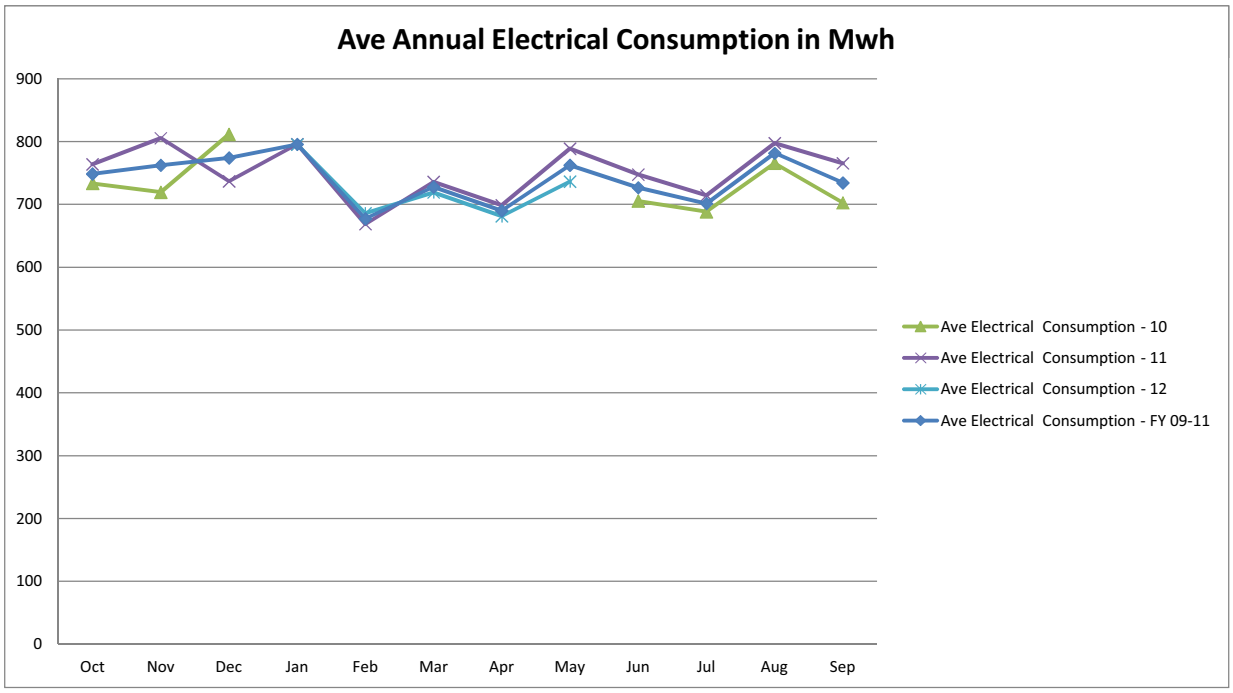
Appendix 1

HISTORICAL ENERGY USE

Hospital: MMMC

	Electrical Consumption - Fiscal Years 2009 - 2011 (Mwh)							
	2007	2008	2009	2,010	2,011	2,012	Average	
Oct				733	764		749	
Nov				719	805		762	
Dec				812	737		774	
Jan					796	795	796	
Feb					669	686	677	
Mar					736	719	728	
Apr					699	681	690	
May					789	736	763	
Jun				706	748		727	
Jul				688	714		701	
Aug				766	797		782	
Sep				703	766		734	
totals				5,127	9,020	3,618	8,882	Mwh/year
Average Cost:		$0.3908	per kwh Non DOD Customers				$3,471,421	per year

Maui Petroleum	2011	2012	AVG
Bulk Fuel (Boiler) off-road	(Jan-Dec)	(Jan-Oct)	
Gallons	177,921	149,445	163,683
Maui Gas	2011	2012	
Propane	(Jan-Dec)	(Jan-Oct)	
Gallons	22,519	20,754	21,637
Maui Fuel	2011	2012	
Vehicle Gas	(Jan-Dec)	(Jan-Oct)	
Gallons	8,184	7,350	7,767



Appendix 2

EQUIPMENT INVENTORY

Hospital: **MMMC**

Hot Water Heating

unit	heating capcity	unit	unit of measure	quantity	hot water/unit	total hw use	heater efficiency	temperature rise	Diesel #2 consumption (gallons/day)	days/week	weeks/year	total gallons Diesel
Boiler	399,000	Btu/hr	patient	900.00	35.0	31,500.00	0.80	70.00	198.78	7.00	52.00	72,357
			cooking	1,645.16	2.5	4,112.90	0.80	70.00	25.95	7.00	52.00	9,448
			laundry	11,612.90	2.0	23,225.81	0.80	100.00	209.38	7.00	52.00	76,216
EWH-Cancer Center		6 kw										
Total, Hot Water Heating	399,000	kw				58,839			434			158,021 gallons/year

