Table B-1: eGRID 2012 CO2 Emission Factors and Heat Rates by NERC Region and eGRID Subregion (2009 year data)

NERC Region and Subregions	All Generation		All Fossil Average		Non-Baseload	
	Heat Rate (Btu/kWh)	CO2 Emission Factor (lb/MWh)	Heat Rate (Btu/kWh)	CO2 Emission Factor (lb/MWh)	Heat Rate (Btu/kWh)	CO2 Emission Factor (lb/MWh)
Alaska Systems Coordinating Council	8,203	1,126	10,235	1,405	9,820	1,348
ASCC Alaska Grid	9,445	1,281	10,321	1,400	9,740	1,321
ASCC Miscellaneous	3,340	521	9,375	1,463	9,416	1,469
Florida Reliability Coordinating Council	7,708	1,177	8,964	1,366	8,464	1,301
FRCC All	7,708	1,177	8,964	1,366	8,464	1,301
Hawaiian Islands Coordinating Council	9,123	1,527	9,587	1,603	9,508	1,620
HICC Miscellaneous	8,434	1,352	10,242	1,725	9,851	1,616
HICC Oahu	9,383	1,593	9,383	1,567	9,396	1,621
Midwest Reliability Organization	7,940	1,624	10,735	2,231	9,900	2,063
MRO East	8,001	1,592	10,038	2,078	9,152	1,868
MRO West	7,931	1,629	10,853	2,257	10,120	2,115
Northeast Power Coordinating Council	4,771	654	8,746	1,183	8,549	1,210
NPCC Long Island	10,139	1,348	10,139	1,260	10,644	1,337
NPCC New England	5,463	728	8,687	1,137	8,201	1,157
NPCC NYC/Westchester	4,967	611	8,467	1,001	9,278	1,118
NPCC Upstate NY	3,150	498	8,684	1,404	8,246	1,347
Reliability First Corporation	6,964	1,370	9,930	1,963	9,463	1,879
RFC East	5,299	947	9,566	1,688	9,052	1,629
RFC Michigan	8,484	1,659	10,024	2,002	9,134	1,835
RFC West	7,500	1,521	10,038	2,048	9,811	2,002
Southeast Reliability Corporation	6,739	1,247	9,681	1,840	8,859	1,671
SERC Midwest	8,401	1,750	10,364	2,162	10,511	2,193
SERC Mississippi Valley	6,633	1,002	9,174	1,432	7,768	1,202
SERC South	7,316	1,326	9,399	1,776	8,713	1,622
SERC Tennessee Valley	6,916	1,358	10,002	1,988	9,697	1,921
SERC Virginia/Carolina	5,522	1,036	9,687	1,877	8,717	1,677
Southwest Power Pool	9,034	1,668	10,274	1,912	9,130	1,693
SPP North	9,014	1,816	10,997	2,215	10,661	2,148
SPP South	9,043	1,599	9,971	1,784	8,506	1,514
Texas Regional Entity	7,199	1,182	8,758	1,441	7,026	1,155
TRE All	7,199	1,182	8,758	1,441	7,026	1,155
Western Electricity Coordinating Council	5,774	953	9,186	1,541	7,407	1,249
WECC California	5,230	659	8,056	1,043	7,498	994
WECC Northwest	4,505	819	9,651	1,793	7,580	1,405
WECC Rockies	9,567	1,825	10,561	2,018	9,203	1,757
WECC Southwest	6,968	1,191	9,333	1,601	6,907	1,188

B.2 Selecting the Appropriate eGRID Aggregation Level

As explained in Section B.1, eGRID data is aggregated in many ways (e.g., plant, state, EGC, eGRID subregion). However, when selecting the appropriate grid electricity emissions factor (EF_G) and heat rate (HR_G) required by Equations 6 and 7 in Section 3.1.2, the aggregation level should reflect the nature of the electricity supply to the site where the CHP system is located. The Partnership therefore recommends using the eGRID emissions factor and heat rate for the eGRID subregion where the CHP system is located. The Partnership bases this recommendation on the following factors[25]:

- In general, eGRID subregions represent sections of the grid that have similar resource mix and emissions characteristics, operate as an integrated entity, and support most of the demand in the subregion with power generated within the subregion.

- Using the state aggregation level may not be appropriate, because emissions factors and heat rates for this level often omit generation that is imported into the state or generation that is exported to other states, and therefore may less accurately reflect the fuel use and emissions impacts of generation displaced by a specific CHP system than the eGRID subregion aggregation level." The EGC level likely omits an even greater amount of imports and exports than the state level, and, therefore, also may not be appropriate for the same reasons as for the state level.

- Emissions factors and heat rates for the NERC region or U.S. average aggregation levels do not reflect significant regional variations in the emissions from generation, and therefore do not accurately reflect the fuel use and emissions impacts of generation displaced by a specific CHP system.

In summary, in the absence of nationally consistent and complete utility-specific import and export data, the eGRID subregion level heat rates and emissions factors most accurately characterize the generation that is displaced by CHP systems.

B.3 Selecting the Appropriate eGRID Emissions and Heat Rate Category

When selecting the eGRID emissions and heat rate category, it is important to select the category that contains central station generators representative of those that are displaced by CHP systems. At first glance, each of the eGRID categories mentioned above (i.e., total output, fossil fuel output, and non-baseload) may seem like reasonable choices for HR_G in Equation 6 and EF_G in Equation 7 of Section 3.1.2; however the Partnership recommends using the following factors:

- the eGRID fossil fuel output emissions factor and heat rate for the eGRID subregion where the CHP system is located for baseload CHP (i.e., greater than 6,500 annual operating hours), and
- the eGRID non-baseload emissions factor and heat rate for the eGRID subregion where the CHP system is located for CHP systems with relatively low annual capacity factors (i.e., less than 6,500 annual operating hours) and with most generation occurring during periods of high system demand.

This section provides a detailed rationale for this recommendation.

Estimating the energy and emissions displaced by CHP requires an estimate of the nature of generation displaced by the use of power produced by the CHP system. Accurate estimates can be made using a

[25] Rothschild, S. et al., "The Value of eGRID and eGRIDweb to GHG Inventories", http://www.epa.gov/cleanenergy/documents/egridzips/The_Value_of_eGRID_Dec_2009.pdf

power system dispatch model to determine how emissions for generation in a specific eGRID subregion are impacted by the shift in the system demand curve and generation mix resulting from the addition of CHP systems. However, these models are complex and costly to run.

As stated previously, eGRID provides two rates that can be used to estimate the mix of generation that is displaced by the use of clean energy technologies such as CHP: the fossil fuel output rates and the non-baseload output rates. Use of the total output rates is not appropriate since it includes a substantial amount of baseload generation that is not offset by CHP projects.

The following load duration curve analysis demonstrates why CHP typically displaces fossil-fuel fired power generation, and explains appropriate uses of the fossil fuel and non-baseload emissions factors and heat rates.

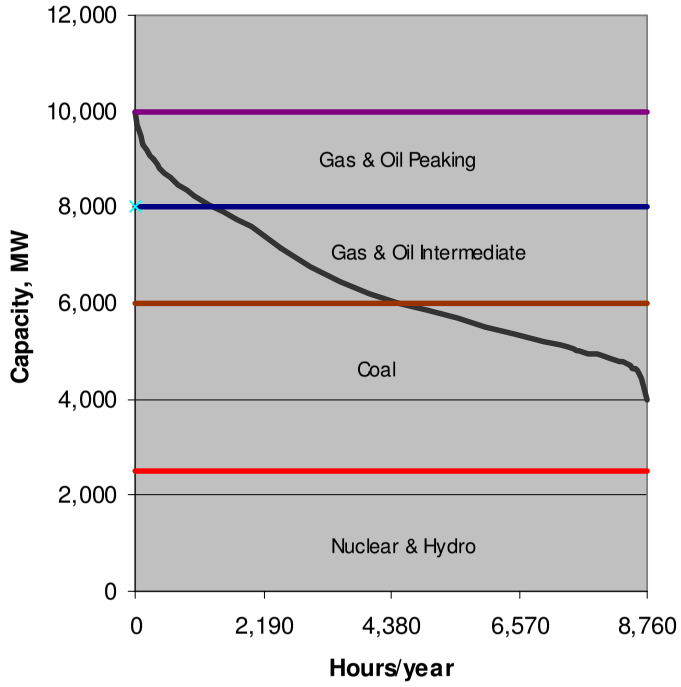
Load Duration Curve Analysis

Using eGRID data, which accurately characterizes the emissions associated with generation in a given region or subregion, a relatively simple load duration curve analysis can be used to show the impact of CHP additions. The load duration curve analysis presented here first introduces a typical load duration curve, and then shows how the addition of CHP affects the resources dispatched.

Demand for electricity varies widely over the year, and different types and sizes of generators are used to meet the varying load as it occurs. A load duration curve represents the electric demand in MW for a specific region or subregion for each of the 8,760 hours in the year.

Figure B-2 below presents a load duration curve for a hypothetical PCA. The shape of the curve is typical of electric load duration curves. Demand in MW is indicated on the vertical axis and the hours of the year are indicated on the horizontal axis. Hourly demand levels are ordered from highest to lowest. In this example, the graph shows that the highest hourly electric demand is 10,000 MW and the demand for the next highest hour is about 9,800 MW. The minimum demand is 4,000 MW, meaning that every hour of the year had at least this much demand. The area under the curve represents the total generation for the year. The zones defined by horizontal lines represent a typical generating mix and dispatch order. In a competitive electric market, the generators are dispatched based on their bid price into the market (typically a function of the variable costs of generation, fuel, other consumable items, and operation and maintenance costs). Generators with low variable costs will be dispatched first, and will therefore operate many hours per year (i.e., serve as baseload generators).

Figure B-2: Hypothetical Power System Load Duration Curve and Dispatch Order



Generators are dispatched in order of operating cost – lowest to highest:

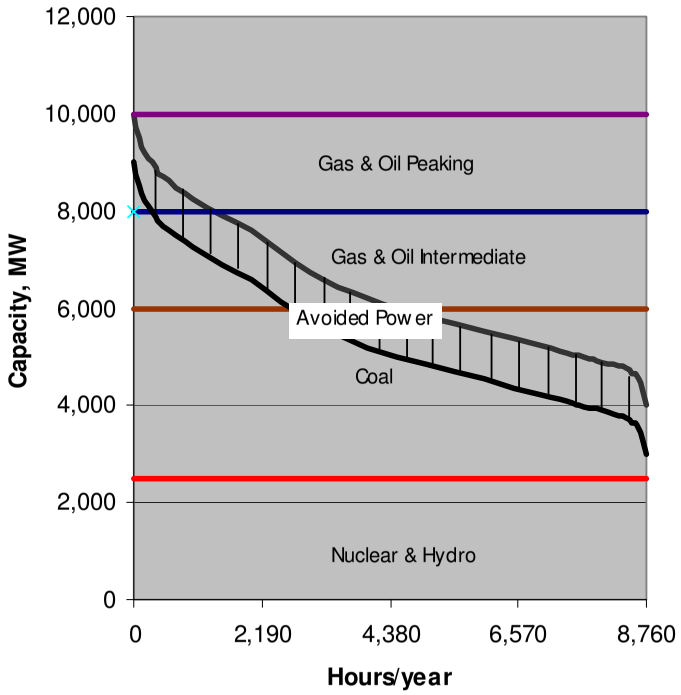
- The lowest-cost generators (nuclear and hydroelectric) operate whenever they are available. This is illustrated in Figure B-2, which shows that these generators operate continuously over the entire year.

- Coal generation is typically the next-lowest operating cost source of power. While coal plants largely serve as baseload plants, there are periods in which coal power must be scaled back or turned off during periods of low demand. This is indicated in Figure B-2 as the area above the curve and below the 'Coal' zone line. Also, some coal capacity—generally older, less efficient systems—are often used as intermediate sources.

- Natural gas and oil-fired systems typically have the highest operating costs, and therefore operate the fewest number of hours. The generators with the very highest operating costs are typically only used to meet peaking loads. Natural gas combined cycle plants have lower costs and are typically used for intermediate loads (and, in some cases, for baseload generation).

Figure B-3 illustrates the effect of baseload CHP capacity that avoids 1,000 MW of central power generation in the aforementioned hypothetical PCA. For simplicity, it is assumed that the CHP system operates for the entire year even though CHP systems may be offline for two or more weeks a year for planned or unplanned maintenance.

Figure B-3: Marginal Displaced Generation due to 1,000 MW of CHP



A review of Figure B-3 indicates the following:

- Because the CHP capacity operates continuously, the load duration curve shifts downward to reflect the 1,000 MW reduction in demand for all hours of the year.

- Compared to the base case (the top curve), the additional CHP capacity displaces an equal amount of generation each hour that it runs, shifting the load curve down while it runs. The CHP system therefore displaces power from the last unit of generation that would have been dispatched in each of these hours.

- Depending on the hour, the displaced generator could be a coal, oil, or gas steam unit, a combined cycle generator, a central station peaking turbine, or a reciprocating engine peaking unit.

- Generators with a lower dispatch order, such as nuclear, hydro, and certain renewables, are unaffected. These resources operate whenever they are available so are unaffected by changes in power demand that result from CHP additions.

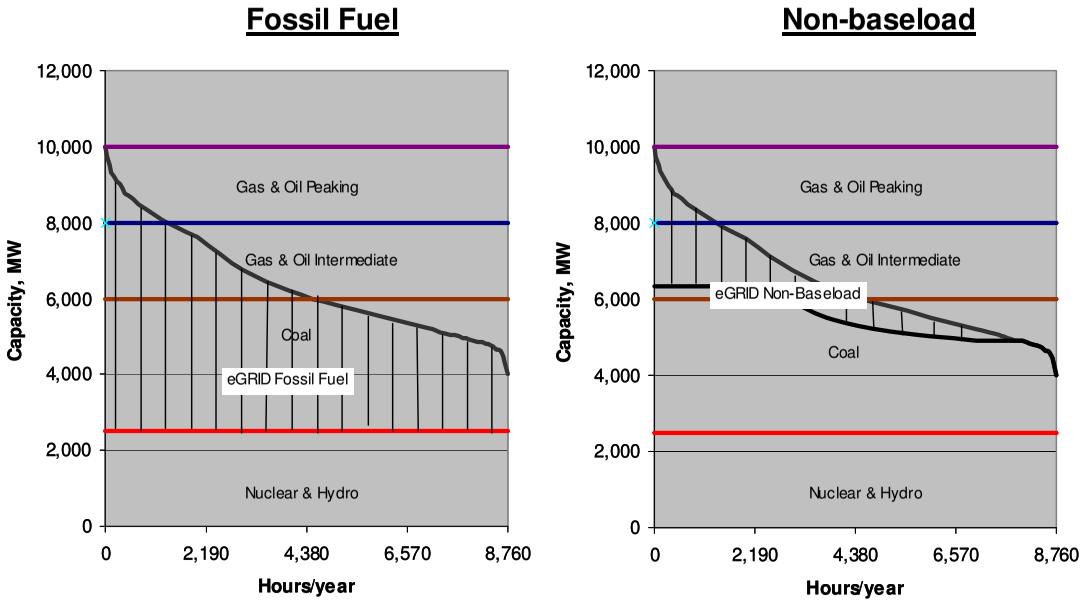
- The generation (and corresponding emissions) displaced with CHP is therefore the fossil plant output represented by the hash-marked area—a mix of mostly baseload and intermediate generation with some peaking generation.

From Figure B-3, we see that CHP additions typically displace fossil fuel-fired power generation. Therefore, the choice of which eGRID emission factor and heat rate to use for fuel and emissions savings calculations depends on whether the CHP system in question operates as a baseload or non-baseload system. As mentioned previously, CHP is mostly a baseload resource since it operates most of the year, so in most cases the eGRID fossil fuel emissions factor and heat rate should be used. For

those CHP systems with relatively low annual capacity factors as well as with most generation occurring during periods of high system demand, the most appropriate estimate of displaced generation is represented by the eGRID non-baseload emission factor and heat rate.

The graphs in Figure B-4 show the eGRID fossil fuel and non-baseload rates mapped onto the hypothetical load duration curve. The difference between the two categories is largely in the amount of coal-fired power that is included. The all fossil category includes a greater share of coal power whereas the non-baseload category does not include coal-fired generators that do not operate during periods of low demand. The eGRID plant data shows that 65.7 percent of the generation in the all fossil average generation is coal-fired while only 47.7 percent of the generation in the non-baseload measure is coal-fired.

Figure B-4: eGRID Fossil Fuel and Non-baseload Rates Mapped onto Hypothetical Load Curve



Note: Non-baseload share cannot be mapped exactly onto the load duration curve. An approximation is shown.

B.5 Conclusion

When calculating the fuel and CO_2 emissions savings associated with CHP, the Partnership recommends using the eGRID emissions factors and heat rates for the eGRID subregion where the CHP system is located. Although not as accurate as a detailed dispatch analysis, a comparison of the displaced generation from baseload CHP (Figure B-3) to the all fossil and non-baseload areas (Figure B-4) suggests that the fossil fuel emission factor and heat rate are reasonable estimates for the calculation of displaced emissions and fuel for a baseload CHP system (i.e., greater than 6,500 annual operating hours). Similarly, for non-baseload CHP systems with relatively low annual capacity factors (i.e., less than 6,500 annual operating hours) and with a relatively high generation contribution during periods of high system demand, the most appropriate estimate of displaced generation is represented by the non-baseload emission factor and heat rate.

ATTACHMENT 6

U.S. ENERGY INFORMATION ADMINISTRATION, STATE ENERGY DATA SYSTEM
TABLE F15: TOTAL PETROLEUM CONSUMPTION ESTIMATE, 2010

Table F15: Total Petroleum Consumption Estimates, 2010

State	Residential	Commercial	Industrial	Transportation	Electric Power	Total	Residential	Commercial	Industrial	Transportation	Electric Power	Total
	Thousand Barrels						Trillion Btu					
Alabama	2,359	1,878	14,361	85,957	215	104,769	9.3	9.6	84.5	463.0	1.3	567.6
Alaska	1,717	2,305	7,095	36,904	795	48,815	9.7	13.0	42.0	207.3	4.8	276.8
Arizona	1,196	1,691	10,061	85,556	117	98,622	4.6	9.1	59.5	459.7	0.7	533.6
Arkansas	1,593	1,133	9,313	52,437	75	64,550	6.1	5.9	52.5	284.7	0.4	349.7
California	8,582	6,891	72,878	562,679	2,242	653,272	33.5	35.5	422.8	3,064.0	13.5	3,569.3
Colorado	3,241	1,580	10,768	76,774	37	92,400	12.5	8.2	58.8	415.0	0.2	494.6
Connecticut	13,292	3,096	2,368	44,243	764	63,762	74.4	16.5	11.9	235.9	4.8	343.4
Delaware	1,634	525	2,783	12,505	104	17,551	7.5	2.5	16.8	66.6	0.6	94.0
Dist. of Col.	219	413	114	2,796	434	3,976	1.3	2.3	0.6	14.8	2.5	21.5
Florida	2,434	6,947	21,620	283,048	16,019	330,068	9.5	35.3	126.7	1,534.4	98.2	1,804.1
Georgia	3,364	2,238	16,173	178,712	212	200,697	13.0	11.1	93.4	972.5	1.2	1,091.3
Hawaii	239	817	3,670	24,144	12,610	41,481	0.9	3.7	21.8	134.0	78.2	238.6
Idaho	1,185	679	5,183	23,762	(s)	30,809	4.9	3.4	31.0	128.7	(s)	168.0
Illinois	6,779	2,266	48,800	178,628	204	236,677	26.3	11.3	264.7	965.7	1.2	1,269.3
Indiana	4,887	1,987	25,693	111,909	256	144,732	19.5	10.0	149.5	607.4	1.5	787.9
Iowa	4,817	3,558	19,315	55,705	317	83,712	18.9	18.0	89.7	301.3	1.9	429.8
Kansas	2,337	815	28,953	44,771	296	77,172	9.0	3.7	135.3	243.2	1.8	393.0
Kentucky	2,881	715	26,543	84,762	4,378	119,281	11.5	3.5	142.8	460.3	26.3	644.3
Louisiana	735	1,281	238,100	115,945	5,621	361,683	2.8	6.9	1,256.4	646.1	33.9	1,946.2
Maine	6,901	3,883	2,845	22,960	413	37,001	37.0	20.4	17.1	124.1	2.6	201.1
Maryland	5,699	3,297	6,700	81,113	650	97,459	29.1	17.5	40.1	434.0	3.9	524.5
Massachusetts	16,808	6,938	3,358	84,328	468	111,900	94.5	39.5	18.4	450.3	2.9	605.7
Michigan	9,911	2,039	13,989	134,118	593	160,650	39.5	10.5	81.4	715.6	3.6	850.6
Minnesota	6,291	2,413	21,940	86,649	64	117,357	26.6	12.4	126.9	467.1	0.4	633.3
Mississippi	2,031	1,197	13,148	62,452	137	78,966	7.8	5.8	77.8	339.8	0.9	432.1
Missouri	4,967	1,558	15,119	105,102	254	126,999	19.2	7.2	83.6	565.7	1.5	677.2
Montana	2,082	437	8,332	19,147	1,154	31,154	8.2	2.0	49.6	104.4	7.0	171.1
Nebraska	2,215	518	6,440	32,117	57	41,348	8.6	2.6	35.8	174.8	0.3	222.1
Nevada	743	576	5,681	38,324	25	45,349	3.1	3.0	33.1	206.8	0.1	246.0
New Hampshire	5,457	2,245	1,964	20,051	116	29,833	27.4	11.5	11.9	106.4	0.7	157.9
New Jersey	7,134	2,718	19,010	172,589	265	201,716	38.6	14.9	114.4	944.1	1.6	1,113.6
New Mexico	1,638	650	11,083	34,881	92	48,344	6.3	3.0	54.8	190.0	0.5	254.6
New York	27,152	21,811	13,944	184,881	3,340	251,128	146.5	127.8	83.4	993.4	20.5	1,371.6
North Carolina	8,404	5,172	14,934	133,787	528	162,825	36.2	25.3	83.1	713.5	3.1	861.2
North Dakota	1,776	735	9,312	16,100	69	27,991	7.3	3.7	52.9	88.2	0.4	152.6
Ohio	7,130	3,824	34,091	174,413	2,481	221,940	31.1	20.1	202.6	941.7	14.8	1,210.3
Oklahoma	2,150	1,302	16,964	71,505	24	91,945	8.3	6.6	100.9	388.3	0.1	504.1
Oregon	1,125	1,181	5,943	57,515	6	65,769	5.3	6.2	34.9	312.6	(s)	359.0
Pennsylvania	21,396	6,333	40,379	173,357	1,143	242,609	113.7	33.3	224.8	934.3	6.8	1,313.0
Rhode Island	3,223	883	1,675	11,678	23	17,483	18.4	5.0	10.4	62.4	0.1	96.3
South Carolina	1,895	1,382	9,413	84,923	281	97,895	7.8	6.6	55.5	457.7	1.7	529.2
South Dakota	1,449	574	3,598	16,383	18	22,022	5.8	2.6	20.7	89.2	0.1	118.5
Tennessee	3,109	1,728	14,404	111,044	397	130,681	12.5	9.2	85.8	599.5	2.3	709.2
Texas	5,357	5,283	721,979	498,447	1,144	1,232,209	20.6	25.9	3,058.0	2,729.9	6.8	5,841.2
Utah	463	831	6,963	40,946	81	49,284	1.8	4.2	40.9	222.9	0.5	270.3
Vermont	3,418	1,510	932	9,804	5	15,670	16.8	7.4	5.3	52.3	(s)	81.8
Virginia	7,099	3,190	9,372	136,294	2,160	158,115	34.4	15.5	55.4	734.1	13.1	852.6
Washington	3,352	2,713	22,324	110,283	37	138,709	14.8	14.5	132.0	604.2	0.2	765.7
West Virginia	1,198	479	7,909	28,103	271	37,961	5.3	2.3	46.8	151.4	1.6	207.4
Wisconsin	7,399	1,633	12,412	81,928	1,080	104,452	30.7	7.7	72.5	440.0	6.5	557.4
Wyoming	897	910	9,538	18,510	104	29,959	3.5	4.4	56.2	102.9	0.6	167.6
United States	243,362	130,756	1,649,483	4,914,968	62,178	7,000,747	1,141.9	688.1	8,227.4	26,646.1	378.3	37,081.7

Where shown, (s) = Physical unit value less than 0.5, or Btu value less than 0.05.
Notes: Total petroleum includes fuel ethanol blended into motor gasoline. • Totals may not equal sum of components due to independent rounding.

