suggesting that based on this PUC decision the likely penetration of CHP is likely to be more like 40-50 MW through 2012 under current conditions.

8. Summary of CHP System Financial Assistance Programs

Federal investment tax credits for CHP system installation have been included under various energy policy legislation proposals in recent years. At present, investment tax credits are available for fuel cell and microturbine installations, but not for CHP systems more generally. A broader CHP federal investment tax credit of 10% was proposed under the 2005 Energy Policy Act, but was cut in the final conference meeting at least partly due to a shift in Office of Management and Budget methodology that showed the program to be a net resource consumer instead of a revenue generator. The USCHPA is currently working on a new proposal for a federal CHP investment tax credit, with either a 20 MW or 50 MW cap on qualifying system size.

For energy end-users in Hawaii that are interested in potential CHP projects, both the PRAC and the U.S. EPA offer services to perform initial project screenings to determine CHP system feasibility, optimal system type and size, and potential system economics. The PRAC feasibility studies are conducted by San Diego State University, with a team of experts deployed to the site to collect equipment and energy use data and a year of utility bills. The CogenPro software package is then used to determine optimal system sizing and approximate system economics. Project screenings are offered by the PRAC on either a no-charge or cost-shared basis, depending on the nature of the potential installation.[4]

The U.S. EPA also offers initial CHP project screening services. Interested parties can contact EPA staff, and if qualified, can then fill out a data submittal form that is available on the U.S. EPA CHP Partnership website. They will then receive a report with the findings from the "Level 1" screening analysis.[5]

9. Action Plan for Advancing the CHP Market in Hawaii

The key barrier that the CHP market in Hawaii faces at the present time is the prospect of new and burdensome standby charges that have been recently proposed by the utilities. The rates proposed by the utilities appear to be unjustified by the factual record and will unduly discriminate against customers who install on-site generation relative to other similarly situated customers. These proposed rates are, in our opinion, likely to prevent customers from installing on-site generation where they otherwise might, and in fact to kill some projects that are currently in the pipeline and where significant investments have already been made. We suggest that the Hawaii PUC reject the proposed tariffs in their entirety and require the companies to resubmit tariffs that are fair, balanced, and non-discriminatory to both those who do and who do not choose to self-generate their electrical power.

Potential longer-term barriers to CHP in Hawaii are: 1) regulatory hurdles that add difficulty and cost to developing and interconnecting projects, 2) an "uneven playing field," that does not recognize and incentivize the environmental and grid benefits of DG/CHP, and 3) standards, codes, permitting, and zoning rules that are predominantly based on and biased toward central power station generation. Since utilities make a return on electricity sold, their incentive is to sell more electricity and not to conserve or partially or fully lose customers through customer-sited generation projects. The utilities are also allowed to pass all fuel costs through to the consumer, so the utility has no incentive to invest in hedging practices such as CHP.

Therefore, it is up to policy makers to reduce the asymmetry between the utility and its customers or competitors. States such as California, Connecticut, and New York have reduced this asymmetry by enacting progressive standards, codes, permitting, and zoning practices that set clear guidelines for the utilities to follow with respect to CHP installations. California and New York were among the first states to develop interconnection standards, in the 1990s, and now have well-developed rules to complete interconnection processes in a timely fashion. For example, New York has an 11-step process from "initial communication from the potential applicant" to "final acceptance and utility cost reconciliation" that is helping to standardize and expedite interconnection procedures (New York State Public Service Commission, 2007). California and Connecticut have significant incentive programs for DG, in the form of capital cost "buy-downs" and low-interest loans, that are helping to expand the DG/CHP markets in those states.

[4] For more details on PRAC CHP project feasibility screenings, please visit http://www.chpcenterpr.org or contact Dr. Asfaw Beyene directly at abeyene@rohan.sdsu.edu.
[5] For more details, please visit: http://www.epa.gov/chp/project_resources/tech_assist.htm

Thus, Hawaii does not have to "re-invent the wheel" but rather examine what other states are doing and adapt the most successful of the policies that are also appropriate for Hawaii's unique market. These three states have proven themselves to be pioneers in fostering clean energy and we would like to see Hawaii join their energy leadership with policies and regulations in support of clean DG/CHP.