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 and 2, old carrier	2	225		270	0.6	0.35	24	2268	7	52	825,552
CH-3 and 4, water cooled cer	2	250		270		0.35	24	2268	7	52	825,552
CH-1 and 2, air cooled packag	2	7.4		15		0.4	24	144	7	52	52,416
CH-1, Air Cooled	1	39.60741667		17.7		0.4	24	169.92	7	52	61,851
RTU-1	1	12.8		12.6		0.8	24	241.92	7	52	88,059
PAC (ACU-1)	1	4		4.4	1.1	0.8	24	84.48	7	52	30,751
PAC (ACU-2)	1	23.83333333		26.21667	1.1	0.8	24	503.36	7	52	183,223
PAC (ACU-3)	1	6.25		6.875	1.1	0.8	24	132	7	52	48,048
RAC	28	1		30.8	1.1	0.8	24	591.36	7	52	215,255
CT-1, 2 and 3	3		5	11.1855		0.4	24	107.3808	7	52	39,087
CT-4 and 5	2		10	14.914		0.4	24	143.1744	7	52	52,115
CHP-1 and 2	2		2	2.9828		0.8	24	57.26976	7	52	20,846
SCHWP-1 and 2	2		100	149.14		0.4	24	1431.744	7	52	521,155
PCHWP-1 and 2	2		10	14.914		0.4	24	143.1744	7	52	52,115
PCHWP-3 and 4	2		15	22.371		0.4	24	214.7616	7	52	78,173
CWP-1 2 and 3	3		30	67.113		0.4	24	644.2848	7	52	234,520
CWP-4 and 5	2		15	22.371		0.4	24	214.7616	7	52	78,173
Reheat Coil	1			1		0.5	24	12	7	52	4,368
Reheat Coil	2			6		0.5	24	72	7	52	26,208
Reheat Coil	1			2.5		0.5	24	30	7	52	10,920
Reheat Coil	6			6		0.5	24	72	7	52	26,208
Reheat Coil	2			3		0.5	24	36	7	52	13,104
inside FCU-7	1			8		0.5	24	96	7	52	34,944
For AHU2-21	1			6		0.5	24	72	7	52	26,208
For AHU2-24	1			6.5		0.5	24	78	7	52	28,392
For AHU2-12 and others	4			10		0.5	24	120	7	52	43,680
For AHU2-15	1			3		0.5	24	36	7	52	13,104
For AHU2-28	1			4		0.5	24	48	7	52	17,472
DH-1 and others, duct heater	3			54		0.5	24	648	7	52	235,872
CVB-4R	1			1		0.5	24	12	7	52	4,368
CVB-5R	1			1.5		0.5	24	18	7	52	6,552
CVB-6R	1			2		0.5	24	24	7	52	8,736
CVB-7R	1			2.5		0.5	24	30	7	52	10,920
CVB-8R	1			3		0.5	24	36	7	52	13,104
CVB-9R	1			4		0.5	24	48	7	52	17,472
CVB-10R	1			5		0.5	24	60	7	52	21,840
CVB-12R	1			7		0.5	24	84	7	52	30,576
CVB-14R	1			10		0.5	24	120	7	52	43,680
CVB-16R	1			15		0.5	24	180	7	52	65,520
RH1-1 and others	4			24		0.5	24	288	7	52	104,832
RH1-3	1			3		0.5	24	36	7	52	13,104