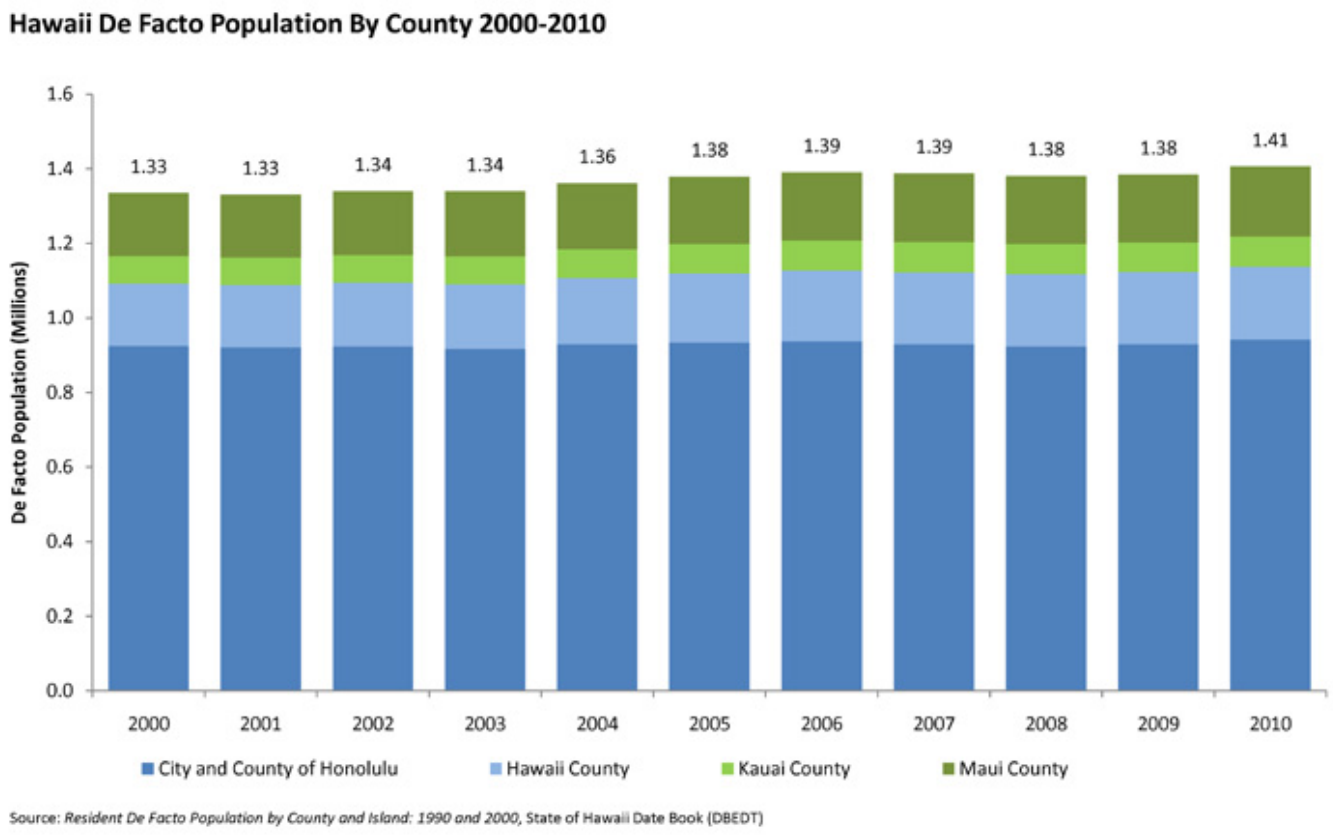
Sources: Data sources, estimation procedures, and assumptions are described in the Technical Notes.

ATTACHMENT 7

HAWAII ENERGY STATISTICS

Hawaii Energy Statistics

The following charts provide general information and insights into Hawaii, its energy goals, and its energy consumption trends.



Source: *Resident De Facto Population by County and Island: 1990 and 2000*, State of Hawaii Date Book (DBEDT)

Hawaii De Facto Population by County 2000-2010

Hawaii State Energy Office

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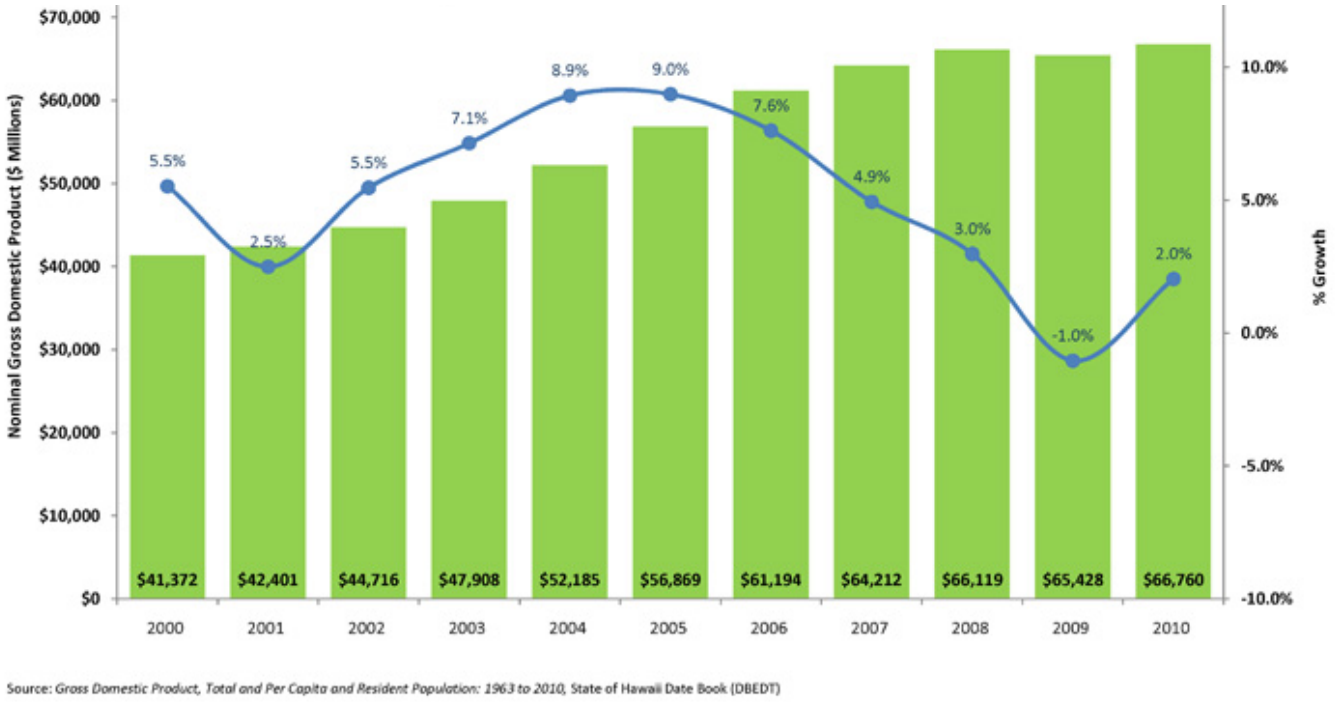
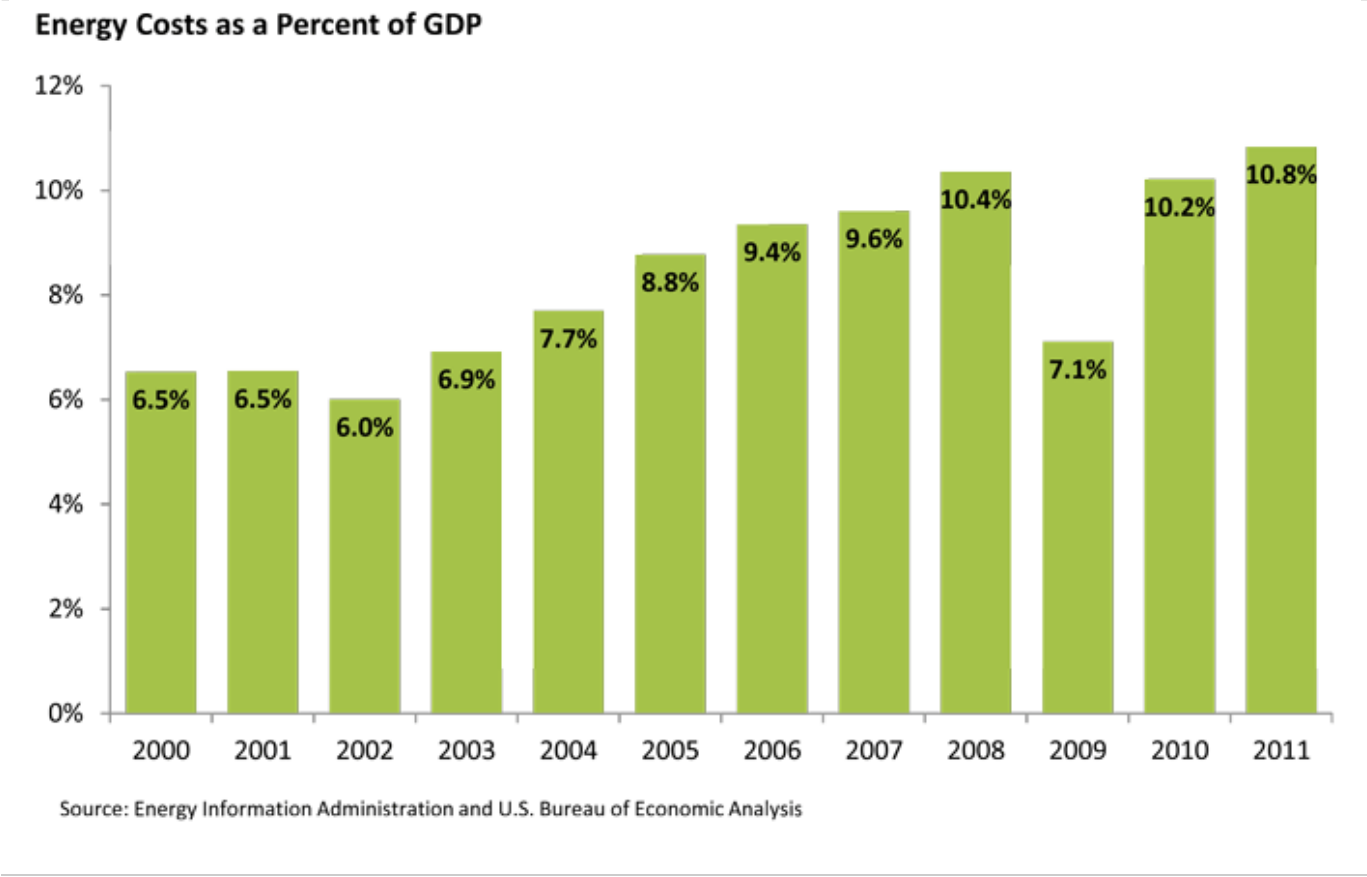
Our island environment is not only the basis for our quality of life, it is also the lifeblood of our economy. We look at environmental issues with future generations in mind, and as we explore Hawaii's boundless, clean energy potential, we trust they will benefit from our stewardship.

-Governor Neil Abercrombie

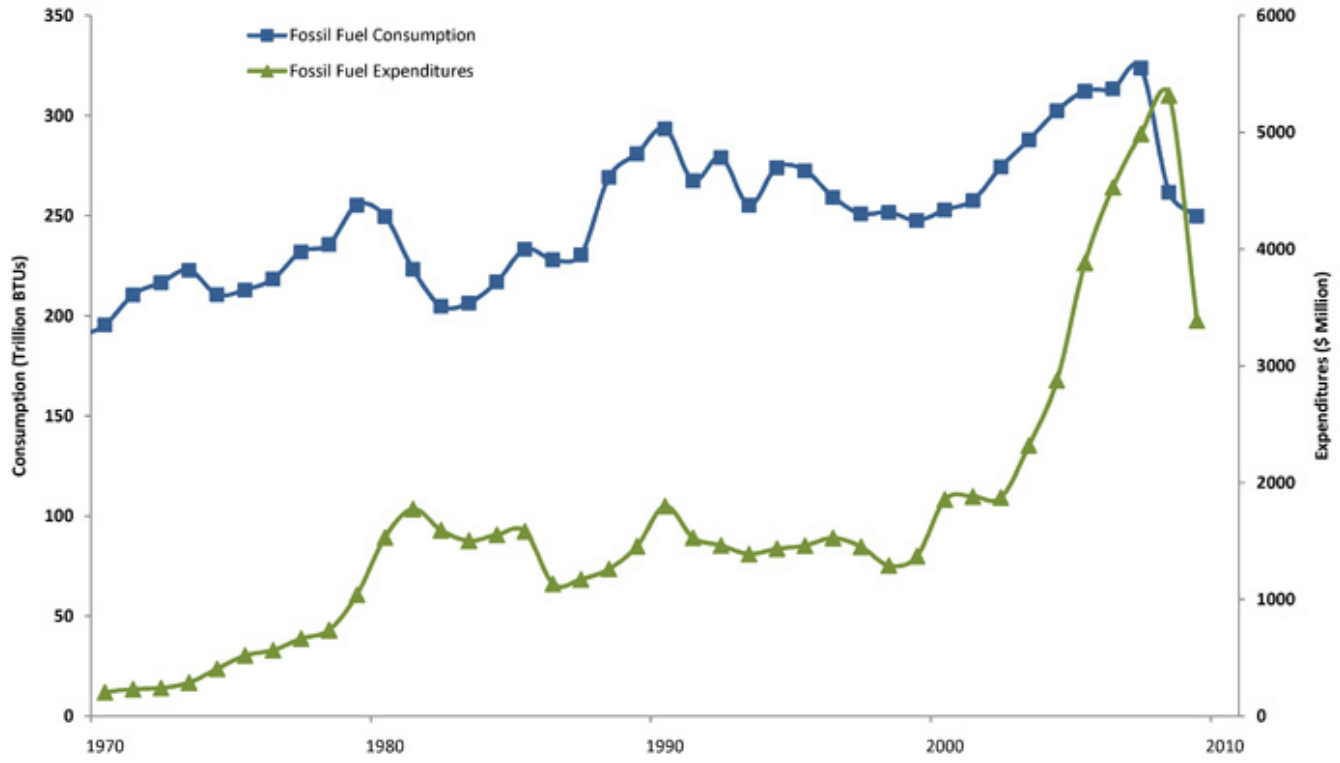


Source: *Gross Domestic Product, Total and Per Capita and Resident Population: 1963 to 2010*, State of Hawaii Date Book (DBEDT)

Hawaii Nominal Gross Domestic Product 2000–2010

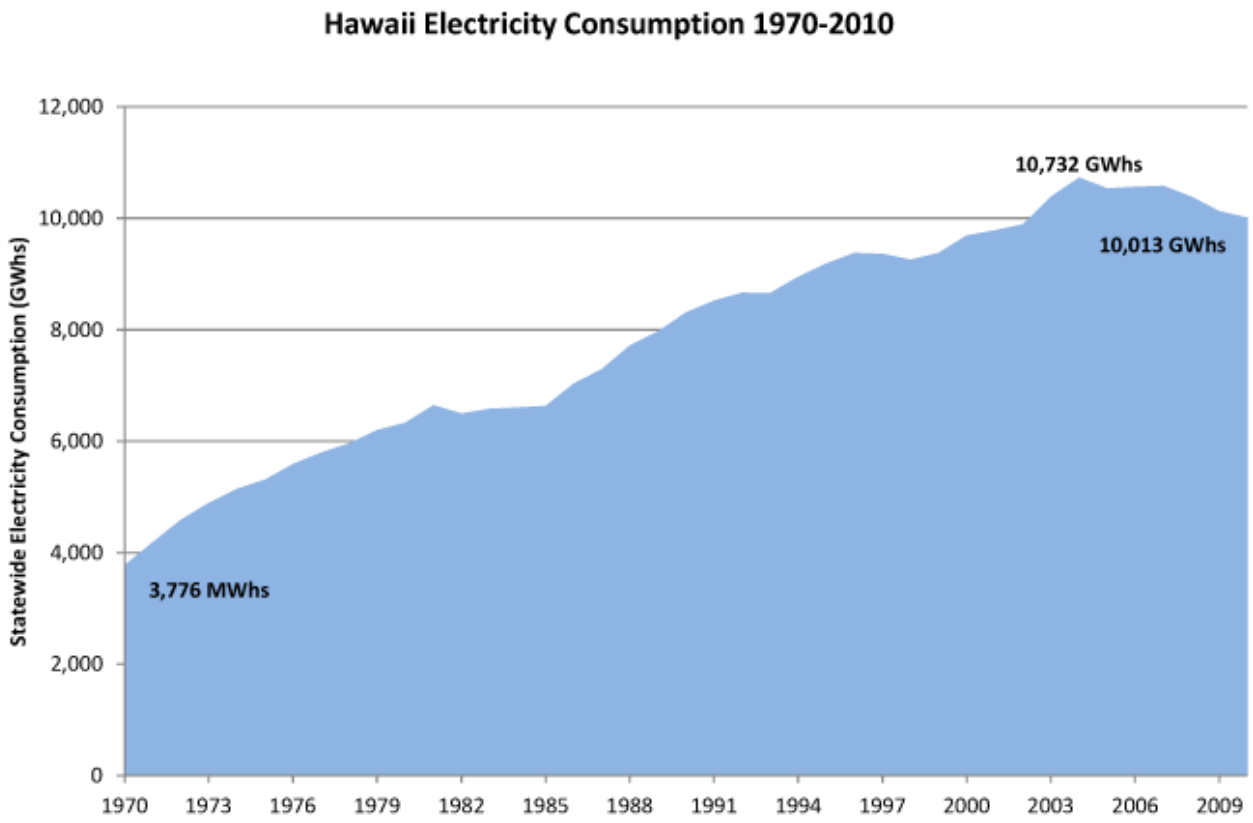

Energy Costs as a Percent of GDP
12%
10%
8%
6%
4%
2%
0%
6.5%
6.5%
6.0%
6.9%
7.7%
8.8%
9.4%
9.6%
10.4%
7.1%
10.2%
10.8%
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Source: Energy Information Administration and U.S. Bureau of Economic Analysis

Hawaii Fossil Fuel Consumption and Expenditures 1970-2009



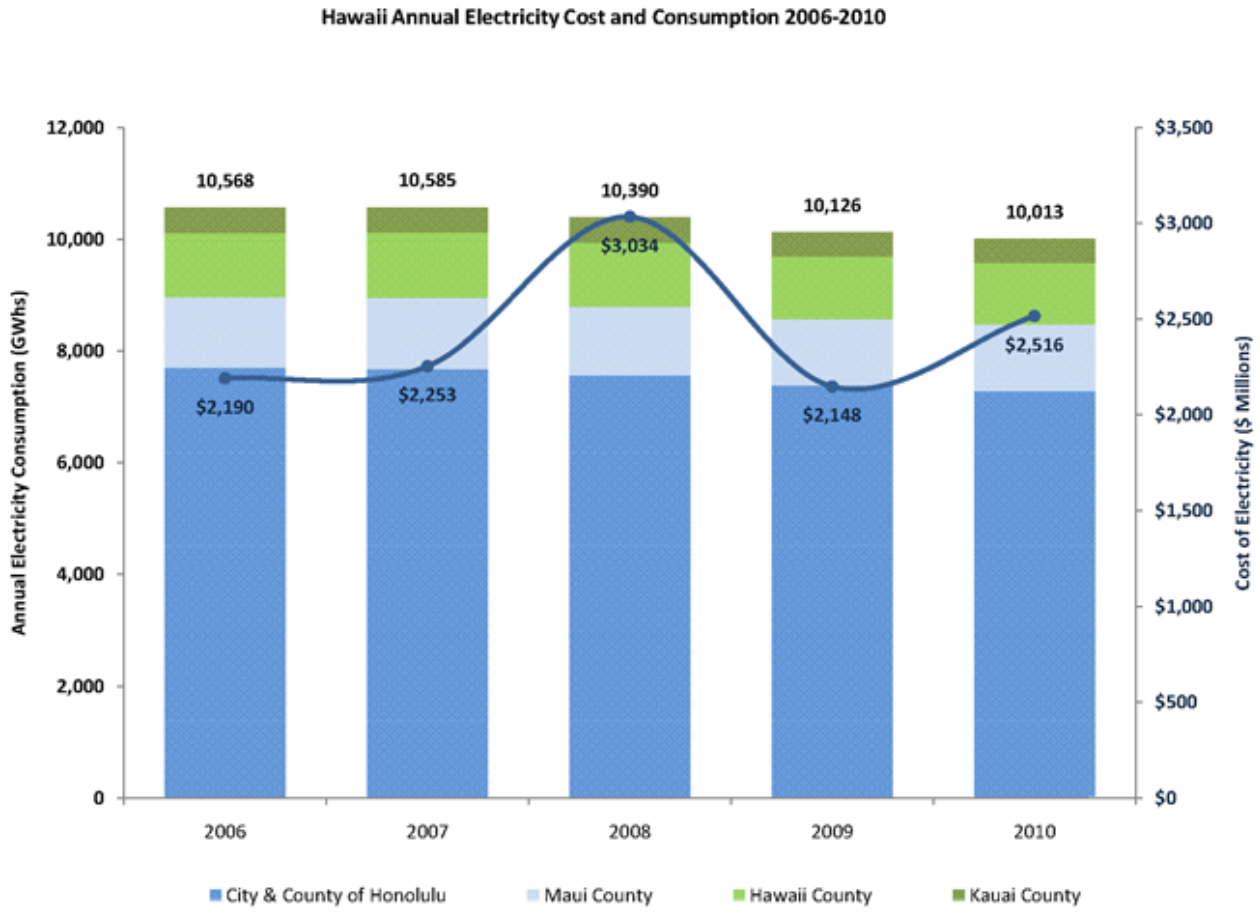
Source: *State Energy Data System: Hawaii Primary Energy Use*, June 2011 (Energy Information Administration)