Our recommendations to advance the CHP market in Hawaii include the following:

<u>1. Issue HPUC policy directives to reject the proposed tariffs in their entirety and require the utilities to resubmit tariffs that are fair, balanced, and non-discriminatory to both those who do and who do not choose to self-generate their electrical power</u>

The dramatic increase in standby charges for DG projects proposed by HECO and KIUC do not appear to be supported by a fair assessment of what these charges should be. It is reasonable to assess reasonable levels of charges for DG projects to make sure that costs are not shifted from customer generators to other customers, as noted in HPUC Order 22248:

> "To ensure that only economic distributed generation projects are developed, and that there is no cost shifting from the customer-generator to other customers or to utility shareholders, utility-incurred costs shall be allocated properly so that those costs that benefit the distributed generation project are borne by the project. This principle is applied to interconnection costs, standby and backup service costs, and unrecovered utility costs, as described above." (HPUC Order 22248)

The standby charges proposed by HECO and KIUC would appear to go well beyond this level, to the point of being discriminatory to DG projects and to customer generators. We therefore recommend that the standby charge proposals be rejected and that the utilities be directed to develop such rates in a transparent manner such that their appropriateness can be carefully studied and verified.

<u>2. Enact legislation that provides relief from regulatory hurdles that add difficulty and cost to developing and interconnecting projects</u>

HPUC Docket 03-0371 did much to advance DG/CHP policy in Hawaii, in terms of broadly outlining important policy areas and issuing general orders to encourage the development of economically beneficial DG projects in the state. However, additional legislation is required to improve the DG interconnection process and to remove remaining regulatory hurdles associated with planning, permitting, and interconnecting DG projects. Streamlined procedures could be developed that would reduce the costs and time required to implement projects, and this would assist the further development of the DG/CHP market in Hawaii.

<u>3. Institute a more even playing field, that recognizes and incentives the environmental and grid benefits of DG/CHP</u>

DG and CHP systems can provide significant environmental and utility grid support benefits. These benefits should be considered in developing fair utility rate and standby chargers for DG projects, as well as potential incentive policies. While the extent of these benefits can by highly variable depending on technology type, the end-use application, and the location within the utility grid, extensive previous research has led to the development of assessment tools and techniques that can evaluate the potential benefits of DG/CHP projects. These findings can then be used as a basis to recognize the actual benefits that individual projects can provide.

4. Encourage standards, codes, permitting, and zoning rules that are not biased toward central power station generation

Despite the progress made for DG development in Hawaii, through HPUC Docket 03-0371 and other developments, various codes, standards, permitting, and zoning rules are still subtly (or not so subtly) biased toward central power generation and away from DG/CHP. We recommend continued action to review these regulations and to systematically make them less biased, so that cost effective DG projects can fairly compete with central generation in meeting the state's growing needs for electrical power and heating/cooling.

5. Adapt the most successful of the CHP policies from other states to Hawaii's unique market

As noted in this report, states such as California, New York, and Connecticut have adopted policies to encourage the development of DG and CHP in ways that recognize the economic and environmental benefits that DG system implementation can provide. We recommend that Hawaii study these other state programs, and consider adopting elements of them that are appropriate for the state, given it's unique energy resource landscape and economic and environmental conditions.

6. Examine and consider implementing a research, development, and demonstration (RD&D) program for clean DG/CHP in Hawaii

Some states, such as California, have active RD&D programs for clean energy technologies to complement RD&D activities at the federal level. Hawaii conducts a limited amount of DG research through DBEDT, and has historically been successful in attracting federal funding particularly for hydrogen and fuel cell research. However the state could consider expanding these activities to develop a more robust and state-focused RD&D program for clean energy technologies. This could be funded through a modest "public goods charge" on energy sales, with funds administered by DBEDT for well-targeted RD&D activities with the ultimate goal of benefiting energy ratepayers in the state through improved energy efficiency, reduced emissions from energy production, and reduced costs of energy services. A state level program would allow Hawaii's specific needs and considerations to be the focus, as opposed to federal programs that are typically more generic and less likely to confer benefits directly to the residents of Hawaii.

10. Conclusions

Hawaii represents an attractive market opportunity for CHP due to a combination of economic conditions, strong growth in demand for energy services, and energy and environmental concerns. There currently is approximately 500 MW of CHP capacity in the state, although some of this capacity is represented by relatively old projects of which some may no longer be operational.

CHP economics in Hawaii are both island and site specific. On Oahu, projects can be attractive where there is a good use for thermal energy that matches the profile of electrical output. On the other major islands of Hawaii, Maui, and Kauai, economics are more attractive due to the very high cost of electrical power. Efficiently designed projects can easily be attractive on these islands.

The greatest immediate threat to the CHP market in Hawaii is the large increase in standby charges for CHP projects that are being proposed by the major island utilities. If these charges are implemented, CHP economics will be dramatically affected and may no longer be attractive except possibly in the very best settings. We hope that moving forward, changes in electricity tariff structures are made carefully and fairly, and in ways that do not preclude the important principle of customer choice with regard to the provision of electrical services for commercial and industrial sites in the state.

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