Hawaii Fossil Fuel Consumption and Expenditures 1970-2009



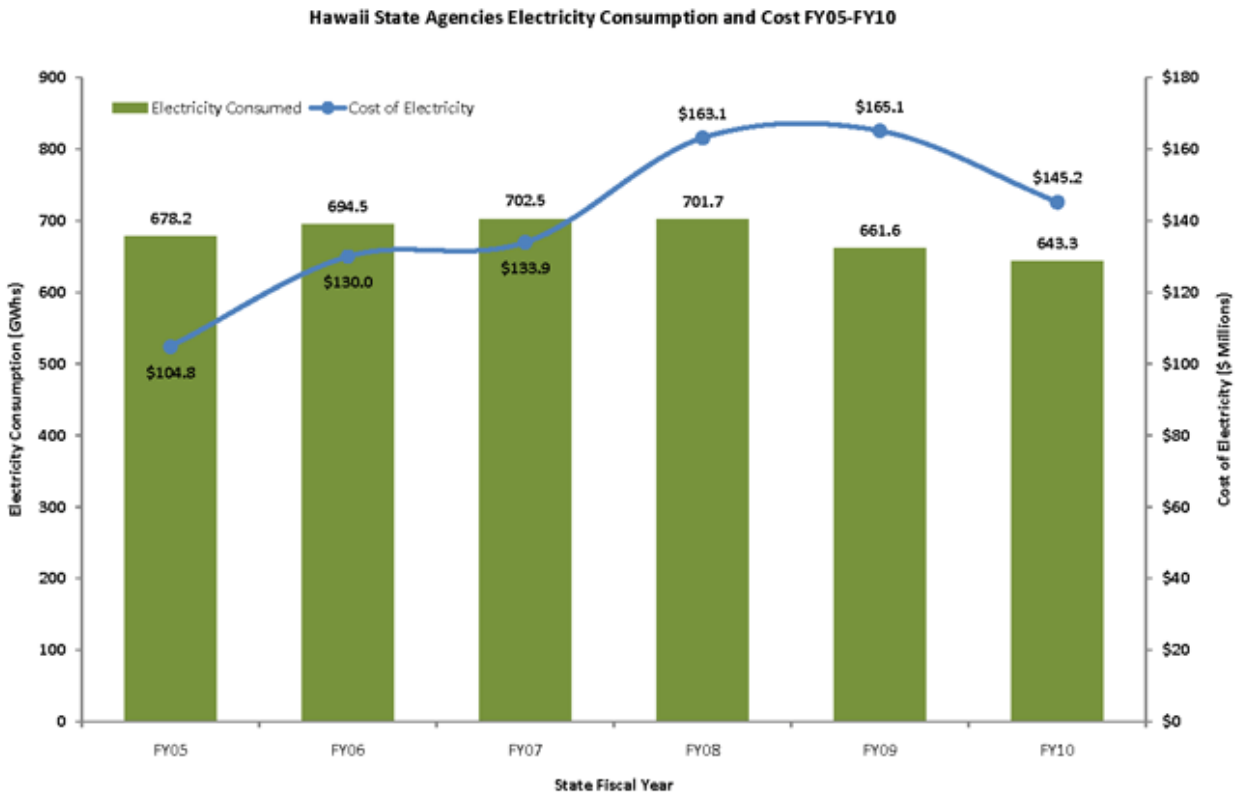
Source: *State Energy Data System: Hawaii*, August 2011 (Energy Information Administration)

Hawaii Electricity Consumption 1970-2010



Source: *Monthly Energy Trends*, 2006-2010 (DBEDT)

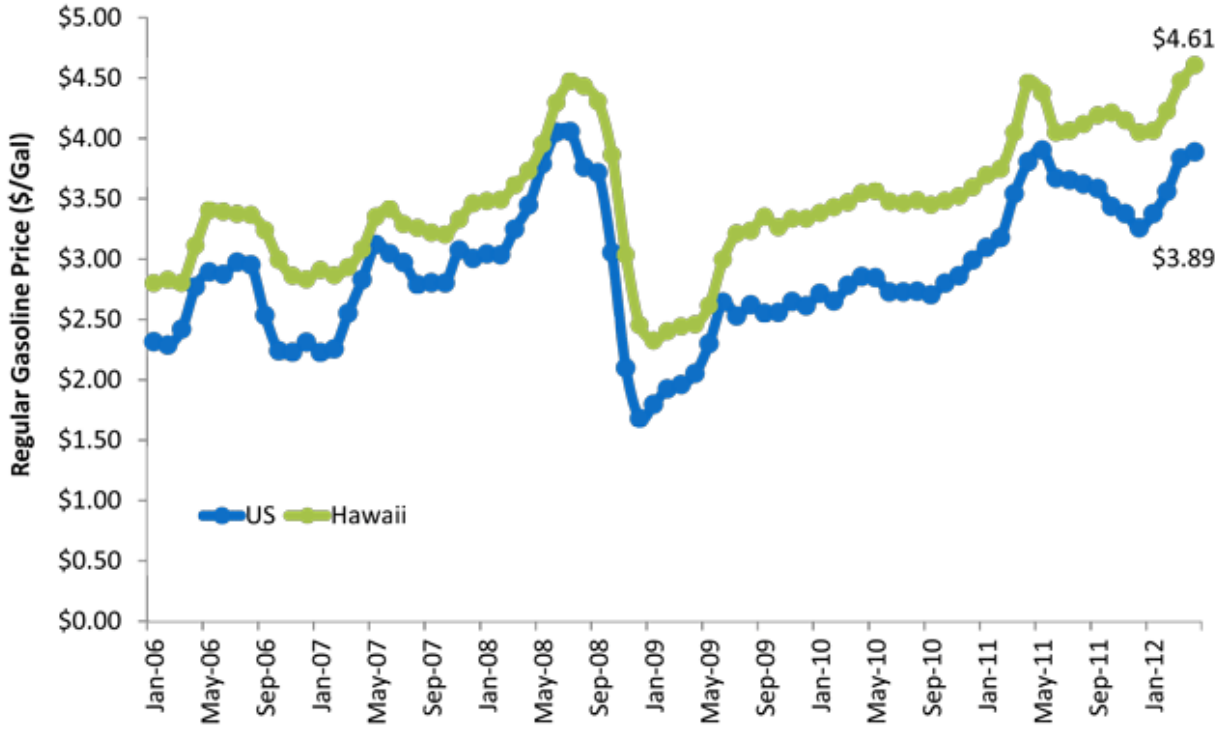
Hawaii Annual Electricity Cost and Consumption 2006-2010



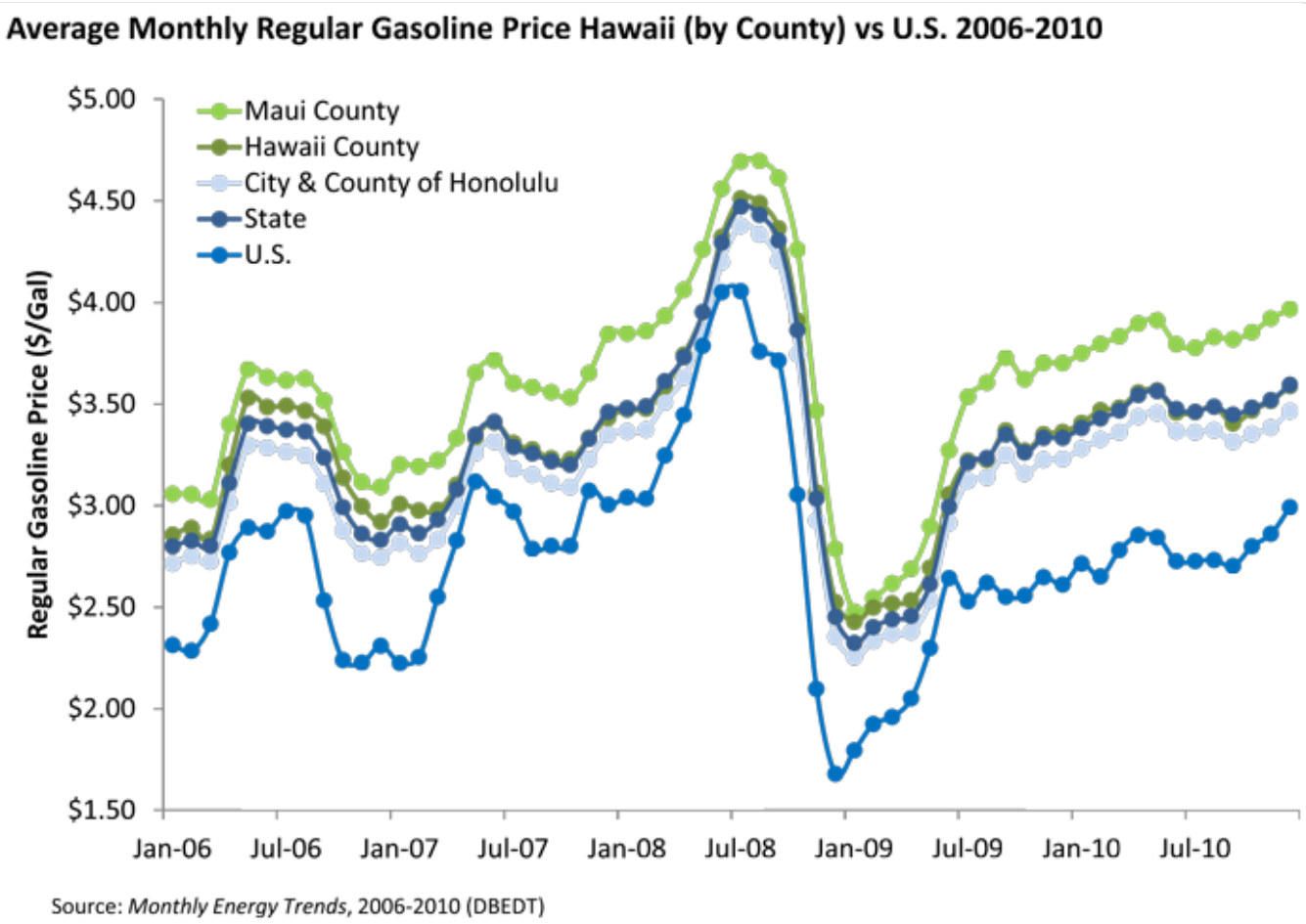
Source: Department of Business, Economic Development and Tourism, August 2011

Hawaii State Agencies Electricity Consumption and Cost FY05-FY10

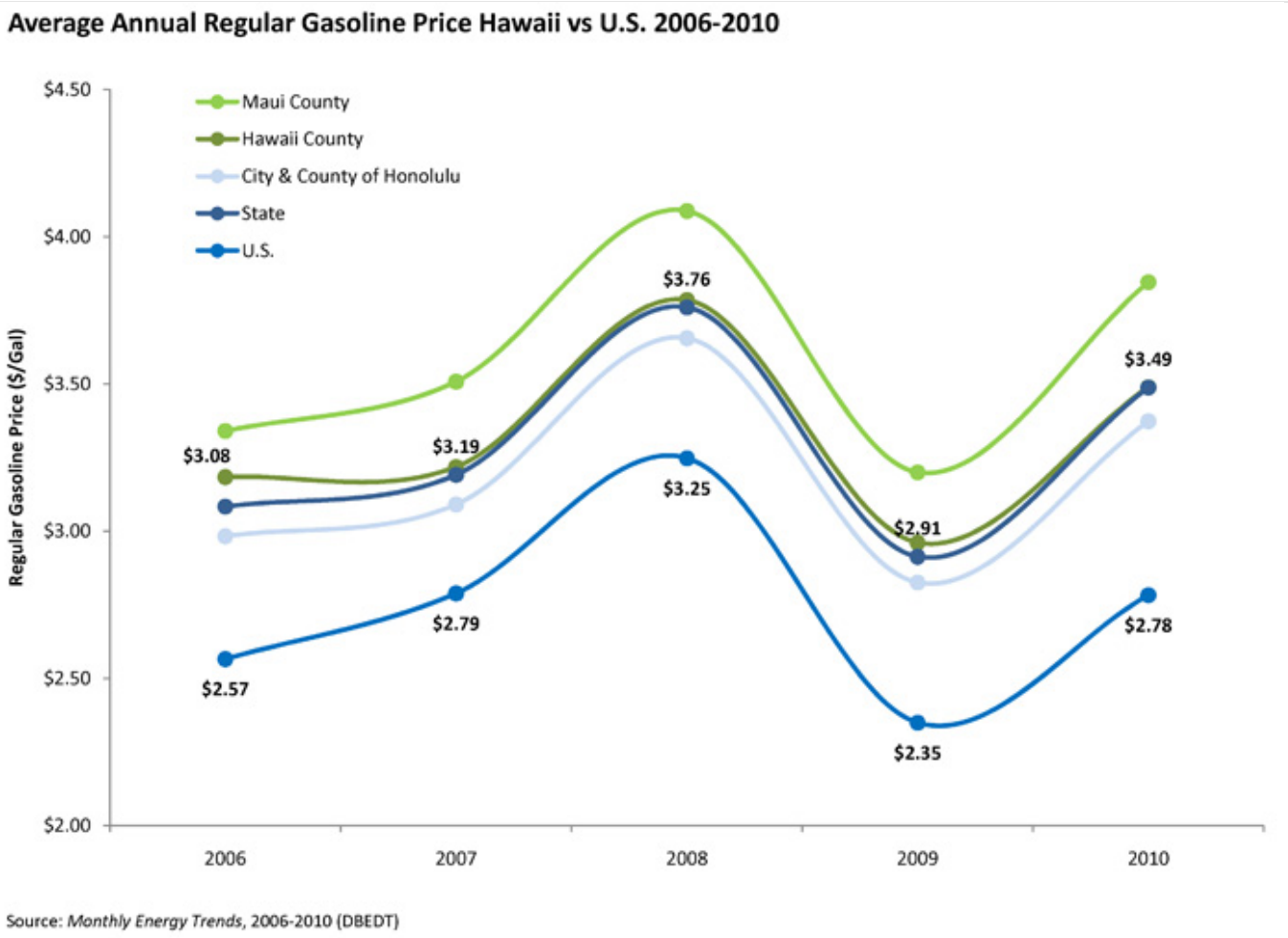
Average Monthly Regular Gasoline Price State of Hawaii vs U.S. 2006-2012



Source: *Monthly Energy Trends*, DBEDT



Average Monthly Regular Gasoline Price Hawaii vs. U.S. 2006-2010



Average Annual Regular Gasoline Price Hawaii vs. U.S. 2006-2010

The data shown on this website is measured and represented as accurately as possible and is subject to change as updates are provided by data sources.

ATTACHMENT 8

ENERGY-DATA-TREND
TABLE 5.8 RESIDENTIAL ENERGY CONSUMPTION PER HOUSEHOLD

Table 5.8 shows the residential energy consumption per household in Hawaii. From 1960 to 2008, residential energy consumption per household increased about 78 percent from 47 MBTU per household to 84 MBTU in 2008; residential electricity consumption per household increased about 108 percent from 3,382 kWh per household to 7,045 kWh per household.

Table 5.8. Residential Energy Consumption per Household

	Hawaii	Residential Energy Consumption per Household					
	State	Total		Other	Index		
	Household	Energy	Electricity	Energy	Total Energy	Electricity	Others
Year	HH	MBTU/HH	kWh/HH	MBTU/HH	1970=100	1970=100	1970=100
1960	152,014	47	3,382	1	62	54	19
1965	174,998	56	4,920	1	75	78	32
1970	204,505	76	6,283	4	100	100	100
1975	251,986	75	6,599	2	99	105	57
1980	296,074	71	6,218	7	94	99	189
1985	322,687	62	5,823	3	82	93	70
1990	356,267	86	6,523	5	114	104	130
1991	361,403	72	6,629	5	96	106	133
1992	367,095	81	6,642	6	107	106	168
1993	371,002	81	6,654	5	107	106	134
1994	375,478	83	6,810	5	110	108	138
1995	382,340	84	6,817	5	111	108	138
1996	388,840	84	6,882	5	112	110	139
1997	391,637	84	6,813	5	111	108	146
1998	395,139	84	6,683	7	111	106	190
1999	399,712	83	6,728	6	110	107	163
2000	404,391	84	6,837	6	111	109	175
2001	409,863	80	6,838	6	106	109	172
2002	415,228	84	6,980	6	111	111	173
2003	421,614	81	7,181	6	108	114	161
2004	427,125	83	7,403	6	110	118	162
2005	432,097	83	7,323	6	110	117	167
2006	435,287	84	7,311	7	111	116	179
2007	434,297	85	7,370	7	113	117	189
2008	437,919	84	7,045	9	111	112	253

Source: Energy Information Administration, State Energy Data System

APPENDIX 2.2

Preliminary Energy Assessment Reports for HHSC's Four Primary Hospitals

PRELIMINARY ENERGY ASSESSMENT
FOR
HILO MEDICAL CENTER
HILO, HAWAII

HHSC TASK ORDER NO: 1.B.

December, 2012

INSYNERGY ENGINEERING INC

828 Fort Street Mall, Suite 500 • Honolulu, Hawaii 96813
Tel: 808 521-3773

Background:

This project evaluates and identifies the Energy Savings Measures (ESM's) that should be implemented to reduce energy utility costs and improve building system performance for Hilo Medical Center based on the facility assessment that was conducted on Dec 13, 2012. The scope of work for this project includes the evaluation of ESM's for water heating, air conditioning and ventilation, lighting, and controls.

The main building of the Hilo Medical Center located in Hilo, Hawaii is a three story, concrete structure having an approximate overall area of about 280,000 square feet. The hospital currently has about 200 beds and offers a full range of services including the following: emergency, surgery, obstetrics, oncology, psychiatry, and long term care. The main buildings that make up the hospital includes the main acute care clinic, the psychiatry building, Building 111 (Extended Care), and Building 1295 (Oncology Clinic).

The main hospital building, was built in 1981 and went through a major renovation in 2002. The emergency services area in the acute care unit went through a major renovation in 2005. The psychiatry building was is a single story building that was constructed in 1992 with approximately 25 beds. Building 1285 is a two story clinic across the street from the Medical Center. This buildings provides oncology services on the 1st floor and the second floor is leased to Veteran's Administration. Building 111 is an older building that pre-existed prior to construction of the main Acute Care unit, and is now used for Extended Care patients with 100 beds.

The main Acute Care Unit, Psychiatry Unit, and Extended Care unit are operated continuously, 24 hours per day, 365 days per year. The Oncology Clinic is operated from 6:30 am – 5:00 pm.

In 2004, Energy Conservation Measures were implemented as part of an Energy Performance Contract by Noresco. The following measures were implemented:

1. ECM -001: Chiller Plant upgrades consisting of chiller replacement, control upgrades, and chilled water primary/secondary variable flow conversion.
2. ECM-002: Installation of a diesel fired cogeneration system consisting of two 356 KW cogeneration units to generate electricity for the hospital while providing hot water and supplemental cooling using waste heat.
3. ECM-004: Installation of a DDC energy management system.
4. ECM-005: Removal of Heat Reclaim Heat Pumps (Hot water produced by cogeneration only)
5. ECM-006: Interconnect psychiatric Building with the main chilled water system serving the Acute Care Unit.
6. ECM-007: Replacement of smoke dampers and actuators throughout the hospital.
7. ECM-009: Replacement of steam traps.
8. ECM-013: Lighting System improvements.
9. ECM- 014: Upgrade and replacement of inefficient motors with premium efficiency motors.

10. ECM-016: Installation of window film to reduce solar heat gain into the building.
11. ECM-018: Vending machine enhancements (occupancy sensors)
12. ECM-021: VFD control of central station air handling equipment.
13. ECM-022: Replacement of plumbing water closets with low flow water closets.

Description of Existing Systems:

Acute Care:

A primary /secondary variable flow chilled water system provides cooling for the main hospital building. Air handling units are located in mechanical rooms on the ground floor, in rooftop mechanical rooms, and in ceiling spaces within the main Acute Care building. Fan coil units are also used throughout the hospital for individual rooms. There is no reheat system serving the hospital. Chilled water is provided by a 400 ton centrifugal chiller that was provided under the ESCO project under ECM-001 and a 450 ton Carrier centrifugal chiller hat serves as back-up. Two 20 ton absorption chillers installed as part of ECM-002 provide supplemental chilled water using waste heat from the cogeneration units. All of the chillers and chilled water pumps are in the maintenance building located on hospital grounds behind the acute care building. Two Evapco Air Coil cooling towers are located adjacent to the maintenance building at grade. The existing Controls are DDC which were provided under ECM-004.

Hot water for the acute care unit is primarily provided by the cogeneration system installed under ECM-002. Waste heat from the cogeneration unit is used to heat domestic hot water. Laundry hot water is boosted in temperature by diesel fired hot water heaters. Back up LP gas water heaters provide backup hot water heating for the domestic hot water heating system.

Restroom facilities and patient room restrooms are provided with exhaust systems with the majority of the exhaust fans located at the roof level. The kitchen area is equipped with a hood for exhausting of the cooking line and the main centrifugal utility set exhaust blower is located at the roof level of the building.

The hospital also has a steam generating system consisting of two 150 HP boilers. Only one boiler is adequate to support the steam loads for the hospital. Steam is primarily used for laundry, dietary, and sterilization. Steam traps were replaced as part of ECM-009.

Regular flow fixtures (i.e. not low flow) are used throughout the hospital with the exception of water closets Approximately 71 water closets were retrofitted to low flow (1.6 gpf) plumbing fixtures in 2004. Low-low plumbing fixtures have not been installed. The remaining fixtures are the original equipment. There is no booster pump serving the hospital.

The hospital has its own laundry services that are provided by gas-fired laundry dryers and large commercial washers. Hot water for the laundry is provided by the domestic hot water system and boosted in temperature by a diesel fired boiler. According to hospital personnel, approximately 150,000 lbs of laundry is processed each month.

The dietary service provides approximately 1000 meals / day for the entire hospital facility including meals for the acute care, psychiatry, and long term care patients and meals for guests and hospital staff.

Medical gases provided include oxygen and nitrous oxide. Medical vacuum is also provided. Oxygen is supplied by a large liquid oxygen tank located on a pad at the rear of the hospital. An Ohmeda vacuum pump located in the mechanical room supplies the vacuum. Currently nitrous oxide is supplied by pressurized cylinders located in a small room near the emergency entrance and also located in a small room in OB.

The lighting in the hospital was previously upgraded as part of ECM-008: Lighting System Improvements.

Psychiatry Unit:

The psychiatry unit has its own air cooled chiller that is only used for back up. The building has been connected to the main chiller plant serving the acute care building. Air handling units located in the ceiling space of the building provide cooling for the conditioned spaces. Air conditioning is provided to this building 24 hours a day. Hot water for the Psychiatry unit is provided by an electric hot water heater

Extended Care Unit:

The extended care unit is mostly un-air-conditioned and is naturally ventilated with the exception of the main day room which has been provided with two 5 ton air cooled portable air conditioning units. These units run 24 hours per day unless exterior conditions are cool enough to allow natural ventilation. Hot water for the extended care unit is provided by an electric water heater.

Building 1282 – Oncology Clinic:

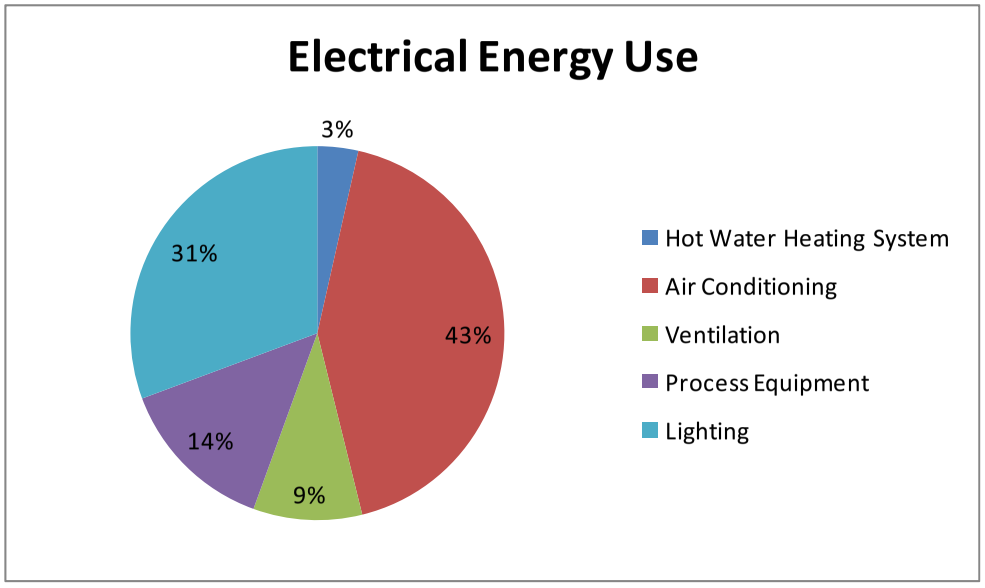
The oncology clinic is air conditioned by a constant flow chilled water air conditioning system. A 45 ton air cooled chiller provides cooling for the chilled water loop. The chillers are also equipped with desuperheaters for hot water production. However, the heat reclaim units are not operational and not in use at this time. Since the desuperheaters are not being utilized, hot water is primarily being provided by an electric hot water heater.

Current Electrical Consumption:

Over the past year, the facility consumed 4,660,000 kwh of electricity at a total cost of $1,803,475 The average cost for electricity was $.359 per kwh, and the average peak demand charge was 665 kw.

From our analysis, the breakdown of the electrical use is presented in the table below, with the majority of the electricity used for air conditioning:

Total Electrical Use	kw	% of total	Kwh/year	% of total
Hot Water Heating System	1	0%	272153	4%
Air Conditioning	669	67%	3,294,014	43%
Ventilation	83	8%	726,360	9%
Process Equipment	210	21%	1,064,873	14%
Lighting	29	3%	2,370,884	31%
Total Electrical Use	993	100%	7,728,284	100%
Generator			-1,987,440	
Electricity from Grid			5,740,844	



The hospital also uses over 272,681 gallons of diesel for heating, which amounts to an additional cost of $1,363,405 per year at a cost for LPG of $5 per gallon.

From our analysis, the breakdown of the Diesel use is presented in the table below, with the majority of the Diesel used for cogen system and patient domestic hot water use and the laundry:

Total Diesel Uses		gallons	% of total
	Steam Generation	52,408	19%
	Cogen	220,273	81%
	Total	272,681	100%

Evaluation of ESM's:

Analysis of the ESM's that were considered for this facility was evaluated and is summarized in the following Table:

Hospital:	Hilo Medical Center																		
		Electrical Consumption		Fuel Consumption				Elec Energy Savings		Fuel Savings				Other Savings		Total Savings	Construction Cost with Mark-ups	Simple Payback	SROI
Energy Savings Measure		KWh/Year	$/year - Elec	Gal/year Diesel	$/year - Diesel	Gal/year LPG	$/year - LPG	KWh/Year	$/year - Elec	Gal/year Diesel	$/year - Diesel	Gal/year LPG	$/year - LPG	$/Yr Avoided Replacement Cost	$/Yr Avoided Labor Cost	$/year	$	years	1/year
Number	Description																		
Baseline		7,577,131	$2,697,459	226,857	737,285	0	0	NA	NA	0	$0	$0	$0	NA	NA	NA	NA	NA	NA
ECM-E3-Hilo	Relamp - Replace T8 Fluorescent with super T-8	7,131,832	$2,525,103	226,857	$737,285	0	$0	445,299	$172,356	0	$0	0	$0	$0	$0	$172,356	$987,599	6	0.17
ECM-R1-Hilo	Roofmount 100 KW PV system	7,445,731	$2,646,599	226,857	$737,285	0	$0	131,400	$50,859	0	$0	0	$0	$0	$0	$50,859	$496,314	10	0.10
ESM-A3-Hilo	New Ventilation Fan controls - Install Variable Speed Controls on Kitchen Exhaust Fan	7,099,081	$2,513,443	226,857	$737,285	0	$0	32,751	$11,659	0	$0	0	$0	$0	$0	$11,659	$43,550	4	0.27
ECM-H3-Hilo	New Solar Water Heating System for long term care and Psychriatic currently utilizing							231330	$89,538			0	$0			$89,538	$446,403	5	0.20
Total, Recommended ESM's		7,445,731	$2,646,599	226,857	$737,285	0	$0	576,699	$223,215	0	$0	0	$0	0	0	$223,215	$1,483,913	7	0.15
Additional ECM's Not Recommended:																			
ESM-A7-Hilo	Connect air cooled chilled water system to central water cooled chiller plant	7,440,063	$2,656,338	226,857	$737,285	0	$0	137,068	$41,120	0	$0	0	$0	$0	$0	$41,120	$978,774	24	0.04
ESM's Not Considered		Reason																	
	New Water Srouce Heat Pump System	Not applicable since cogen system is producing all hot water.																	
	New High efficiency chiller plant	The existing chiller plant has already been modernized and features high efficiency centrigual chillers and vaiable pumping systems.																	

Based on this assessment, the following ESM's are cost effective and should be implemented to reduce energy consumption and associated utility costs for the facility:

ECM-E3 - Hilo : Relamp / Replace T8 Fluorescent with super T-8. The existing linear fluorescent lamps in existing light fixtures should be replaced with high efficiency T8 lamps.

ECM-R1-Kona: Roof mount 100 KW PV system. Installation of a new PV system should be considered and appears to be viable.

ESM-A3-Hilo: New ventilation fan control. Installing variable speed controls on Kitchen exhaust fan appears to be economical feasible and should be considered

ECM-H3-Hilo: New Solar Water Heating System .Installation of a solar water heating system for Psychiatric building and extended care facility will save energy and should be implemented.

The implementation of these recommended ESM's will save approximately $223,215 per year in utility costs at a construction cost of $1,483,913, resulting in a simple payback of 7 years.

The following other ESM's were not considered feasible or not recommended for implementation:

ECM-H2-Kona: New Water Source Heat Pump Heating System. Since existing cogeneration system produces most of the hot water in to the facility, new water source heat pump heating system is not considered.

ECM-H4-Kona: New Cogeneration Heating System: There is existing cogeneration system in the facility.

ECM-A5- Kona: Replace Chiller with Higher Efficiency Unit. Installation of a higher efficiency water cooled chiller was considered but the chiller that was installed as part of the ESPC project operates at .62 kw/ton, and the slight increase in efficiency with a new higher efficiency water cooled chiller will not be cost effective.

ESM-A7-Kona: Connect the air cooled chiller system to the central water cooled chiller plant. The existing 40 ton air cooled chiller system that serves Oncology building is considered. Implementation for this ECM will not be cost effective due to the distance of the building from the chiller plant.

The following other ESM's were not considered feasible or not recommended for implementation:

ESM-A7-Hilo: Connecting air cooled chilled water system to central water cooled chiller plant. This ESM is not economically feasible due to higher construction cost and long payback period.

ECM-H2-Hilo: New water source heat pump system: This is not applicable since existing co-generation system is producing all hot water.

ECM-A5- Hilo: Replace Chiller with Higher Efficiency Unit. The existing chiller plant has already been modernized and features high efficiency centrifugal chillers and variable pumping systems.

Appendix 1

HISTORICAL ENERGY USE

Hospital: HILO

	Electrical Consumption - Fiscal Years 2009 - 2011 (Mwh)							
	2007	2008	2009	2010	2011	2012	Average	
Aug					372.9	417.0	394.9	
Sep					368.8	406.1	387.5	
Oct					369.5	376.4	373.0	
Nov					367.7	367.5	367.6	
Dec					363.0	343.9	353.5	
Jan					347.3	356.7	352.0	
Feb					339.6	387.1	363.4	
Mar					405.5	343.1	374.3	
Apr					396.0	376.5	386.2	
May					390.1	529.2	459.6	
Jun					368.3	525.4	446.8	
July					406.2	396.4	401.3	
totals					4,495.0	4,825.3	4,660.1	Mwh/year
Average Cost:		$0.39	per kwh Non DOD Customers				$1,803,475	per year

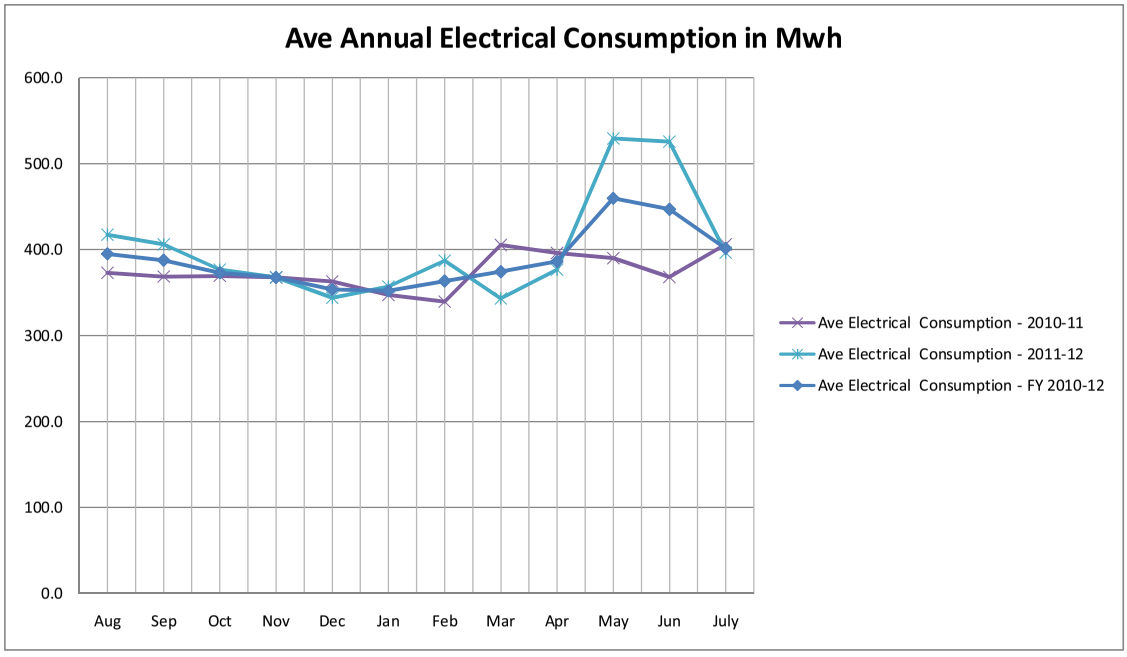
Hilo Bulk Fuel

Boiler/Em Generator Diesel Consumption:

January – December 2009	51,582 gallons
January – December 2010	47,604 gallons
January – December 2011	58,039 gallons
average	52,408 gallons

Cogen Diesel Consumption:

January – December 2009	213,136 gallons
January – December 2010	226,191 gallons
January – December 2011	221,493 gallons
average	220,273 gallons



Appendix 2

EQUIPMENT INVENTORY

Hospital: HILO

Hot Water Heating - normal hot water demand is met by co-gen syste. However, psychiatric Building and extended care facilities has their own electric Hot Water Heater

Unit	Number of Bed	Hot Water /Unit	Total HW Use	Heater Efficiency	Temp. Rise	Elec. Consumption KWH/Day)	Days/Week	Weeks/year	Total Elec. Use (KWH/Year)
Psychiatric	25	35	875	1	70.0	149.53	7	52	54430.64185
Extended Care	100	35	3500	1	70.0	598.14	7	52	217722.5674
Total KWH/Year for the Hot water generation									272153.2093

AC Systems

unit	Quantity	Cooling Capacity (tons)	Motor Load (hp)	KW	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
CH-1 (water Cooled)		360		180	0.5	0.5	24	2160	7	52	786,240
CH-2		150		90	0.6	0.0	0	0	7	52	0
CH-3 (absorbtion)		40		40	1	1.0	24	960	7	52	349,440
Aircooled Chiller	1	40		46	1.15	0.7	24	772.8	7	52	281,299
Ductless DX	1	6		6.9	1.15	0.7	24	115.92	7	52	42,195
Ductless DX	1	5		5.75	1.15	0.7	24	96.6	7	52	35,162
Window AC	1	5		5.75	1.15	0.7	24	96.6	7	52	35,162
						0.7					
CT-1 and 2	1		20	14.914		0.7	24	250.5552	7	52	91,202
SCHWP	1		20	14.914		0.7	24	250.5552	7	52	91,202
PCHWP	1		15	11.1855		0.7	24	187.9164	7	52	68,402
CHWP (Absortion Chiller)	1		2	1.4914		0.7	24	25.05552	7	52	9,120
EHWP-1 (heat medium circulation)	1		7.5	5.59275		0.7	24	93.9582	7	52	34,201
Hot Water Circ. Pump	1		1.5	1.11855		0.7	24	18.79164	7	52	6,840
CWP	1		40	29.828		0.7	24	501.1104	7	52	182,404
Oncology CHWP	1		5	3.7285		0.5	24	44.742	7	52	16,286
Extended Care Portable	1	10		11.5	1.15	0.8	24	220.8	7	52	80,371
AHU-1	1		10.000	7.457		0.7	24	125.2776	7	52	45,601
AHU-2	1		15.000	11.1855		0.7	24	187.9164	7	52	68,402
AHU-3	1		7.500	5.59275		0.7	24	93.9582	7	52	34,201
AHU-4	1		5.000	3.7285		0.7	24	62.6388	7	52	22,801
AHU-5	1		2.00	1.4914		0.7	24	25.05552	7	52	9,120
AHU-6	1		7.00	5.2199		0.7	24	87.69432	7	52	31,921
AHU-7	1		5	3.7285		0.7	24	62.6388	7	52	22,801
AHU-8	1		7	5.2199		0.7	24	87.69432	7	52	31,921
AHU-9	1		20	14.914		0.7	24	250.5552	7	52	91,202
AHU-10	1		10	7.457		0.7	24	125.2776	7	52	45,601
AHU-11	1		10	7.457		0.7	24	125.2776	7	52	45,601
AHU-12	1		20	14.914		0.7	24	250.5552	7	52	91,202
AHU-13	1		20	14.914		0.7	24	250.5552	7	52	91,202
AHU-14	1		25	18.6425		0.7	24	313.194	7	52	114,003
AHU-15	1		15	11.1855		0.7	24	187.9164	7	52	68,402
AHU-16	1		15	11.1855		0.7	24	187.9164	7	52	68,402
AHU-17	1		15.000	11.1855		0.7	24	187.9164	7	52	68,402
AHU-18	1		10.000	7.457		0.7	24	125.2776	7	52	45,601
AHU-19	1		15.000	11.1855		0.7	24	187.9164	7	52	68,402
AHU-20	1		10.000	7.457		0.7	24	125.2776	7	52	45,601
AHU-21	1		5.000	3.7285		0.7	24	62.6388	7	52	22,801
AHU-1, 2 & 7 (Psych. Bld.)	3		1.000	2.2371		0.7	24	12.52776	7	52	4,560
AHU-1,4,8,9,7 (Psych. Bld.)	4		0.750	2.2371		0.7	24	9.39582	7	52	3,420
AHU-5 (Psych. Bld.)	1		1.500	1.11855		0.7	24	18.79164	7	52	6,840
AHU-1-1 & 2 (HPOC)	2		5	7.457		0.7	24	62.6388	7	52	22,801
AHU-1-3 (HPOC)	1		3	2.2371		0.7	24	37.58328	7	52	13,680
sf		total	sf/ton	kw							kwh/yr
280000		606	462.0462046	669.266	kw						3,294,014

Hospital: HILO

Ventilation Systems

	quanitity	Motor Size	KW	cfm	Div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
ME Rm. SF	1	1	0.7457	2550	1.0	24	18	7	52	6,514
ME Rm. EF	1	0.25	0.186425	3000	1.0	24	4	7	52	1,629
EF-R-2	1	7.5	5.59275	3000	1.0	24	134	7	52	48,858
EF-1	1	25	18.6425	165	1.0	24	447	7	52	162,861
EF-2	2	0.25	0.37285	195	1.0	24	9	7	52	3,257
EF-3	1	1.5	1.11855	800	1.0	24	27	7	52	9,772
EF-4	1	0.75	0.559275	150	1.0	24	13	7	52	4,886
EF-5	2	1.5	2.2371	100	1.0	24	54	7	52	19,543
EF-6,7 & 16	3	0.75	1.677825	240	1.0	24	40	7	52	14,657
EF-8 & 12	2	1	1.4914	1030	1.0	24	36	7	52	13,029
EF-10 & 11	2	2	2.9828	280	1.0	24	72	7	52	26,058
EF-13	1	5	3.7285	810	1.0	24	89	7	52	32,572
EF-14, 15 & 17	3	0.5	1.11855	4750	1.0	24	27	7	52	9,772
EF-15A & B	2	0.25	0.37285	475	1.0	24	9	7	52	3,257
EF-18,21 & 28	3	1	2.2371	100	1.0	24	54	7	52	19,543
EF-19,25 & 26	3	0.5	1.11855	180	1.0	24	27	7	52	9,772
EF-22 & 23	2	0.75	1.11855	170	1.0	24	27	7	52	9,772
EF-20,24 & 27	3	0.25	0.559275	320	1.0	24	13	7	52	4,886
SF-1	1	20	14.914	200	1.0	24	358	7	52	130,289
SF-2	1	15	11.1855	480	1.0	24	268	7	52	97,717
SF-3	1	5	3.7285	100	1.0	24	89	7	52	32,572
SF-4	1	5	3.7285	75	1.0	24	89	7	52	32,572
SF-5	1	5	3.7285	215	1.0	24	89	7	52	32,572
			kw							kwh/yr
Total ventilation			83.14555							726,360

Process Equipment

system

	quantity	Motor Size	KW	Capacity	Div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
Air Compresser	1	0.75	0.559275	NA	1.0	1	1	7	52	204
Vaccum pump	2	4	5.9656	NA	1.0	1	6	7	52	2,171
Shop Air Com.	2	20	29.828	NA	1.0	1	30	7	52	10,857
Vaccum pump	2	15	22.371	NA	1.0	1	22	7	52	8,143
Elevator M/C	6	45	201.339	NA	1.0	1	201	7	52	73,287
Medical Air	2	7.5	11.1855	NA	1.0	1	11	7	52	4,072
Dietary Refrigerator condenser	1	7.5	5.59275	NA	1.0	24	134	7	52	48,858
	sf	w/sf	kw			hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
Misc	280000	0.75	210			12	2,520	7	52	917,280
			kw							kwh/yr
Total Process System			210							1,064,873

		kwh/yr	kw
Lighting From lighting calc spreadsheet		2370884	29.1
		kwh/yr	kw
Total Lighting		2370884	29.1

Generators

G-1 (generator)	1	-350	0.65	24	-5,460	7	52	-1,987,440

Total Electrical Use	kw	% of total	kwh		% of total
Hot Water Heating System	1	0%	272,153		4%
Air Conditioning	669	67%	3,294,014		43%
Ventilation	83	8%	726,360		9%
Process Equipment	210	21%	1,064,873		14%
Lighting	29.1	3%	2,370,884		31%
Total Electrical Use	993	100%	7,728,284		100%
Total Electrical Cost			$2,990,846		

Appendix 3

PROPOSED ESM'S/ECM'S

Hospital: **HILO**

ESM-H1-Hilo **New Hot Water Heat Recovery System - NA (already have**

Normal hot water demand is met by running the co-gen system

Current energy use				0	gallons/year
Energy use with heat recovery desuperheater				0	gallons/year
Energy savings				0	gallons/year
cost savings =					per year
Estimated Construction Costs:					
description	unit	quantity	unit cost	total	
Demolition	hours	0	75	0	
New 40 Ton desuperheater	each	0	20000	0	
Refrigerant piping - 1.5 inch	lf	0	40	0	
HW pump	each	0	5000	0	
HW piping	lf	0	50	0	
HW tank - 200 gallons	each	0	6000	0	
Controls	ls	0	5000	0	
Test and Balance	ls	0	5000	0	
SubTotal				$0.00	
Total with mark-ups				$0.00	
Simple Payback =				#DIV/0!	

ECM-H2-Hilo **New Water Source Heat Pump Heating System (NA)**

Normal hot water demand is met by running the co-gen system

Current LPG energy use					gallons/year
Energy use with heat pump				0	gallons/year
LPG Energy savings				0	gallons/year
LPG cost savings =				$0.00	per year
Electrical Energy use with heat pump				0	kwh/year
Electrical Savings for chiller				0	kwh/year
Net Electrical use				0	kwh/year
Elec Energy Cost				0	$/year
Net Cost savings =				$0.00	per year
Estimated Construction Costs:					
description	unit	quantity	unit cost	total	
Demolition	hours				
New Heat Pump	each	0	2000	0	
HW pump	each	1	10000	10000	
CHW Pump	each	1	10000	10000	
piping	lf	200	50	10000	
HW tank	each	6,080	15	91200	
Controls	ls	1	20000	20000	
Test and Balance	ls	1	10000	10000	
SubTotal				$151,200.00	
Total with mark-ups				$196,560.00	
Simple Payback =				#DIV/0!	

ECM-H3-Hilo **New Solar Water Heating System**

New Solar Water Heating System for long term care and psychitric building

Current energy use				272,153	kwh/year
Energy use with solar				40,823	kwh/year
Energy savings				231,330	kwh/year
cost savings =				$89,524.80	per year
Estimated Construction Costs:					
description	unit	quantity	unit cost	total	
Reroof	sf	2385.069	10	23850.68707	
New Solar Panels	each	49.68893	2500	124222.3285	
HW pump	each	2	10000	20000	
HW piping	lf	993.7786	50	49688.9314	
HW tank	each	3,500	15	52500	
Controls	ls	1	20000	20000	
Test and Balance	ls	1	20000	20000	
Electrical	ls	1	20000	20000	
SubTotal				$330,261.95	
Total with mark-ups				$429,340.53	
Simple Payback =				5	

ECM-H4-Hilo **New Cogeneration Heating System (NA-already have)**

Absorption Chiller	30	tons
Absorption Chiller COP	0.8	COP
Avoided Electrical Chiller Efficiency	0.62	kw/ton
Generator	455	kw
Generator Electrical Efficiency	0.38	
Genertor Heat Recovery Efficiency	0.45	
cost for electricity	0.387	$/kwh
cost for diesel	4	gallon
cost for Lpg	3.5	gallon

Assume 90% energy savings by using a new heat recovery water source heat pump to heat hot water

LPG Heat Requirement for hot water and reheat water	220,085	Btu/hr
Additional Heat for Absorption Chiller	405,000	btu/hr
Total Heat Requirement	625,085	Btu/hr
Fuel Required to Operate Generator	10	gallons/hr
Annual Fuel Consumption	-88,176	gallons/yr
Annual Fuel Cost	($352,704.87)	$/yr
Current LPG energy use	26,309	gallons/year
Energy use with cogen	2,631	gallons/year
LPG Energy savings	23,678	gallons/year
LPG cost savings =	$82,874.20	per year
Avoided Electrical Chiller Energy Use	226,331	kwh/yr
Net Electrical Chiller Cost Savings	$87,589.99	$/yr
Total kwh electricity generated	1354808.353	kwh/yr
Total Avoided Electrical Cost Savings:	$524,310.83	$/yr
Additional Maintenance:	($27,096.17)	$/yr
Net Cost Savings:	$314,973.97	$/year

Additional Savings if Generator is run 90% of the time

Additional Electrical generated:	2232411.647	kwh/yr
Additional avoided electrical cost savings:	$863,943.31	$/yr
Additional Maintenance Cost:	($44,648.23)	$/yr
Additional Fuel Consumption:	-145,294	gallons/yr
Additional Fuel Cost	($581,176.27)	$/yr

ECM-H4-Hilo **New Cogeneration Heating System (NA-already have) - cont.**

Net Additional Cost Savings:				$238,118.80	$/yr	
Total LPG Savings				$82,874.20	gallons/year	
Total Electrical Savings				$1,475,844.13	$/yr	
Total Fuel Cost				($933,881.15)		
Total Maintenance Cost				($71,744.40)	$/yr	
Total Cost Savings				$553,092.77		$553,092.77
Total Net LPG Savings				23,678	gallons/year	
Total Net Electrical Energy Savings				3,813,551	kwh/year	1475844.128
Total Fuel Use				-233,470	gallons/year	

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Demolition	hours	3840	100	384000
New Generator	KW	455	3000	1365000
New Generator Heat Recovery	KW	455	1000	455000
New Absorption Chiller	tons	30	4000	120000
New Cooling tower	tons	30	1000	30000
HW pump	each	1	10000	10000
CHW Pump	each	1	10000	10000
CHW Pump	each	1	10000	10000
Fuel Pump	each	1	10000	10000
piping	lf	400	50	20000
HW tank	each	6,080	15	91200
Controls	ls	1	20000	20000
Test and Balance	ls	1	10000	10000
Electrical	ls	1	200000	200000
SubTotal				$2,735,200.00
Total with mark-ups				$3,555,760.00
Simple Payback =				6

ESM-A1-Hilo **Fix Supply Air Discharge Duct Leak - NA**

Current energy use for AHU				6514.4352	kwh/year	
Fan Power reduction without leak				0	kwh/year	
Energy savings				0	kwh/year	
cost savings =				$0.00	per year	

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Repair Duct				
Rrepair Duct Materials				
Test and Balance				
SubTotal				$0.00
Total with mark-ups				$0.00
Simple Payback =				N/A

ESM-A2-Hilo **Retrocommission AC system/reset time schedule to shutdown ac system after hours - NA**

Current energy use for ACU: kwh/year

Revised Schedule

System	unit	Cooling Capacity	Motor Load	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year	
											kwh/year
Energy savings					0.00	kwh/year					
cost savings =					$0.00	per year					

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Revise Time Schedule	hours	0	100	0
New Controls Settings	hours	0	100	0
Test and Balance	hours	0	100	0
SubTotal				$0.00
Total with mark-ups				$0.00
Simple Payback =				#DIV/0!

ESM-A3-Hilo **New Ventilation Fan controls - Install Variable Speed Controls on Kitchen Exhaust Fan**

Current energy use for ventilation systems: 65323.32 kwh/year

Revised Schedule

system	quanitity	Motor Size	cfm	Div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year	
rmen's	0	0.5	NA	1	12	0	7	52	0	
womens	0	0.5	NA	1	12	0	7	52	0	
kitchen makeup	0	0.75	NA	1	24	0	7	52	0	
Kitchen exhaust	1	15	NA	0.5	16	89	7	52	32572.176	
Kitchen exhaust	0	5	NA	1	12	0	7	52	0	
Total									32572.176	kwh/year
Energy savings				32,751.14	kwh/year					
cost savings =				$11,692.16	per year					

Estimated Construction Costs:

description	unit	quantity	unit cost	total
New fan controllers	ea	1	15000	15000
Revise /Expand DDC system	hours	2	8000	16000
Test and Balance	hours	1	2500	2500
SubTotal				$33,500.00
Total with mark-ups				$43,550.00
Simple Payback =				4

ESM-A4-Hilo **Replace pretreated outside air system - NA**

Assume 0% energy savings in ACU cooling with pretreated outside air

Current energy use for AHU						kwh/year
Energy use after pretreated system is replaced					0	kwh/year
Energy savings					0	kwh/year
cost savings =					$0.00	per year
Estimated Construction Costs:						
description	unit	quantity	unit cost	total		
Remove existing unit						
New Pretreated OA unit						
Duct Mods						
Electrical Power						
Controls						
Test and Balance						
SubTotal					$0.00	
Total with mark-ups					$0.00	
Simple Payback =				NA		

ECM-A5- Hilo **Replace Chiller with Higher Efficiency Unit - Not applicable. A new high efficiency chiller plant currently exists and was installed per Noresco's ECM-001**

Current energy use for Chiller: 0 kwh/year

Revised Energy Use

System	unit	Total Cooling Capacity (tons)	Motor Load (hp)	KW	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
chiller	All	150			0.54	0.5	24	972	7	52	353,808

Total			353,808
Energy savings	(353,808.00)	kwh/year	
cost savings =	($136,923.70)	per year	

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Chiller Replacement	tons	150	2000	300000
SubTotal				$300,000.00
Total with mark-ups				$390,000.00
Simple Payback =				(3)

ESM-A7-Hilo **Connect air cooled chilled water system to central water cooled chiller plant**

Current energy use for Chiller: 223,729 kwh/year

Revised Energy Use

System	unit	Total Cooling Capacity (tons)	Motor Load (hp)	KW	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
chiller	All	40			0.62	0.4	24	238.08	7	52	86,661

Total			86,661
Energy savings	137,067.88	kwh/year	
cost savings =	$41,120.36	per year	

Total		
Energy savings	0.00	kwh/year
cost savings =	$0.00	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Retain existing chiller as back-up unit				
New booster pump	ea	1	10000	10000
New control valves	ea	4	5000	20000
Pipe Mods	lf	2000	200	400000
Electrical Power	ls	1	10000	10000
Trenching and runing CHW piping	lf	1000	300	300000
Paving the Road	lf	100	400	40000
Controls	ls	1	10000	10000
Test and Balance	hours	80	100	8000
SubTotal				$798,000.00
Total with mark-ups				$978,774.45
Simple Payback =				24

ESM-E1-KVMH **New High Efficiency Lighting -NA**

Energy savings	0	kwh/year
cost savings =	$0.00	per year
Cost:		
subTotal	$0.00	
total with mark-ups	$0.00	
simple payback =	N/A	

ESM-E2-KVMH **New Lighting Controls - Provide Occupancy Sensors in Restrooms, Storage Areas and Offices**

Provide Occupancy Sensors in Restrooms, Storage Areas and Offices

Energy savings	3,010	kwh/year
cost savings =	$1,053.50	per year
Cost:		
subTotal	$5,778.00	
total with mark-ups	$7,086.92	
simple payback =	7	

ECM-E3-KVMH **Relamp - Replace T8 Fluorescent with super T-8**

Remove Fluorescent lamps and ballast, replace with 25W T8

Current energy use for lighting:				2370884	kwh/year
lighting use with super t8:				1925585	
Energy savings to convert t8 to super T8:				445,299	kwh/year
cost savings =				$172,330.71	per year
Estimated Construction Costs:					
description	unit	quantity	unit cost	total	
Remove Existing T8	ea	6888	$10	$68,880	
New Super T8	ea	6888	$120	$826,560	
subTotal				$895,440.00	
total with mark-ups				$987,598.68	
simple payback =				6	

ECM-R1-KVMH **Roofmount 100 KW PV system**

Estimated Electrical Yield:

100	kw Pv System x	4	sunhours/day x	0.9	inverter efficiency x	365	days/year =	131400	kwh/year
cost savings =								$50,851.80	per year

description	unit	quantity	unit cost	total
Reroof	sf	10000	$5	$50,000
PV system	kw	100	$4,000	$400,000
subTotal				$450,000.00
total with mark-ups				$496,314.00
simple payback =				10

PRELIMINARY ENERGY ASSESSMENT
FOR
KAUAI VETERANS MEMORIAL HOSPITAL
WAIMEA, HAWAII

HHSC TASK ORDER NO: 1.B.

December, 2012

INSYNERGY ENGINEERING INC

828 Fort Street Mall, Suite 500 • Honolulu, Hawaii 96813
Tel: 808 521-3773

Background:

This project evaluates and identifies the Energy Savings Measures (ESM's) that should be implemented to reduce energy utility costs and improve building system performance for Kauai Veterans Memorial Hospital in Waimea, Hawaii based on the facility assessment that was conducted on Dec 13, 2012. The scope of work for this project includes the evaluation of ESM's for water heating, air conditioning and ventilation, lighting, and controls.

The Kauai Veterans Memorial Hospital located in Waimea, Kauai is made up of three adjoining, single story concrete structures with an approximate overall area of 110,000 square feet. The original hospital building was constructed in the 1957. A new wing was built in 1978, and a Medical Surgery Unit was added in 1992. The hospital currently has 49 beds and offers a full range of services including: emergency, surgery, occupational therapy, and long term care. In 1993, and 1997 a two story Medical Office Building, including Dialysis suit was constructed adjacent to the hospital. The main hospital is operated continuously, 24 hours per day, 365 days per year. The most recent renovation was in 2001 to renovate the existing labor, delivery, and postpartum wing.

The following improvements were made to the facility under the ESPC project with Noresco:

- ECM-001: Replace Chiller and Cooling Towers
- ECM-002: Variable Volume Pumping and Upgraded Condenser Water Pumping
- ECM-003: Cogeneration system
- ECM-004: Remove Steam Boiler
- ECM-005: Install Energy Management Control System
- ECM-007: Lighting Efficiency Improvements
- ECM-010: Low-Flow Plumbing Fixtures
- ECM-011: Install Solar Window Film
- ECM-013: Strip Curtains for Walk-In Coolers
- ECM-014: Vending Machine Enhancements

Description of Existing Systems:

A variable volume chilled water system provides cooling for the1978 and 1992 sections of the hospital as well as the Medical Office Building. Air handling units are located in the ceiling spaces. The air handling units also have hydronic re-heat coils. Two 150 ton chillers located in the mechanical room provide chilled water. One of the original Carrier chiller was replaced with a new York 165 tons chiller in 2002. The chillers are cooled by two cooling towers located just outside the mechanical room. The original cooling towers have been replaced with two 160 tons CTS cooling towers. In addition to the conventional chilled water cooling plant, a co-generation system was installed in 1995. A 20 tons absorption chiller, cooling tower, and associated pumping system were added to supplement the chilled water system. Controls on majority of the HVAC system are pneumatic system.

The 1957 section of the hospital is cooled by one 20 tons York package air cooled chiller and numerous window air conditioning units. It cools the Dietary, the dining room, Physical therapy areas, and adjacent spaces. Approximately 29 window air conditioning units cool the patient rooms in the West Wing and several other rooms in Nursing and the East Wing.

The most recent renovated area is the labor and delivery, and post partum Wing. New chilled water fan coil units are provided with a dedicated outdoor cooling air handling unit. This area was completed in 2001.

Domestic hot water for the most of the hospital space is produced by the co-generation system. There is a backup Maxim Oil diesel fuel fired water heater, which was installed in 2002. In addition, there are two 200 gallons electric water heaters that provide domestic hot water to one of the older 1957 wings. Steam for Dietary, sterilizing, and hot water production is generated by a diesel fuel fired Lattner steam generator, which was also installed in 2002. There is no steam requirement for laundry since the hospital out-sources its laundry. Regular flow fixtures were replaced with low-flow fixtures as part of Noresco's energy conservation measure projects

Medical air, oxygen, nitrogen, nitrous oxide, and vacuum are provided in various locations throughout the hospital. Oxygen is supplied by a large liquid oxygen tank located outside near the mechanical room. Nitrogen and nitrous oxide are supplied by pressurized cylinders. There are two vacuum pumps, each with 5 hp motor. There are two medical air compressors, each with 1 hp motor.

LPG tanks are located in various places around the hospital property. There are also one 10,000 gallon diesel fuel underground storage tank that provides fuel to the Cogeneration generator, a backup emergency power generator, a steam generator, and the backup domestic water heater.

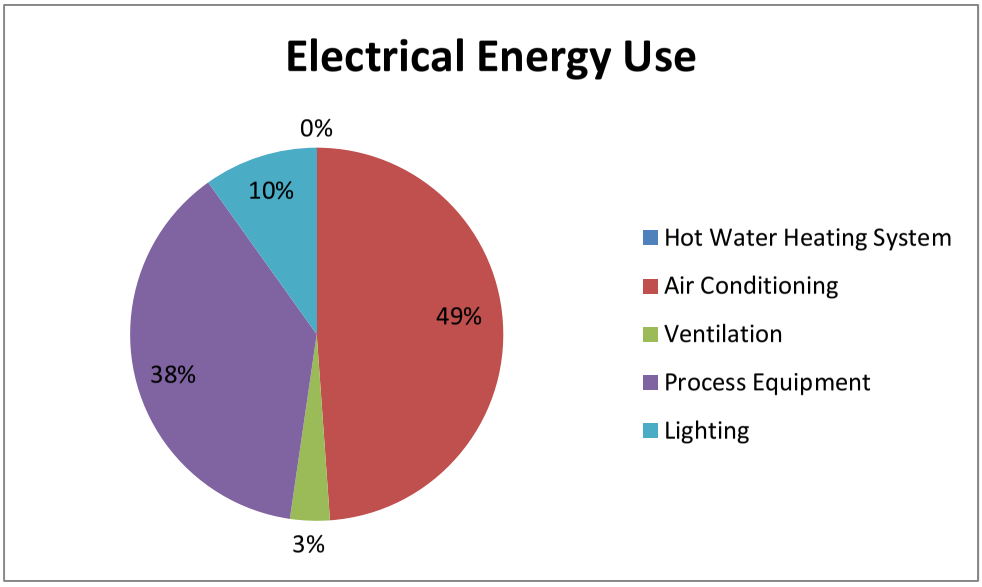
The entire facility is provided with an automatic fire sprinkler system.

Current Electrical Consumption:

Over the past two years, the facility consumed an average of 812,000 kwh of electricity at an average cost of $380,000 per year. The average cost for electricity was $.468 per kwh.

From our analysis, the breakdown of the electrical use is presented in the table below, with the majority of the electricity used for air conditioning:

Total Electrical Use	kw	% of total	Kwh/year	% of total
Hot Water Heating System	1	0%	0	0%
Air Conditioning	273	54%	1,258,861	49%
Ventilation	10	2%	88,489	3%
Process Equipment	193	38%	974,386	38%
Lighting	29	6%	254,235	10%
Total Electrical Use	506	100%	2,575,971	100%
Generator			-1,839,802	
Electricity from Grid			736,170	



Evaluation of ESM's:

Analysis of the ESM's that were considered for this facility was evaluated and is summarized in the following Table:

Hospital:		Kauai Veterans Memorial Hospital																	
		Electrical Consumption		Fuel Consumption				Elec Energy Savings		Fuel Savings				Other Savings		Total Savings	Construction Cost with Mark-ups	Simple Payback	SROI
Energy Savings Measure		KWh/Year	$/year - Elec	Gal/year Diesel	$/year - Diesel	Gal/year LPG	$/year - LPG	KWh/Year	$/year - Elec	Gal/year Diesel	$/year - Diesel	Gal/year LPG	$/year - LPG	$/Yr Avoided Replacement Cost	$/Yr Avoided Labor Cost	$/year	$	years	1/year
Number	Description																		
Baseline		2,575,971	$1,206,224	135,800	$577,150	2,142	$7,498	NA	NA	$0	$0	$0	$0	NA	NA	NA	NA	NA	NA
ECM-E4-KVMH	Relamp - Replace U-lamp Fluorescent with linear F17	2,552,383	$1,195,179	135,800	$577,150	2,142	$7,498	23,588	$11,045	0	$0	0	$0	$0	$0	$11,045	$21,507	2	0.51
ESM-A7-KVMH	Connect air cooled chilled water system to central water cooled chiller plant	2,442,659	$1,143,799	135,800	$577,150	2,142	$7,498	109,724	$51,379	0	$0	0	$0	$0	$0	$51,379	$169,262	3	0.30
ECM-E3-KVMH	Relamp - Replace T8 Fluorescent with super T-8	2,398,551	$1,123,145	135,800	$577,150	2,142	$7,498	44,108	$20,654	0	$0	0	$0	$0	$0	$20,654	$80,436	4	0.26
ESM-A8-KVMH	connect window a/c unit to central water cooled chiller plant	2,246,335	$1,051,869	135,800	$577,150	2,142	$7,498	152,216	$71,277	0	$0	0	$0	$0	$0	$71,277	$383,905	5	0.19
ECM-R1-KVMH	Roofmount 100 KW PV system	2,114,935	$990,339	135,800	$577,150	2,142	$7,498	131,400	$61,529	0	$0	0	$0	$0	$0	$61,529	$496,314	8	0.12
Total, Recommended ESM's		2,114,935	$990,339	135,800	$577,150	2,142	$7,498	461,036	$215,885	0	$0	0	$0	0	0	$215,885	$1,151,424	5	0.19
Additional ECM's Not Recommended:																			
ECM-A5-KVMH	Replace Chiller with Higher Efficiency Unit							39,312	$18,408							$18,408	$390,000	21	0.05

Based on this assessment, the following ESM's are cost effective and should be implemented to reduce energy consumption and associated utility costs for the facility:

ECM-E4 - KVMH : Relamp / Replace 35 watt U-lamp Fluorescent with 2ft, 17 watt T-8. The existing U-lamp fluorescent lamps in existing light fixtures should be replaced with linear high efficiency T8 lamps.

ESM-A7-KVMH: Connect the air cooled chiller system to the central water cooled chiller plant. The existing 20 ton air cooled chiller system should be connected to the main chiller plant which is more energy efficient.

ECM-E3 - KVMH : Relamp / Replace 34 watt T12 Fluorescent with 25 watt T-8. The existing linear fluorescent lamps in existing light fixtures should be replaced with high efficiency T8 lamps.

ESM-A8-KVMH: Existing window a/c units serving one of the older wings should be replaced with ceiling mounted chilled water fan coil units. Chilled water would be by the main chiller plant.

ECM-R1-KVMH :Roof-mount 100 KW PV system. Installation of a new PV system should be considered and appears to be viable.

The implementation of these recommended ESM's will save approximately $216,000 per year in utility costs at a construction cost of $1,150,000, resulting in a simple payback of 6 years.

The following other ESM's were not considered feasible or not recommended for implementation:

ECM-H3-KVMH: New Solar Water Heating System. Installation of a solar water heating system will save energy , but does not appear to be as cost effective as the installation of a chilled water source heat pump.

ECM-H4-KVMH: New Cogeneration Heating System: This is not applicable since there is an existing co-generation system.

ECM-A5- KVMH: Replace Chiller with Higher Efficiency Unit. Installation of a higher efficiency water cooled chiller was considered but the chiller that was installed as part of the ESPC project operates at .62 kw/ton, and the slight increase in efficiency with a new higher efficiency water cooled chiller will not be cost effective.

Appendix 1

HISTORICAL ENERGY USE

Hospital: KVMH

	Electrical Consumption - Fiscal Years 2009 - 2011 (Mwh)							
	2007	2008	2009	2010	2011	2012	Average	
Oct					63.0	47.3	55.1	
Nov					63.0	45.2	54.1	
Dec				79.4	49.1		64.3	
Jan					78.3	58.0	68.1	
Feb					66.2	37.2	51.7	
Mar					103.5	47.9	75.7	
Apr					104.6	43.7	74.2	
May					102.1	44.9	73.5	
Jun					64.1	88.2	76.1	
Jul					86.7	155.4	121.1	
Aug					49.6	51.0	50.3	
Sep					48.5	47.5	48.0	
totals				79.4	878.7	666.1	1,624.2	Mwh/year
Average Cost:		$0.4683	per kwh Non DOD Customers				$760,551	per year

KVMH Bulk Fuel

Propane Consumption:

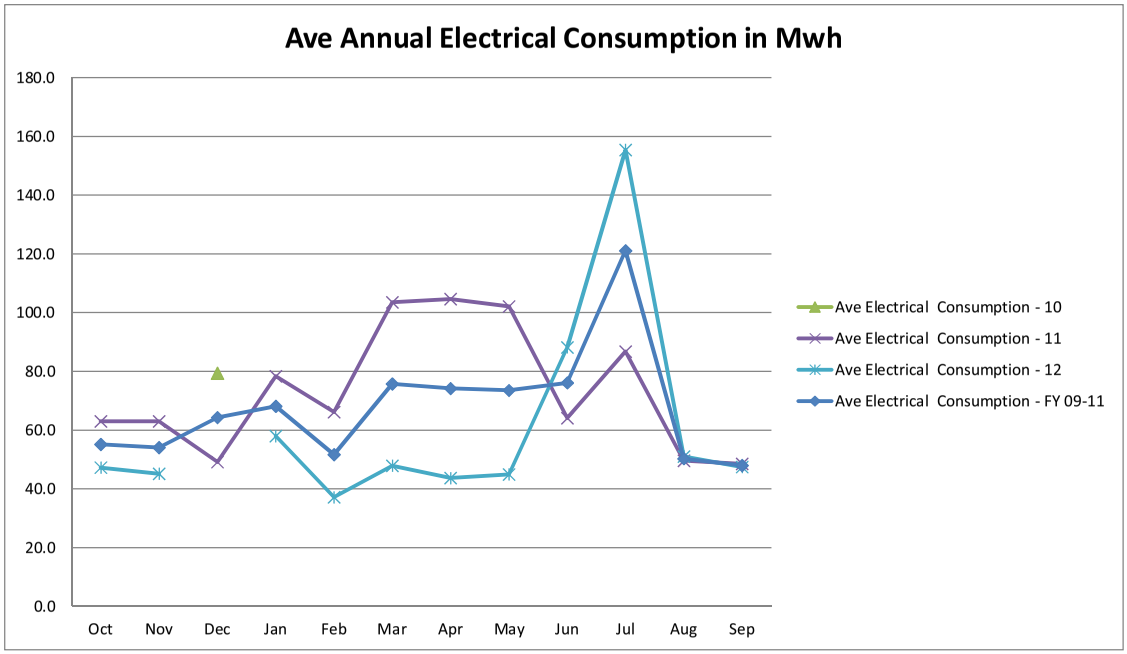
January – December 2011 2,488 gallons
January – November 2012 1,797 gallons
average 2,142

Gas Consumption:

January – December 2011 4,000 gallons (estimate)
January – November 2012 3,396 gallons
average 3,698

Diesel Consumption:

January – December 2011 150,000 gallons (estimate)
January – November 2012 121,600 gallons
average 135,800



Appendix 2

EQUIPMENT INVENTORY

Hospital: KVMH

Hot Water Heating - normal hot water demand is met by co-gen system

AC Systems

unit	Quantity	Cooling Capacity (tons)	Motor Load (hp)	KW	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
CH-1		150		0		0.5	0	0	7	52	0
CH-2		150		90	0.6	0.5	24	1080	7	52	393,120
CH-3 (absorbtion)		20		0.52			24	12.48	7	52	4,543
PAC-1		20		25	1.25	0.8	24	480	7	52	174,720
Ductless DX	2	3		6.6	1.1	0.8	24	126.72	7	52	46,126
Ductless DX	1	2.5		2.75	1.1	0.8	24	52.8	7	52	19,219
Window AC	33	1		36.3	1.1	0.8	24	696.96	7	52	253,693
CT-1 and 2	2		5	7.457		0.8	24	71.5872	7	52	26,058
CT-3	1		1.5	1.11855		0.8	24	21.47616	7	52	7,817
CHWP-1 and 2	2		7.5	11.1855		0.8	24	107.3808	7	52	39,087
CHWP-3 and 4	2		10	14.914		0.8	24	143.1744	7	52	52,115
EHWP-1 (heat medium	1		1.5	1.11855		0.8	24	21.47616	7	52	7,817
EHWP-2	1		1	0.7457		0.8	24	14.31744	7	52	5,212
CWP-1 and 2	2		15	22.371		0.8	24	214.7616	7	52	78,173
CWP-3	1		7.5	5.59275		0.8	24	107.3808	7	52	39,087
FCU-1 and others	11		0.416	3.413204		0.8	24	5.957592483	7	52	2,169
FCU-6	1		0.456	0.340319		0.8	24	6.534133691	7	52	2,378
FCU-7 and others	3		0.470	1.050987		0.8	24	6.726314094	7	52	2,448
FCU-16	1		0.275	0.205193		0.8	24	3.939698255	7	52	1,434
FCU-1 and 3	2		0.75	1.11855		0.8	24	10.73808	7	52	3,909
FCU-2	1		0.75	0.559275		0.8	24	10.73808	7	52	3,909
FCU-1A and others	4		0.75	2.2371		0.8	24	10.73808	7	52	3,909
FCU-1B and others	3		0.75	1.677825		0.8	24	10.73808	7	52	3,909
FCU-3	1		0.5	0.37285		0.8	24	7.15872	7	52	2,606
FCU-5	1		1	0.7457		0.8	24	14.31744	7	52	5,212
FCU-7 and others	2		0.75	1.11855		0.8	24	10.73808	7	52	3,909
FCU-9A and others	2		0.75	1.11855		0.8	24	10.73808	7	52	3,909
FCU-10 and others	3		1	2.2371		0.8	24	14.31744	7	52	5,212
FCU-11B and others	2		0.5	0.7457		0.8	24	7.15872	7	52	2,606
FCU-12B	1		1	0.7457		0.8	24	14.31744	7	52	5,212
FCU-13A	1		0.33	0.246081		0.8	24	4.7247552	7	52	1,720
FC-2 and others	6		0.387	1.729624		0.8	24	5.534795597	7	52	2,015
FC-8 and others	2		0.419	0.624586		0.8	24	5.996028564	7	52	2,183
FC-15	1		0.180	0.134526		0.8	24	2.582904612	7	52	940
FCU-1 and others	2		0.216	0.322303		0.8	24	3.094104483	7	52	1,126
FCU-2 and others	2		0.082	0.122015		0.8	24	1.171339554	7	52	426
FCU-3 and others	5		0.193	0.719425		0.8	24	2.762593289	7	52	1,006
FCU-8 and others	3		0.324	0.725181		0.8	24	4.641156725	7	52	1,689
AH-1 and others	6		1	4.4742		0.8	24	14.31744	7	52	5,212
AH-3 and others	4		1.5	4.4742		0.8	24	21.47616	7	52	7,817
AH-14 and others	2		3	4.4742		0.8	24	42.95232	7	52	15,635
AH-16 and others	6		2	8.9484		0.8	24	28.63488	7	52	10,423
AH-20 and others	4		0.75	2.2371		0.8	24	10.73808	7	52	3,909
AHU-1	1		0.750	0.559019		0.8	24	10.73315838	7	52	3,907
AHU-2	1		0.257	0.191664		0.8	24	3.679940016	7	52	1,339
sf		total	sf/ton	kw							kwh/yr
110000		381.5	288.3355177	273.3422	kw						1,258,861

Hospital: KVMH

Ventilation Systems

	quanitity	Motor Size	KW	cfm	Div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
EF-A	1	0.25	0.186425	2550	1.0	24	4	7	52	1,629
EF-15	1	0.25	0.186425	3000	1.0	24	4	7	52	1,629
EF-4	1	0.134228188	0.100094	165	1.0	24	2	7	52	874
EF-1 and 2	2	0.111409396	0.166156	195	1.0	24	4	7	52	1,452
PF-1	1	0.166666667	0.124283	800	1.0	24	3	7	52	1,086
PF-2	1	0.04	0.029828	150	1.0	24	1	7	52	261
EF-8 and 9	2	0.067114094	0.100094	100	1.0	24	2	7	52	874
EF-1 and 6	2	0.25	0.37285	240	1.0	24	9	7	52	3,257
EF-2	1	0.25	0.186425	1030	1.0	24	4	7	52	1,629
EF-3 and 5	2	0.25	0.37285	280	1.0	24	9	7	52	3,257
EF-4	1	0.25	0.186425	810	1.0	24	4	7	52	1,629
EF-7	1	1	0.7457	4750	1.0	24	18	7	52	6,514
EF-1 and others	13	0.25	2.423525	475	1.0	24	58	7	52	21,172
EF-2 and others	2	0.140939597	0.210197	100	1.0	24	5	7	52	1,836
EF-5 and others	2	0.0167	0.024906	180	1.0	24	1	7	52	218
EF-7 and others	2	0.174496644	0.260244	170	1.0	24	6	7	52	2,273
EF-12 and others	6	0.025	0.111855	320	1.0	24	3	7	52	977
EF-16 and others	4	0.033333333	0.099427	200	1.0	24	2	7	52	869
EF-19	1	0.142857143	0.106529	480	1.0	24	3	7	52	931
EF-26	1	0.014285714	0.010653	100	1.0	24	0	7	52	93
EF-30	1	0.0125	0.009321	75	1.0	24	0	7	52	81
EF-31	1	0.066666667	0.049713	215	1.0	24	1	7	52	434
EF-1	1	0.186577181	0.139131	234	1.0	24	3	7	52	1,215
EF-2	1	0.040268456	0.030028	234	1.0	24	1	7	52	262
EF-3 and others	6	0.120805369	0.540507	180	1.0	24	13	7	52	4,722
PRV-1 and others	4	0.25	0.7457	600	1.0	24	18	7	52	6,514
SF-1	1	0.5	0.37285	3200	1.0	24	9	7	52	3,257
SF-1	1	3	2.2371	15000	1.0	24	54	7	52	19,543
			kw							kwh/yr
Total ventilation			10.12924							88,489

Process Equipment

system

	quantity	Motor Size	KW	Capacity	Div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
Steam Generator	1	10	7.457	NA	1.0	24	179	7	52	65,144
HWRP	2	1	1.4914	NA	1.0	24	36	7	52	13,029
HWCP	3	0.5	1.11855	NA	1.0	24	27	7	52	9,772
Vaccum pump	1	5	3.7285	NA	1.0	24	89	7	52	32,572
Air Compresser	2	1	1.4914	NA	1.0	24	36	7	52	13,029
	sf	w/sf	kw			hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
Misc	110000	1.75	192.5			12	2,310	7	52	840,840
			kw							kwh/yr
Total Process System			192.5							974,386

Appendix 3

PROPOSED ESM'S/ECM'S

Hospital: **KVMH**

ESM-H1-KVMH **New Hot Water Heat Recovery System - NA (already have**

Normal hot water demand is met by running the co-gen system

Current energy use				0	gallons/year
Energy use with heat recovery desuperheater				0	gallons/year
Energy savings				0	gallons/year
cost savings =					per year
Estimated Construction Costs:					
description	unit	quantity	unit cost	total	
Demolition	hours	0	75	0	
New 40 Ton desuperheater	each	0	20000	0	
Refrigerant piping - 1.5 inch	lf	0	40	0	
HW pump	each	0	5000	0	
HW piping	lf	0	50	0	
HW tank - 200 gallons	each	0	6000	0	
Controls	ls	0	5000	0	
Test and Balance	ls	0	5000	0	
SubTotal				$0.00	
Total with mark-ups				$0.00	
Simple Payback =				#DIV/0!	

ECM-H2-KVMH **New Water Source Heat Pump Heating System (NA)**

Normal hot water demand is met by running the co-gen system

Current LPG energy use					gallons/year
Energy use with heat pump				0	gallons/year
LPG Energy savings				0	gallons/year
LPG cost savings =				$0.00	per year
Electrical Energy use with heat pump				0	kwh/year
Electrical Savings for chiller				0	kwh/year
Net Electrical use				0	kwh/year
Elec Energy Cost				0	$/year
Net Cost savings =				$0.00	per year
Estimated Construction Costs:					
description	unit	quantity	unit cost	total	
Demolition	hours				
New Heat Pump	each	0	2000	0	
HW pump	each	1	10000	10000	
CHW Pump	each	1	10000	10000	
piping	lf	200	50	10000	
HW tank	each	6,080	15	91200	
Controls	ls	1	20000	20000	
Test and Balance	ls	1	10000	10000	
SubTotal				$151,200.00	
Total with mark-ups				$196,560.00	
Simple Payback =				#DIV/0!	

ECM-H3-KVMH **New Solar Water Heating System -NA**

Normal hot water demand is met by running the co-gen system

Current energy use					gallons/year
Energy use with solar				0	gallons/year
Energy savings				0	gallons/year
cost savings =				$0.00	per year
Estimated Construction Costs:					
description	unit	quantity	unit cost	total	
Reroof	sf	0	10	0	
New Solar Panels	each	0	2500	0	
HW pump	each	2	10000	20000	
HW piping	lf	0	50	0	
HW tank	each	6,080	15	91200	
Controls	ls	1	20000	20000	
Test and Balance	ls	1	20000	20000	
Electrical	ls	1	20000	20000	
SubTotal				$171,200.00	
Total with mark-ups				$222,560.00	
Simple Payback =				#DIV/0!	

ECM-H4-KVMH **New Cogeneration Heating System (NA-already have)**

Absorption Chiller	30	tons
Absorption Chiller COP	0.8	COP
Avoided Electrical Chiller Efficiency	0.62	kw/ton
Generator	455	kw
Generator Electrical Efficiency	0.38	
Genertor Heat Recovery Efficiency	0.45	
cost for electricity	0.468259871	$/kwh
cost for diesel	4	gallon
cost for Lpg	3.5	gallon

Assume 90% energy savings by using a new heat recovery water source heat pump to heat hot water

LPG Heat Requirement for hot water and reheat water	220,085	Btu/hr
Additional Heat for Absorption Chiller	405,000	btu/hr
Total Heat Requirement	625,085	Btu/hr
Fuel Required to Operate Generator	10	gallons/hr
Annual Fuel Consumption	-88,176	gallons/yr
Annual Fuel Cost	($352,704.87)	$/yr
Current LPG energy use	26,309	gallons/year
Energy use with cogen	2,631	gallons/year
LPG Energy savings	23,678	gallons/year
LPG cost savings =	$82,874.20	per year
Avoided Electrical Chiller Energy Use	226,331	kwh/yr
Net Electrical Chiller Cost Savings	$105,981.59	$/yr
Total kwh electricity generated	1354808.353	kwh/yr
Total Avoided Electrical Cost Savings:	$634,402.38	$/yr
Additional Maintenance:	($27,096.17)	$/yr
Net Cost Savings:	$443,457.13	$/year

Additional Savings if Generator is run 90% of the time

Additional Electrical generated:	2232411.647	kwh/yr
Additional avoided electrical cost savings:	$1,045,348.79	$/yr
Additional Maintenance Cost:	($44,648.23)	$/yr
Additional Fuel Consumption:	-145,294	gallons/yr
Additional Fuel Cost	($581,176.27)	$/yr

ECM-H4-KVMH **New Cogeneration Heating System (NA-already have) - cont.**

Net Additional Cost Savings:				$419,524.28	$/yr	
Total LPG Savings				$82,874.20	gallons/year	
Total Electrical Savings				$1,785,732.77	$/yr	
Total Fuel Cost				($933,881.15)		
Total Maintenance Cost				($71,744.40)	$/yr	
Total Cost Savings				$862,981.41		$862,981.41
Total Net LPG Savings				23,678	gallons/year	
Total Net Electrical Energy Savings				3,813,551	kwh/year	1785732.767
Total Fuel Use				-233,470	gallons/year	

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Demolition	hours	3840	100	384000
New Generator	KW	455	3000	1365000
New Generator Heat Recovery	KW	455	1000	455000
New Absorption Chiller	tons	30	4000	120000
New Cooling tower	tons	30	1000	30000
HW pump	each	1	10000	10000
CHW Pump	each	1	10000	10000
CHW Pump	each	1	10000	10000
Fuel Pump	each	1	10000	10000
piping	lf	400	50	20000
HW tank	each	6,080	15	91200
Controls	ls	1	20000	20000
Test and Balance	ls	1	10000	10000
Electrical	ls	1	200000	200000
SubTotal				$2,735,200.00
Total with mark-ups				$3,555,760.00
Simple Payback =				4

ESM-A1-KVMH **Fix Supply Air Discharge Duct Leak - NA**

Current energy use for AHU				6514.4352	kwh/year	
Fan Power reduction without leak				0	kwh/year	
Energy savings				0	kwh/year	
cost savings =				$0.00	per year	
Estimated Construction Costs:						
description	unit	quantity	unit cost	total		
Repair Duct						
Rrepair Duct Materials						
Test and Balance						
SubTotal				$0.00		
Total with mark-ups				$0.00		
Simple Payback =				N/A		

ESM-A2-KVMH **Retrocommission AC system/reset time schedule to shutdown ac system after hours - NA**

Current energy use for ACU: kwh/year

Revised Schedule

System	unit	Cooling Capacity	Motor Load	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year	
											kwh/year
Energy savings					0.00	kwh/year					
cost savings =					$0.00	per year					

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Revise Time Schedule	hours	0	100	0
New Controls Settings	hours	0	100	0
Test and Balance	hours	0	100	0
SubTotal				$0.00
Total with mark-ups				$0.00
Simple Payback =				#DIV/0!

ESM-A3-KVMH **New Ventilation Fan controls - NA**

Current energy use for ventilation systems: kwh/year

Revised Schedule

system	quanitity	Motor Size	cfm	Div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year	
rmen's	1	0.5	NA	1	12	4	7	52	1628.6088	
womens	1	0.5	NA	1	12	4	7	52	1628.6088	
kitchen makeup	2	0.75	NA	1	12	13	7	52	4885.8264	
Kitchen exhaust	2	3	NA	1	12	54	7	52	19543.3056	
Kitchen exhaust	1	5	NA	1	12	45	7	52	16286.088	
Total									35829.3936	kwh/year
Energy savings				0.00	kwh/year					
cost savings =				$0.00	per year					

Estimated Construction Costs:

description	unit	quantity	unit cost	total
New fan controllers	ea	0	3000	0
Revise /Expand DDC system	hours	0	100	0
Test and Balance	hours	0	100	0
SubTotal				$0.00
Total with mark-ups				$0.00
Simple Payback =				NA

ESM-A4-KVMH **Replace pretreated outside air system - NA**

Assume 0% energy savings in ACU cooling with pretreated outside air

Current energy use for AHU													kwh/year
Energy use after pretreated system is replaced												0	kwh/year
Energy savings												0	kwh/year
cost savings =												$0.00	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Remove existing unit				
New Pretreated OA unit				
Duct Mods				
Electrical Power				
Controls				
Test and Balance				
SubTotal				$0.00
Total with mark-ups				$0.00
Simple Payback =				NA

ECM-A5- KVMH Replace Chiller with Higher Efficiency Unit

Current energy use for Chiller: 393,120 kwh/year

Revised Energy Use

System	unit	Total Cooling Capacity (tons)	Motor Load (hp)	KW	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
chiller	All	150			0.54	0.5	24	972	7	52	353,808
Total											353,808

Energy savings	39,312.00	kwh/year
cost savings =	$18,408.23	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Chiller Replacement	tons	150	2000	300000
SubTotal				$300,000.00
Total with mark-ups				$390,000.00
Simple Payback =				21

ESM-A7-KVMH **Connect air cooled chilled water system to central water cooled chiller plant**

Current energy use for Chiller: 174,720 kwh/year

Revised Energy Use

System	unit	Total Cooling Capacity (tons)	Motor Load (hp)	KW	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
chiller	All	30			0.62	0.4	24	178.56	7	52	64,996

Total		64,996
Energy savings	109,724.16	kwh/year
cost savings =	$51,379.42	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Retain existing chiller as back-up unit				
New booster pump	ea	1	10000	10000
New control valves	ea	4	5000	20000
Pipe Mods	lf	200	200	40000
Electrical Power	ls	1	10000	10000
CHW piping	lf	800	50	40000
Controls	ls	1	10000	10000
Test and Balance	hours	80	100	8000
SubTotal				$138,000.00
Total with mark-ups				$169,261.75
Simple Payback =				3

ESM-A8-KVMH connect window a/c unit to central water cooled chiller plant

Revised Energy Use

System	unit	Total Cooling Capacity (tons)	# of units	EER	KW	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
window units	All	1.5	33	12	1.5	-	0.4	24	712.8	7	52	259,459

System	unit	Total Cooling Capacity (tons)	Motor Load (hp)	KW	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
chiller	All	49.5			0.62	0.4	24	294.624	7	52	107,243
Total											107,243

Energy savings	152,216.06	kwh/year
cost savings =	$71,276.67	per year

Estimated Construction Cost

Description	unit	quantity	unit cost	total ($)	
1 ton fan coil unit	ea	30	1500	45,000	
control valves	ea	30	300	9,000	
CHW piping extension w/insulation	ft	500	50	25,000	2" pipe avg
Electrical power	ea	30	2500	75,000	
controls	ls	30	1000	30,000	
ductwork	lbs	30	700	21,000	
air devices	ea	60	150	9,000	
TAB	ea	30	300	9,000	
misc architetural work	ea	30	3000	90,000	window patch, ceiling work
Subtotal				313,000	
total with mark ups				383,905	
simple payback				5	

ESM-E1-KVMH **New High Efficiency Lighting -NA**

Energy savings	0	kwh/year
cost savings =	$0.00	per year
Cost:		
subTotal	$0.00	
total with mark-ups	$0.00	
simple payback =	N/A	

ESM-E2-KVMH **New Lighting Controls - Provide Occupancy Sensors in Restrooms, Storage Areas and Offices (NA)**

Provide Occupancy Sensors in Restrooms, Storage Areas and Offices

Energy savings	3,010	kwh/year
cost savings =	$1,409.46	per year
Cost:		
subTotal	$5,778.00	
total with mark-ups	$7,086.92	
simple payback =	5	

ECM-E3-KVMH **Relamp - Replace T8 Fluorescent with super T-8**

Remove Fluorescent lamps and ballast, replace with 25W T8

Current energy use for lighting:	166630	kwh/year
lighting use with super t8:	122522	
Energy savings to convert t8 to super T8:	44,108	kwh/year
cost savings =	$20,654.01	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Remove Existing T8	ea	561	$10	$5,610
New Super T8	ea	561	$120	$67,320
subTotal				$72,930.00
total with mark-ups				$80,435.96
simple payback =				4

ECM-R1-KVMH **Roofmount 100 KW PV system**

Estimated Electrical Yield:

100 kw Pv System x 4 sunhours/day x 0.9 inverter efficiency x 365 days/year = 131400 kwh/year

cost savings = $61,529.35 per year

description	unit	quantity	unit cost	total
Reroof	sf	10000	$5	$50,000
PV system	kw	100	$4,000	$400,000
subTotal				$450,000.00
total with mark-ups				$496,314.00
simple payback =				8

ECM-E4-KVMH **Relamp - Replace U-lamp Fluorescent with linear F17**

Remove Fluorescent U-lamps and ballast, replace with 17W linear lamps

Current energy use 35W U:				45864	kwh/year
Energy use with 17WT8:				22276	
Energy savings to convert :				23,588	kwh/year
cost savings =				$11,045.31	per year
Estimated Construction Costs:					
description	unit	quantity	unit cost	total	
Remove Existing U-lamp	ea	150	$10	$1,500	
New Super F17T8	ea	150	$120	$18,000	
subTotal				$19,500.00	
total with mark-ups				$21,506.94	
simple payback =				2	

PRELIMINARY ENERGY ASSESSMENT
FOR
KONA COMMUNITY HOSPITAL
KONA, HAWAII

HHSC TASK ORDER NO: 1.B.

December, 2012

INSYNERGY ENGINEERING INC

828 Fort Street Mall, Suite 500 • Honolulu, Hawaii 96813
Tel: 808 521-3773

Background:

This project evaluates and identifies the Energy Savings Measures (ESM's) that should be implemented to reduce energy utility costs and improve building system performance for Kona Hospital based on the facility assessment that was conducted on Dec 10, 2012. The scope of work for this project includes the evaluation of ESM's for water heating, air conditioning and ventilation, lighting, and controls.

The main building of the Kona Community Hospital located in Kona, Hawaii is a three story, concrete structure having an approximate overall area of about 80,000 square feet. The hospital currently has about 90 beds and offers a full range of services including the following: emergency, surgery, obstetrics, and long term care.

The main hospital building, was built in 1975. In 1991 a new wing was added, and in 1998 an adjacent two-story administration building (Special Services) was constructed. A psychiatric unit providing 13 beds was completed in 2001 and is a two story structure attached to the main hospital building. An oncology wing was also added within the last 15 years. The OB Room was recently renovated in 1999. X-Ray and the Darkroom were also recently renovated. .

The main hospital is operated continuously, 24 hours per day, 365 days per year.

The clinic spaces are operated (Mon-Sat): 8 am ~ 5 pm.

The following improvements were made to the facility under the ESPC project with Noresco:

- ECM-001: Chiller Plant Upgrade
- ECM-002: Cogeneration System
- ECM-004: Install Energy Management System
- ECM-005: Intelli-Hood VFD Control of Kitchen Exhaust
- ECM-007: Domestic Water Booster Pump System Upgrade
- ECM-008: Lighting System Improvements
- ECM-009: Premium Efficiency Motors
- ECM-010: Install Solar Window Film

Description of Existing Systems:

A variable volume chilled water system consisting of a primary and secondary chilled water pumping system provides cooling for the main hospital building. Air handling units are located on the roof and in the mechanical room on the first floor of the hospital. Fan coil units are also used throughout the hospital for individual rooms. Air handling units and fan coil units have reheat coils fed by a dedicated Ruud Commerical LPG-fired water heater located on the roof. Chilled water is provided by a 240 ton screw chiller that was provided under the ESCO project under ECM-001 and a 250 ton Trane centrifugal

chiller serves as back-up. Both chillers are in the first floor mechanical room. Evapco and Baltimore Air Coil cooling towers are located on the roof. Controls are DDC which were provided under ECM-004.

The Lab has three self-contained KoldWave air conditioning units separate from the central chilled water system. Two of the units are water cooled by once-through domestic cold water systems which are dumped to drain. The third is air-cooled.

A 20 ton Trane air-cooled chiller located on the roof provides back-up cooling for OR and ICU. The Special Services building is cooled primarily by a 50 ton Carrier air-cooled chiller in a constant volume system. Several air handling units are located in the ceiling serving the various spaces. Two Mitsubishis mini ductless split systems also provide some cooling. An air cooled chiller was provided for the psychiatric unit under the original design, but is no longer utilized. The air handling units serving this area have been connected to the main chilled water system serving the remainder of the hospital

Restroom facilities and patient room restrooms are provided with exhaust systems. The kitchen is equipped with a hood for exhausting of the cooking line. The exhaust fan is located on the roof. A VFD system was installed on the kitchen exhaust under ECM-005.

The hospital has one negative pressure room with only slight negative pressure according to maintenance personnel. A portable recirculating HEPA unit providing 20 ACH is available to clean the air. There are also four isolation rooms.

An LPG-fired incinerator has been installed on the property but is currently not being used and is scheduled for demolition to make room for a new fire pump building.

Regular flow fixtures (i.e. not low flow) are used throughout the hospital. The fixtures are the original equipment. A cold water booster pump station is located in the first floor mechanical room. The booster pump system was replaced under ECM-007.

Hot water is provided by three Ruud Commercial LPG-fired water heaters located on the roof. A cogeneration system consisting of a 455 kw Generator, a 30 to absorption chiller, and heat recovery exchangers to operate the absorption chiller, and to generate domestic hot water and reheat water was previously provided under ECM-002. However the system has not been operational for the past 5 years due to equipment failures.

The hospital has a few electric, self generating steam sterilizers. Service steam is not produced at the hospital.

The hospital has a laundry facility which is currently located in a small room across the hall from Dietary. The facility has a GE residential type washer, two 55 lb. capacity Milnor washers, two Milnor LPG-fired dryers, and a GE residential type dryer. The hospital is considering providing laundering service for the adjacent Dialysis operated by St. Francis.

Medical gases provided include oxygen and nitrous oxide. Medical vacuum is also provided. Oxygen is supplied by a large liquid oxygen tank located on a pad at the rear of the hospital. An Ohmeda vacuum

pump located in the mechanical room supplies the vacuum. Currently nitrous oxide is supplied by pressurized cylinders located in a small room near the emergency entrance and also located in a small room in OB. The hospital would like to see the cylinders moved outside and closer to the oxygen tank.

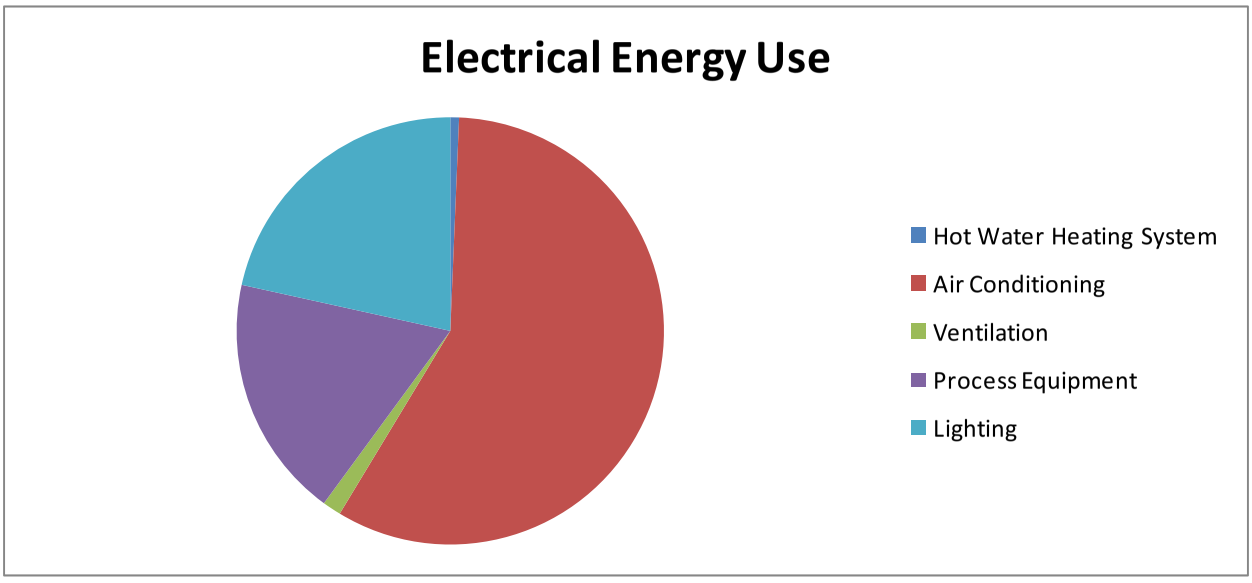
The lighting in the hospital was previously upgraded as part of ECM-008: Lighting System Improvements.

Current Electrical Consumption:

Over the past year, the facility consumed 3,895,325 kwh of electricity at a total cost of $1,398,532.14. The average cost for electricity was $.359 per kwh, and the average peak demand charge was 665 kw.

From our analysis, the breakdown of the electrical use is presented in the table below, with the majority of the electricity used for air conditioning:

	Total Electrical Use	kw	% of total	Kwh/year	% of total
	Hot Water Heating System	0	0%	26,309	1%
	Air Conditioning	669	60%	2,334,013	58%
	Ventilation	83	1%	57,000	1%
	Process Equipment	210	21%	740,180	18%
	Lighting	29	3%	866,558	22%
	Total Electrical Use	993	100%	4,024,061	100%



The hospital also uses over 26,300 gallons of LPG for heating, which amounts to an additional cost of 131,546 per year at a cost for LPG of $5 per gallon.

From our analysis, the breakdown of the LPG use is presented in the table below, with the majority of the LPG used for patient domestic hot water use and the laundry:

Total LPG Use		Lpg gallons	% of total
	patient	9,428	36%
	cooking	1,231	4.6%
	laundry	9,931	37.7%
	reheat	5,720	21.7%
	Total	26,309	100%

Evaluation of ESM's:

Analysis of the ESM's that were considered for this facility was evaluated and is summarized in the following Table:

Hospital: Kona Community Hospital

Energy Savings Measure		Electrical Consumption		Fuel Consumption				Elec Energy Savings		Fuel Savings				Other Savings		Total Savings	Construction Cost with Mark-ups	Simple Payback	SROI
		KWh/Year	$/year - Elec	Gal/year Diesel	$/year - Diesel	Gal/year LPG	$/year - LPG	KWh/Year	$/year - Elec	Gal/year Diesel	$/year - Diesel	Gal/year LPG	$/year - LPG	$/Yr Avoided Replacement Cost	$/Yr Avoided Labor Cost	$/year	$	years	1/year
Number	Description																		
Baseline		3,895,401	$1,386,763	$0	$0	26,309	131,546	NA	NA	$0	$0	$0	$0	NA	NA	NA	NA	NA	NA
ESM-A7-Kona	Connect air cooled chilled water system to central water cooled chiller plant	3,750,733	$1,343,362	0	$0	26,309	$131,546	144,668	$43,400	0	$0	0	$0	$0	$0	$43,400	$120,200	3	0.36
ECM-H2-Kona	New Water Source Heat Pump Heating System	3,546,549	$1,285,124	0	$0	26,309	$131,546	204,184	$58,238	0	$0	0	$0	$0	$0	$58,238	$345,576	6	0.17
ECM-E3	Relamp - Replace T8 Fluorescent with super T-8	3,345,444	$1,212,922	0	$0	26,309	$131,546	201,105	$72,202	0	$0	0	$0	$0	$0	$72,202	$357,015	5	0.20
ECM-R1	Roofmount 100 KW PV system	3,214,044	$1,165,745	0	$0	26,309	$131,546	131,400	$47,176	0	$0	0	$0	$0	$0	$47,176	$496,314	11	0.10
Total, Recommended ESM's		3,214,044	$1,165,745	0	$0	26,309	$131,546	681,358	$221,018	0	$0	0	$0	0	0	$221,018	$1,319,105	6	0.17
Additional ECM's Not Recommended:																			
ECM-H3-Kona	New Solar Water Heating System											22363	$111,814			$111,814	$756,335	7	0.15
ECM-H4-Kona	New Cogeneration Heating System							3,813,551	$1,369,173	-$233,470	-$933,881	23678	$118,392		-$71,744	$481,939	$3,555,760	7	0.14
ECM-A5- Kona	Replace Chiller with Higher Efficiency Unit							83,866	$25,160							$25,160	$624,000	25	0.04

Based on this assessment, the following ESM's are cost effective and should be implemented to reduce energy consumption and associated utility costs for the facility:

ESM-A7-Kona: Connect the air cooled chiller system to the central water cooled chiller plant. The existing 50 ton air cooled chiller system should be connected to the main chiller plant which is more energy efficient.

ECM-H2-Kona: New Water Source Heat Pump Heating System . A new chilled water source heat pump should be installed to provide domestic hot water, reheat water, and preheated water to the laundry. This ECM appears to be more cost effective than the installation of a solar thermal hot water heating system or the restoration of the cogeneration system.

ECM-E3 - Kona : Relamp / Replace T8 Fluorescent with super T-8. The existing linear fluorescent lamps in existing light fixtures should be replaced with high efficiency T8 lamps.

ECM-R1-Kona: Roofmount 100 KW PV system. Installation of a new PV system should be considered and appears to be viable.

The implementation of these recommended ESM's will save approximately $221,000 per year in utility costs at a construction cost of $1,320,000, resulting in a simple payback of 6 years.

The following other ESM's were not considered feasible or not recommended for implementation:

ECM-H3-Kona: New Solar Water Heating System. Installation of a solar water heating system will save energy, but does not appear to be as cost effective as the installation of a chilled water source heat pump.

ECM-H4-Kona: New Cogeneration Heating System: Installation of a cogeneration system will also save energy , but does not appear to be as cost effective as the installation of a chilled water source heat pump.

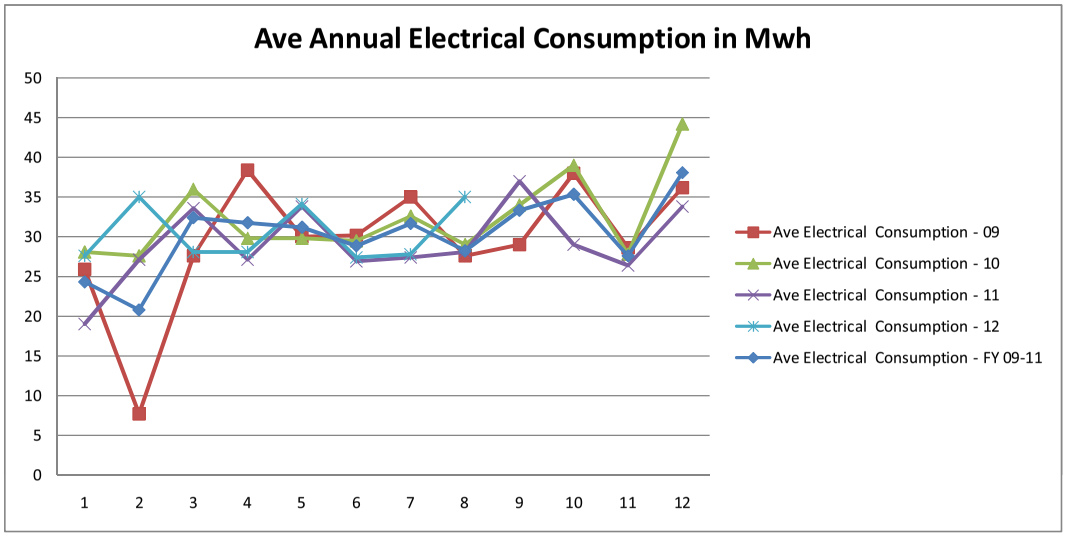
ECM-A5- Kona: Replace Chiller with Higher Efficiency Unit. Installation of a higher efficiency water cooled chiller was considered but the chiller that was installed as part of the ESPC project operates at .62 kw/ton, and the slight increase in efficiency with a new higher efficiency water cooled chiller will not be cost effective.

Appendix 1

HISTORICAL ENERGY USE

Hospital: Kona

	Electrical Consumption - Fiscal Years 2009 - 2011 (Mwh)							
	2007	2008	2009	2010	2011	2012	Average	
Oct			25.9	28.1	19	27.6	24.3	
Nov			7.7	27.6	27.1	35	20.8	
Dec			27.6	36	33.6	28.1	32.4	
Jan			38.4	29.8	27.1	28.1	31.8	
Feb			30	29.8	33.8	34.1	31.2	
Mar			30.2	29.5	26.9	27.4	28.9	
Apr			35	32.6	27.4	27.8	31.7	
May			27.6	29	28.1	35	28.2	
Jun			29	34	37		33.3	
Jul			38	39	29		35.3	
Aug			28.6	27.8	26.4		27.6	
Sep			36.2	44.2	33.8		38.1	
totals			354.2	387.4	349.2		363.6	Mwh/year
Average Cost:		$0.36	per kwh Non DOD Customers				$129,442	per year



Appendix 2

EQUIPMENT INVENTORY

Hospital: Kona

	Electrical Consumption - Fiscal Years 2009 - 2011 (Mwh)									See attached 2 year history						
											1-13-10 to 1/12/11			1-13-11 to 1/12/12		
											ave peak KW	KWH/year	$/yr	ave peak KW	KWH/year	$/yr
Oct										9600-6247-001-3	0.9	1145	1048.35	5	2271	1631.82
Nov										8602-4927-001-5	0	1593	946.34	0	1640	1069.09
Dec										8602-4926-001-6	0	16831	6206.28	0	16000	7205.5
Jan										8602-4930-001-0	0	1169	793.47	0	648	643.65
Feb										8602-4928-001-4	0	12477	4332.59	0	13166	5555.92
Mar										8602-4929-001-3	611	3648000	1069170	660	3861600	1382426.16
Apr																
May																
Jun										Totals	611.9	3681215	1082497.1	665	3895325	1398532.14
Jul																
Aug										ave cost per kwh		0.294059725			0.35902836	
Sep																
totals	0	0		0	0	0		0.0	Mwh/year	ave cost per gallon LPG					5	
Average Cost:		$0.36		per Kwh				$0	per year							

Hot Water Heating

	unit	heating capcity		unit	unit of measure		quantity	hot water/unit	total hw use	heater efficiency	temperature rise	LPG consumption (gallons/day)	days/week	weeks/year	total gallons LPG	
	GWH-1-4	399,000		Btu/hr	patient		93.00	35.0	3,255.00	0.80	70.00	25.90	7.00	52.00	9,428	
					cooking		170.00	2.5	425.00	0.80	70.00	3.38	7.00	52.00	1,231	
					laundry		1,200.00	2.0	2,400.00	0.80	100.00	27.28	7.00	52.00	9,931	
					reheat							15.71423581	7.00	52.00	5,720	
Total, Hot Water Heating		399,000		kw					6,080			57			26,309	gallons/year

AC Systems

	System	unit	Quantity	Cooling Capacity (tons)	Motor Load (hp)	KW	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year			
	1	CH-1 (Water Cooled)		240		148.8	0.62	0.5	24	1785.6	7	52	649,958			
		SCHWP-1			20	14.914		0.8	24	286.3488	7	52	104,231			
		PCHWP-1			20	14.914		0.8	24	286.3488	7	52	104,231			
		CT-1			20	14.914		0.8	24	286.3488	7	52	104,231			
		CDWP -1			20	14.914		0.8	24	286.3488	7	52	104,231			
		CH(Air Cooled)		50		60	1.2	0.4	24	576	7	52	209,664			
		CHWP			15	11.1855		0.8	24	214.7616	7	52	78,173			
		AH-G-1	1	6.1		4.6		0.8	24	87.575008	7	52	31,877			
		AH-G-2	1	10.8		8.1		0.8	24	155.1056	7	52	56,458			
		AH-G-3	1	9.8		7.3		0.8	24	139.59504	7	52	50,813			
		AH-G-4	1	13.2		9.8		0.8	24	188.51296	7	52	68,619			
		AH-G-5	1	4.4		3.3		0.8	24	63.23536	7	52	23,018			
		AH-G-6	1	3.3		2.5		0.8	24	47.12824	7	52	17,155			
		AH-G-7	1	3.3		2.5		0.8	24	47.12824	7	52	17,155			
		AH-G-8	1	2.9		2.1		0.8	24	40.924016	7	52	14,896			
		AH-G-9	1	2.6		1.9		0.8	24	36.748096	7	52	13,376			
		AH-G-10	1	3.9		2.9		0.8	24	55.599392	7	52	20,238			
		AH-G-11	1	3.7		2.7		0.8	24	52.258656	7	52	19,022			
		AH-G-12	1	5.7		4.2		0.8	24	81.13216	7	52	29,532			
		AH-F-1	1	5.2		3.9		0.8	24	75.047248	7	52	27,317			
		AH-F-2	1	1.9		1.4		0.8	24	27.799696	7	52	10,119			
		AH-F-3	1	3.8		2.8		0.8	24	54.28696	7	52	19,760			
		AH-F-4	1	2.7		2.0		0.8	24	38.657088	7	52	14,071			
		AH-F-5	1	6.0		4.5		0.8	24	86.023952	7	52	31,313			
		AH-F-6	1	3.2		2.4		0.8	24	46.173744	7	52	16,807			
		AH-F-7	1	3.4		2.6		0.8	24	49.275856	7	52	17,936			
		AH-F-8	1	1.5		1.1		0.8	24	21.237536	7	52	7,730			
		AH-S-1	1	4.5		3.4		0.8	24	65.02504	7	52	23,669			
		AH-S-2	1	4.4		3.3		0.8	24	62.877424	7	52	22,887			
		FC-G-1	1	0.6		0.5		0.8	24	8.829088	7	52	3,214			
		FC-G-2	1	0.4		0.3		0.8	24	6.084912	7	52	2,215			
		FC-F-1	1	0.8		0.6		0.8	24	11.9312	7	52	4,343			
		FC-F-2	1	0.4		0.3		0.8	24	5.9656	7	52	2,171			
		FC-F-3	17	0.7		0.5		0.8	24	166.320928	7	52	60,541			
		FC-S-1	22	0.8		0.6		0.8	24	262.4864	7	52	95,545			
		FC-S-2	1	1.0		0.8		0.8	24	14.914	7	52	5,429			
		AH-G-1A	1	2.0		1.5		0.8	24	28.396256	7	52	10,336			
		AH-F-1A	1	3.6		2.7		0.8	24	51.065536	7	52	18,588			
		AH-F-2A	1	4.2		3.1		0.8	24	59.656	7	52	21,715			
		AH-F-3A	1	2.7		2.0		0.8	24	38.17984	7	52	13,897			
		AH-F-4A	1	7.4		5.5		0.8	24	105.233184	7	52	38,305			
		AH-F-5A	1	5.1		3.8		0.8	24	72.422384	7	52	26,362			
		AH-F-6A	1	2.0		1.5		0.8	24	28.992816	7	52	10,553			
		AH-S-1A	1	4.3		3.2		0.8	24	62.04224	7	52	22,583			
		AH-S-2A	1	3.3		2.5		0.8	24	47.7248	7	52	17,372			
		AH-S-3A	1	4.8		3.6		0.8	24	68.6044	7	52	24,972			
		AH-S-4A	1	4.5		3.4		0.8	24	64.42848	7	52	23,452			
		AH-S-5A	1	4.6		3.4		0.8	24	65.740912	7	52	23,930			
		AHU/ACCU				0	1.1	0.4	24	0	7	52	0			
		AHU/ACCU				0	1.1	0.4	24	0	7	52	0			
		AHU/ACCU				0	1.1	0.4	24	0	7	52	0			
		AHU/ACCU				0	1.1	0.4	24	0	7	52	0			
		AHU/ACCU				0	1.1	0.4	24	0	7	52	0			
		AHU/ACCU				0	1.1	0.4	24	0	7	52	0			
		AHU/ACCU				0	1.1	0.4	24	0	7	52	0			
		AHU/ACCU				0	1.1	0.4	24	0	7	52	0			
		sf		total	sf/ton											
Total ac		80000		240	333.3333333	398.562	kw						2,334,013	kwh/yr		

Ventilation Systems

	system			quanitity	Motor Size	KW	cfm	Div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year	
	Mechanical Room SF			1	1	0.7457	NA	1.0	24	18	7	52	6,514	
	Mechanical Room EF			1	0.25	0.186425	NA	1.0	24	4	7	52	1,629	
	EF-R-2			1	7.5	5.59275	NA	1.0	24	134	7	52	48,858	
					0.25	0.186425	NA	1.0	24	0	7	52	0	
Total ventilation						6.7113	kw						57,001	kwh/yr
Process Equipment														
	system			quantity	Motor Size	KW	Capacity	Div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year	
	Cold Water Booster			1	5	3.7285	NA	1.0	24	89	7	52	32,572	
	Vaccum Pump			1	7.5	5.59275	NA	1.0	24	134	7	52	48,858	
	Shop Air Compressor			1	2	1.4914	NA	1.0	24	36	7	52	13,029	
	Domestic Hot Water Return Pump			1	0.25	0.186425	NA	1.0	24	4	7	52	1,629	
	Reheat Pump			1	5	3.7285	NA	1.0	24	89	7	52	32,572	

				sf	w/sf									
	Misc			80000	1.75	140			12	1,680	7	52	611,520	
Total Process System						140	kw						740,180	kwh/yr
					kwh/yr	kw								
Lighting From lighting calc spreadsheet					866558	114								
					kwh/yr	kw								
Total Lighting					866558	114								

0.4

Total Electrical Use	kw	% of total	kwh		% of total
Hot Water Heating System	0	0%	26,309		1%
Air Conditioning	399	60%	2,334,013		58%
Ventilation	7	1%	57,001		1%
Process Equipment	140	21%	740,180		18%
Lighting	114	17%	866,558		22%
Total Electrical Use	659	100%	4,024,061		100%
Total Electrical Cost			$1,432,565.89		

Total LPG Use	Lpg gallons	% of total
patient	9,428	0.358344867
cooking	1,231	0.0467885
laundry	9,931	0.377453447
reheat	5,720	0.217413186
Total	26,309	1
	131,546	5

Appendix 3

PROPOSED ESM'S/ECM'S

Hospital: Kona

ESM-H1-Kona New Hot Water Heat Recovery System - NA (water cooled chiller not appropriate for heat recovery

Assume 90% energy savings by using a new heat recovery desuperheater to heat hot water

Current energy use	0	gallons/year
Energy use with heat recovery desuperheater	0	gallons/year
Energy savings	0	gallons/year
cost savings =		per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Demolition	hours	0	75	0
New 40 Ton desuperheater	each	0	20000	0
Refrigerant piping - 1.5 inch	lf	0	40	0
HW pump	each	0	5000	0
HW piping	lf	0	50	0
HW tank - 200 gallons	each	0	6000	0
Controls	ls	0	5000	0
Test and Balance	ls	0	5000	0
SubTotal				$0.00
Total with mark-ups				$0.00
Simple Payback =				#DIV/0!

ECM-H2-Kona New Water Source Heat Pump Heating System

Assume 100% energy savings by using a new heat recovery water source heat pump to heat hot water

Current LPG energy use	26,309	gallons/year
Energy use with heat pump	0	gallons/year
LPG Energy savings	26,309	gallons/year
LPG cost savings =	$131,546.34	per year
Electrical Energy use with heat pump	256,765	kwh/year
Electrical Savings for chiller	52,580	kwh/year
Net Electrical use	204,184	kwh/year
Elec Energy Cost	73,308	$/year
Net Cost savings =	$58,238.35	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Demolition	hours			
New Heat Pump	each	57.31376	2000	114627.5198
HW pump	each	1	10000	10000
CHW Pump	each	1	10000	10000
piping	lf	200	50	10000
HW tank	each	6,080	15	91200
Controls	ls	1	20000	20000
Test and Balance	ls	1	10000	10000
SubTotal				$265,827.52
Total with mark-ups				$345,575.78
Simple Payback =				6

ECM-H3-Kona New Solar Water Heating System

Assume 85% energy savings by using a new solar thermal system to heat hot water

Current energy use	26,309	gallons/year
Energy use with solar	3,946	gallons/year
Energy savings	22,363	gallons/year
cost savings =	$111,814.39	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Reroof	sf	4951.909	10	49519.08855
New Solar Panels	each	103.1648	2500	257911.9195
HW pump	each	2	10000	20000
HW piping	lf	2063.295	50	103164.7678
HW tank	each	6,080	15	91200
Controls	ls	1	20000	20000
Test and Balance	ls	1	20000	20000
Electrical	ls	1	20000	20000
SubTotal				$581,795.78
Total with mark-ups				$756,334.51
Simple Payback =				7

ECM-H4-Kona New Cogeneration Heating System

Absorption Chiller	30	tons
Absorption Chiller COP	0.8	COP
Avoided Electrical Chiller Efficiency	0.62	kw/ton
Generator	455	kw
Generator Electrical Efficiency	0.38	
Genertor Heat Recovery Efficiency	0.45	
cost for electricity	0.359028358	$/kwh
cost for diesel	4	gallon
cost for Lpg	5	gallon

Assume 90% energy savings by using a new heat recovery water source heat pump to heat hot water

LPG Heat Requirement for hot water and reheat water	220,085	Btu/hr
Additional Heat for Absorption Chiller	405,000	btu/hr
Total Heat Requirement	625,085	Btu/hr
Fuel Required to Operate Generator	10	gallons/hr
Annual Fuel Consumption	-88,176	gallons/yr
Annual Fuel Cost	($352,704.87)	$/yr
Current LPG energy use	26,309	gallons/year
Energy use with cogen	2,631	gallons/year
LPG Energy savings	23,678	gallons/year
LPG cost savings =	$118,391.71	per year
Avoided Electrical Chiller Energy Use	226,331	kwh/yr
Net Electrical Chiller Cost Savings	$81,259.15	$/yr
Total kwh electricity generated	1354808.353	kwh/yr
Total Avoided Electrical Cost Savings:	$486,414.62	$/yr
Additional Maintenance:	($27,096.17)	$/yr
Net Cost Savings:	$306,264.43	$/year

Additional Savings if Generator is run 90% of the time

Additional Electrical generated:	2232411.647	kwh/yr
Additional avoided electrical cost savings:	$801,499.09	$/yr
Additional Maintenance Cost:	($44,648.23)	$/yr
Additional Fuel Consumption:	-145,294	gallons/yr
Additional Fuel Cost	($581,176.27)	$/yr
Net Additional Cost Savings:	$175,674.58	$/yr

Total LPG Savings	$118,391.71	gallons/year	
Total Electrical Savings	$1,369,172.85	$/yr	
Total Fuel Cost	($933,881.15)		
Total Maintenance Cost	($71,744.40)	$/yr	
Total Cost Savings	$481,939.01		$481,939.01
Total Net LPG Savings	23,678	gallons/year	
Total Net Electrical Energy Savings	3,813,551	kwh/year	1369172.854
Total Fuel Use	-233,470	gallons/year	

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Demolition	hours	3840	100	384000
New Generator	KW	455	3000	1365000
New Generator Heat Recovery	KW	455	1000	455000
New Absorption Chiller	tons	30	4000	120000
New Cooling tower	tons	30	1000	30000
HW pump	each	1	10000	10000
CHW Pump	each	1	10000	10000
CHW Pump	each	1	10000	10000
Fuel Pump	each	1	10000	10000
piping	lf	400	50	20000
HW tank	each	6,080	15	91200
Controls	ls	1	20000	20000
Test and Balance	ls	1	10000	10000
Electrical	ls	1	200000	200000
SubTotal				$2,735,200.00
Total with mark-ups				$3,555,760.00
Simple Payback =				7

ESM-A1-Kona Fix Supply Air Discharge Duct Leak - NA

Current energy use for AHU					6514.4352	kwh/year
Fan Power reduction without leak					0	kwh/year
Energy savings					0	kwh/year
cost savings =					$0.00	per year
Estimated Construction Costs:						
description	unit	quantity	unit cost	total		
Repair Duct						
Rrepair Duct Materials						
Test and Balance						
SubTotal					$0.00	
Total with mark-ups					$0.00	
Simple Payback =				N/A		

ESM-A2-Kona Retrocommission AC system/reset time schedule to shutdown ac system after hours - NA

Current energy use for ACU: kwh/year

Revised Schedule

System	unit	Cooling Capacity	Motor Load	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year	
											kwh/year
Energy savings										0.00	kwh/year
cost savings =										$0.00	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Revise Time Schedule	hours	0	100	0
New Controls Settings	hours	0	100	0
Test and Balance	hours	0	100	0
SubTotal				$0.00
Total with mark-ups				$0.00
Simple Payback =				#DIV/0!

ESM-A3-Kona New Ventilation Fan controls - NA

Current energy use for ventilation systems: kwh/year

Revised Schedule

system	quanitity	Motor Size	cfm	Div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year	
rmen's	1	0.5	NA	1	12	4	7	52	1628.6088	
womens	1	0.5	NA	1	12	4	7	52	1628.6088	
kitchen makeup	2	0.75	NA	1	12	13	7	52	4885.8264	
Kitchen exhaust	2	3	NA	1	12	54	7	52	19543.3056	
Kitchen exhaust	1	5	NA	1	12	45	7	52	16286.088	
Total									35829.3936	kwh/year
Energy savings									0.00	kwh/year
cost savings =									$0.00	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
New fan controllers	ea	0	3000	0
Revise /Expand DDC system	hours	0	100	0
Test and Balance	hours	0	100	0
SubTotal				$0.00
Total with mark-ups				$0.00
Simple Payback =				NA

ESM-A4-Kona Replace pretreated outside air system - NA

Assume 0% energy savings in ACU cooling with pretreated outside air

Current energy use for AHU						kwh/year
Energy use after pretreated system is replaced					0	kwh/year
Energy savings					0	kwh/year
cost savings =					$0.00	per year
Estimated Construction Costs:						
description	unit	quantity	unit cost	total		
Remove existing unit						
New Pretreated OA unit						
Duct Mods						
Electrical Power						
Controls						
Test and Balance						
SubTotal					$0.00	
Total with mark-ups					$0.00	
Simple Payback =				NA		

ECM-A5- Kona Replace Chiller with Higher Efficiency Unit

Current energy use for Chiller: 649,958 kwh/year

Revised Energy Use

System	unit	Total Cooling Capacity (tons)	Motor Load (hp)	KW	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
chiller	All	240			0.54	0.5	24	1555.2	7	52	566,093
Total											566,093
Energy savings											83,865.60 kwh/year
cost savings =											$25,159.68 per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Chiller Replacement	tons	240	2000	480000
SubTotal				$480,000.00
Total with mark-ups				$624,000.00
Simple Payback =				25

ESM-A7-Kona Connect air cooled chilled water system to central water cooled chiller plant

Current energy use for Chiller: 209,664 kwh/year

Revised Energy Use

System	unit	Total Cooling Capacity (tons)	Motor Load (hp)	KW	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
chiller	All	30			0.62	0.4	24	178.56	7	52	64,996

Total 64,996
Energy savings 144,668.16 kwh/year
cost savings = $43,400.45 per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Retain existing chiller as back-up unit				
New booster pump	ea	1	10000	10000
New control valves	ea	4	5000	20000
Pipe Mods	lf	200	200	40000
Electrical Power	ls	1	10000	10000
Controls	ls	1	10000	10000
Test and Balance	hours	80	100	8000
SubTotal				$98,000.00
Total with mark-ups				$120,200.37
Simple Payback =				3

ESM-E1-Kona New High Efficiency Lighting -NA

Energy savings 0 kwh/year
cost savings = $0.00 per year
Cost:
subTotal $0.00
total with mark-ups $0.00
simple payback = N/A

ESM-E2-Kona New Lighting Controls - Provide Occupancy Sensors in Restrooms, Storage Areas and Offices (NA)

Provide Occupancy Sensors in Restrooms, Storage Areas and Offices

Energy savings 3,010 kwh/year
cost savings = $1,071.56 per year
Cost:
subTotal $5,778.00
total with mark-ups $7,086.92
simple payback = 7

ECM-E3-Kona Relamp - Replace T8 Fluorescent with super T-8

Remove Fluorescent lamps and ballast, replace with 15W Linear LED lamps

Current energy use for lighting: 866558 kwh/year
lighting use with super t8: 665453
Energy savings to convert t8 to super T8: 201,105 kwh/year
cost savings = $72,202.40 per year
Estimated Construction Costs:

description	unit	quantity	unit cost	total
Remove Existing T8	ea	2490	$10	$24,900
New Super T8	ea	2490	$120	$298,800
subTotal				$323,700.00
total with mark-ups				$357,015.20
simple payback =				5

ECM-R1-Kona Roofmount 100 KW PV system
Estimated Electrical Yield:
100 kw Pv System x 4 sunhours/day x 0.9 inverter efficiency x 365 days/year = 131400 kwh/year
cost savings = $47,176.33 per year

description	unit	quantity	unit cost	total
Reroof	sf	10000	$5	$50,000
PV system	kw	100	$4,000	$400,000
subTotal				$450,000.00
total with mark-ups				$496,314.00
simple payback =				11

PRELIMINARY ENERGY ASSESSMENT
FOR
MAUI MEMORIAL MEDICAL CENTER
WAILUKU, MAUI

HHSC TASK ORDER NO: 1.B.

December, 2012

INSYNERGY ENGINEERING INC

828 Fort Street Mall, Suite 500 • Honolulu, Hawaii 96813
Tel: 808 521-3773

Background:

This project evaluates and identifies the Energy Savings Measures (ESM's) that should be implemented to reduce energy utility costs and improve building system performance for Maui Memorial Medical Center, Maui based on the facility assessment that was conducted on Dec 11, 2012. The scope of work for this project includes the evaluation of ESM's for water heating, air conditioning and ventilation, lighting, and controls.

Maui Memorial Medical Center is located in Wailuku, Maui. The original complex consisted of 5 primary wings: a 4 level, 35,000 SF North Wing, a 5 level, 40,000 SF East Wing, a 5 level 40,000 SF South Wing, 20,000 SF East Wing, and a single level 40,000 SF Ancillary building. There are three separate buildings – 27,000 SF psychiatric wards, a 3,000 SF substance abuse treatment center and 7,000 SF service building adjoining the North wing houses the boiler, laundry rooms, and the maintenance offices. The Medical Center currently has more than 350 beds and offers full medical services including emergency, surgery, oncology, obstetrics, physical therapy, a pharmacy, imagining, cancer treatment, and adult and adolescent psychiatric wards.

Most of the older sections have been renovated since the 1980s, and some areas are currently under renovation. The North and West Wing second floor are the only area that has not been substantially renovated since the original construction.

The hospital has expanded several times. A 11,500 SF Cancer Center has been added to the main hospital building in 1993 and is currently operated by a private company. Currently, a new 4000 SF cancer center expansion building is being constructed. In 2004, a new 60,000 SF Kahului Tower was added to the complex.

The existing emergency department was expanded in 2006. There is a plan to add a new 3,500 SF MRI, and CT Scan Imaging building in preparation for future renovation of the existing 5000 SF imagining department located in the main ancillary building.

The following improvements were made to the facility under the ESPC project with Noresco:

- ECM-001: Variable Volume Chilled Water Pumping
- ECM-002: Cooling tower Fan VFD's
- ECM-003: Energy management System
- ECM-008: Lighting Efficiency Upgrades
- ECM-010: Replace Delivery Ward and Surgicenter Air-Handlers
- ECM-015: New Wing Chiller Plant Installation
- ECM-016: Variable Volume Pumping for New Wing
- ECM-017: VFDs for New Wing Air-Handlers
- ECM-019: Direct Digital Control (DDC) Energy Management System (EMS) for New Wing
- ECM-A: Replace Air-Handlers Serving the OR and ICU

Description of Existing Systems:

A variable volume chilled water system provides cooling for most of spaces except for the 2nd floor North and the East Wing. Most of the patient rooms in the older wings are provided with numerous ceiling-mounted fan coil units. New buildings, and recently renovated spaces are provided with central air handing units which are located throughout the hospitals in mechanical rooms or the building's roof. The original chiller plant, equipped with two 200 ton water-cooled carrier chillers and three Marley cooling towers, were renovated in 2006 to add two 250 tons water-cooled Trane chillers, and two 250 tons cooling towers. The chilled water piping within the central plant was reconfigured to a primary/secondary decoulpled loop for better staging and control of pumps and chillers. Currently, the peak cooling load is met by operating just one Carrier chiller (200 tons) and one Trane (250 tons) chillers. All chillers and pumps are monitored, and controlled by the Delta brand DDC system, and the operating hours of all major chiller plant equipment are evenly distributed via DDC system.

Two older 2nd floor North and East Wings are provided with about 30 window air conditioners, each with a capacity of about 15,000 btuh.

The Cancer Center is cooled by four packaged units. The Center also has an air cooled chiller exclusively for cooling cancer treatment equipment. The new cancer center expansion building will be provided by a rooftop dx unit with variable volume terminal units with electric reheat. Substance abuse and treatment building is provided with a dedicated air cooled chiller and air handling units. The original chiller has been replaced with a new Mcquay air-cooled chiller.

Available medical gases in the hospital are oxygen, nitrogen, nitrous oxide, and air. Oxygen, nitrogen, and nitrous oxide are supplied by pressurized cylinders. Medical vacuum is also available. The alarm panel for the zoned medical gas alarm system is located through the complex. Four vacuum pumps, each with a 10 hp motors, Two air compressors, one 35 cfm with 120 gallon tank, and one 15 cfm with 80 gallon tanks are located in the main mechanical rooms. Two Quincy medical air pumps, each with a 15 hp motors, are also located in the mechanical room.

Two 540 gallon Ace Buehler steam hot water generators are located across from the boiler room. The hot water from this system serves the main hospital up to the 2nd floor of the North Wing. A separate hot water generation system serving the remainder of the main hospital is located in the mechanical room. The system consists of two 480 gallon Magna Tank steam generators. A third system consisting of three Ruudglass electric commercial water heaters serves the psychiatric wards. The electric heaters each have a 120 gallon storage capacity with a 24 kW input.

Steam for sterilizing, kitchen appliances, and hot water heating is provided by two Superior Boiler Works Mohawk diesel-fired boilers, each with a 6900 lb/hr. steam capacity.

Maui Memorial does its own laundry as well as the laundry for Kula Hospital. The laundry room has two 450 pound capacity, and one 200 pound capacity washers. In addition, it has four steam dryers each with an input of about 225,000 BTUH, a large LPG-fired drier with an input of 3,350,000 BTUH, and a steam flat iron.

There are two 2.5 MW emergency generators that provide backup power critical and life safety equipment. The generators and the two dedicated 6000 gallon aboveground storage tanks are located adjacent to the existing North Wing.

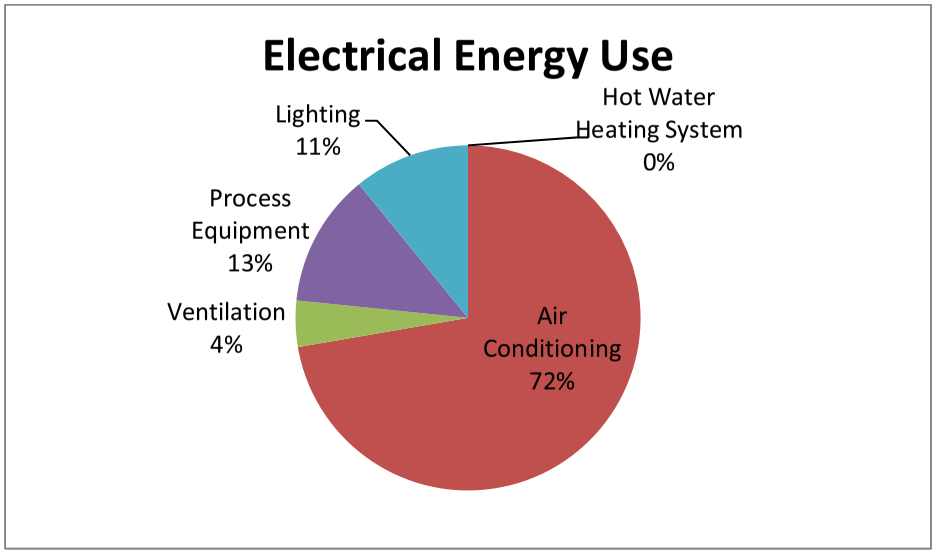
Several fuel supplies are currently used for the various mechanical and electrical equipment serving the hospital. An underground diesel fuel tank located in the service building under the current carpenter shop supplies fuel for the steam boilers. An above-ground LPG tank located behind the service building supplies fuel for the incinerator.

Current Electrical Consumption:

Over the past two years, the facility consumed an average of 8,882,000 kwh of electricity at an average total cost of $3,471,000. The average cost for electricity was $.3908 per kwh.

From our analysis, the breakdown of the electrical use is presented in the table below, with the majority of the electricity used for air conditioning:

Total Electrical Use	kw	% of total	Kwh/year	% of total
Hot Water Heating System	0	0%	0	0%
Air Conditioning	1500	78%	6,701,220	72%
Ventilation	46	2%	400,667	4%
Process Equipment	265	14%	1,157,520	12%
Lighting	115	6%	1,009,654	11%
Total Electrical Use	1926	100%	9,269,060	100%



Evaluation of ESM's:

Analysis of the ESM's that were considered for this facility was evaluated and is summarized in the following Table:

Hospital:		Maui Memorial Medical Center																	
		Electrical Consumption		Fuel Consumption				Elec Energy Savings		Fuel Savings				Other Savings		Total Savings	Construction Cost with Mark-ups	Simple Payback	SROI
Energy Savings Measure		KWh/Year	$/year - Elec	Gal/year Diesel	$/year - Diesel	Gal/year LPG	$/year - LPG	KWh/Year	$/year - Elec	Gal/year Diesel	$/year - Diesel	Gal/year LPG	$/year - LPG	$/Yr Avoided Replacement Cost	$/Yr Avoided Labor Cost	$/year	$	years	1/year
Number	Description																		
Baseline		9,269,060	$3,622,518	158,021	$632,083	21,637	$75,728	NA	NA	$0	$0	$0	$0	NA	NA	NA	NA	NA	NA
ECM-E5-MMMC	Relamp - Replace 40WT12 Fluorescent with 25WT8	9,189,309	$3,591,350	158,021	$632,083	21,637	$75,728	79,751	$31,168	0	$0	0	$0	$0	$0	$31,168	$76,995	2	0.40
ECM-H4-MMMC	New Cogeneration Heating System	2,539,944	$992,656	426,299	$1,705,197	21,637	$75,728	6,649,366	$2,598,693	-$268,278	-$1,073,114	0	$0	$0	-$126,144	$1,399,435	$6,632,055	5	0.21
ECM-E3-MMMC	Relamp - Replace 32WT8 Fluorescent with 25WT8	2,400,028	$937,975	426,299	$1,705,197	21,637	$75,728	139,916	$54,682	0	$0	0	$0	$0	$0	$54,682	$328,053	6	0.17
ECM-A8-MMMC	Replace existing window units with chilled water fan coil units	2,245,435	$877,557	426,299	$1,705,197	21,637	$75,728	154,592	$60,417	0	$0	0	$0	$0	$0	$60,417	$373,602	6	0.16
ESM-A7-MMMC	Connect air cooled chilled water system to central water cooled chiller plant	2,000,537	$781,846	426,299	$1,705,197	21,637	$75,728	244,898	$95,711	0	$0	0	$0	$0	$0	$95,711	$683,180	7	0.14
ECM-H3-MMMC	New Solar Water Heating System	2,000,537	$781,846	291,982	$1,167,926	21,637	$75,728	0	$0	134,318	$537,271	0	$0	$0	$0	$537,271	$4,457,354	8	0.12
ECM-R1-MMMC	Roofmount 100 KW PV system	1,869,137	$730,493	291,982	$1,167,926	21,637	$75,728	131,400	$51,354	0	$0	0	$0	$0	$0	$51,354	$496,314	10	0.10
Total, Recommended ESM's		1,869,137	$730,493	291,982	$1,167,926	21,637	$75,728	7,399,923	$2,892,025	-133,961	-$535,843	0	$0	0	-126,144	$2,230,038	$13,047,552	5	0.22
Additional ECM's Not Recommended:																			
ECM-A5-MMMC	Replace Chiller with Higher Efficiency Unit							82,555	$32,264							$32,264	$1,170,000	36	0.03
ECM-H2-MMMC	New Water Source Heat Pump Heating System							1,546,374	$27,732							$27,732	$1,596,559	58	0.02

Based on this assessment, the following ESM's are cost effective and should be implemented to reduce energy consumption and associated utility costs for the facility:

ECM-E5 - MMMC : Relamp / Replace 42 watt U-lamp Fluorescent with 25 watt T-8. The existing linear fluorescent lamps in existing light fixtures should be replaced with linear high efficiency T8 lamps.

ECM-H4-MMMC: New Cogeneration Heating System: Installation of a cogeneration system will also save energy by producing chilled water and domestic hot water

ECM-E3 - MMMC : Relamp / Replace 32 watt T12 Fluorescent with 25 watt T-8. The existing linear fluorescent lamps in existing light fixtures should be replaced with high efficiency T8 lamps.

ESM-A8-MMMC: Replace existing window units with chilled water fan coil units. Chilled water would be provided from the central plant.

ESM-A7-MMMC: Connect the air cooled AC systems to the central water cooled chiller plant. The existing air cooled chillers and air cooled packaged systems, totaling 100 tons, should be connected to the main chiller plant which is more energy efficient.

ECM-H3-MMMC: New Solar Water Heating System . It will largely replace the domestic hot water service which is currently provided by the steam boiler during daytime.

ECM-R1-MMMC: Roofmount 100 KW PV system. Installation of a new PV system should be considered and appears to be viable.

The implementation of these recommended ESM's will save approximately $2,230,038 per year in utility costs at a construction cost of $13,047,552, resulting in a simple payback of 5 years.

The following other ESM's were not considered feasible or not recommended for implementation:

ECM-A5- MMMC: Replace Chiller with Higher Efficiency Unit. Installation of a higher efficiency water cooled chiller was considered but the chiller that was installed as part of the ESPC project operates at .62 kw/ton, and the slight increase in efficiency with a new higher efficiency water cooled chiller will not be cost effective.

ECM-H2-MMMC: New Water Source Heat Pump Heating System . A new chilled water source heat pump was considered and will save energy, but does not appear to be cost effective.