unit	Quantity	Cooling Capacity (tons)	Motor Load (hp)	KW	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
3 speed fan	6		0.23	1.02		0.8	24	19.584	7	52	7,129
3 speed fan	3		0.23	0.51		0.8	24	9.792	7	52	3,564
3 speed fan	12		0.30	2.64		0.8	24	50.688	7	52	18,450
FCU-1	4		0.12	0.356		0.8	24	6.8352	7	52	2,488
FCU-2	7		0.18	0.945		0.8	24	18.144	7	52	6,604
FCU-3	6		0.20	0.9		0.8	24	17.28	7	52	6,290
FCU-4	1		0.21	0.16		0.8	24	3.072	7	52	1,118
FCU-5	1		0.38	0.28		0.8	24	5.376	7	52	1,957
FCU-6	1		1.04	0.775		0.8	24	14.88	7	52	5,416
FCU-7	4		0.86	2.56		0.8	24	49.152	7	52	17,891
FCU-1	1		1.00	0.745		0.8	24	14.304	7	52	5,207
FCU-2, has reheat coil	2		0.25	0.3725		0.8	24	7.152	7	52	2,603
FCU-3	1		1.00	0.745		0.8	24	14.304	7	52	5,207
FCU-4 and others	9		0.30	2.025		0.8	24	38.88	7	52	14,152
FCU-8 and others	7		0.27	1.435		0.8	24	27.552	7	52	10,029
FCU-22	7		0.30	1.575		0.8	24	30.24	7	52	11,007
FCU-21 and others	7		0.27	1.435		0.8	24	27.552	7	52	10,029
FCU-30	1		0.25	0.18625		0.8	24	3.576	7	52	1,302
FCU-1 and others	3		0.07	0.15		0.8	24	2.88	7	52	1,048
FCU-4	1		0.50	0.3725		0.8	24	7.152	7	52	2,603
FCU-5	1		0.22	0.165		0.8	24	3.168	7	52	1,153
FCU-6	1		0.75	0.55875		0.8	24	10.728	7	52	3,905
FCU-7 and 9	2		0.30	0.44		0.8	24	8.448	7	52	3,075
FCU-8	1		0.19	0.145		0.8	24	2.784	7	52	1,013
FCU-10	1		0.11	0.085		0.8	24	1.632	7	52	594
FC2-29	1		0.50	0.3725		0.8	24	7.152	7	52	2,603
FC2-30	1		0.50	0.3725		0.8	24	7.152	7	52	2,603
FCU-2 and 3	2		1.50	2.235		0.8	24	42.912	7	52	15,620
FCU-1	1		2.00	1.49		0.8	24	28.608	7	52	10,413
FCU-1 and others	4		0.50	1.49		0.8	24	28.608	7	52	10,413
FCU-3	2		0.33	0.4917		0.8	24	9.44064	7	52	3,436
FCU-4 and others	3		0.75	1.67625		0.8	24	32.184	7	52	11,715
EFCU-1 and others	6		0.75	3.3525		0.8	24	64.368	7	52	23,430
EFCU-2 and others	5		0.33	1.22925		0.8	24	23.6016	7	52	8,591
EFCU-8 and others	5		0.50	1.8625		0.8	24	35.76	7	52	13,017
EFCU-16 and others	1		1.50	1.1175		0.8	24	21.456	7	52	7,810
EFCU-16 and others	1		1.50	1.1175		0.8	24	21.456	7	52	7,810
FCU-1	1		1.50	1.1175		0.8	24	21.456	7	52	7,810
FCU-2	1		0.12	0.093125		0.8	24	1.788	7	52	651
FC1-1	1		3.00	2.235		0.8	24	42.912	7	52	15,620
FC1-2	3		3.00	6.705		0.8	24	128.736	7	52	46,860
FC1-3	1		2.00	1.49		0.8	24	28.608	7	52	10,413
FCE1-8	1		3.00	2.235		0.8	24	42.912	7	52	15,620
FCE1-9	1		2.00	1.49		0.8	24	28.608	7	52	10,413
FC4-1	1		1.00	0.745		0.8	24	14.304	7	52	5,207
FC4-2 and others	2		0.25	0.3725		0.8	24	7.152	7	52	2,603
FC4-3	1		1.00	0.745		0.8	24	14.304	7	52	5,207
FC4-4 and others	16		0.27	3.28		0.8	24	62.976	7	52	22,923
FC4-21	1		0.17	0.124167		0.8	24	2.384	7	52	868
FC4-22 and others	14		0.27	2.87		0.8	24	55.104	7	52	20,058
FC3-20	1		0.23	0.17		0.8	24	3.264	7	52	1,188
FC3-6 and others	14		0.27	2.87		0.8	24	55.104	7	52	20,058
FC3-1	1		1.00	0.745		0.8	24	14.304	7	52	5,207
FC3-2 and others	2		0.75	1.1175		0.8	24	21.456	7	52	7,810
FC3-3	1		2.00	1.49		0.8	24	28.608	7	52	10,413
FC3-5	1		5.00	3.725		0.8	24	71.52	7	52	26,033
FC2-28	1		0.27	0.205		0.8	24	3.936	7	52	1,433
FC2-31	1		0.75	0.55875		0.8	24	10.728	7	52	3,905
FC2-19 and 20	2		0.50	0.745		0.8	24	14.304	7	52	5,207
FC1-5	1		0.33	0.248333		0.8	24	4.768	7	52	1,736
FC1-6	1		0.22	0.165		0.8	24	3.168	7	52	1,153
AHU	1		7.5	5.59275		0.8	24	107.3808	7	52	39,087
AHU	1		7.5	5.59275		0.8	24	107.3808	7	52	39,087
AHU-2	1		1	0.7457		0.8	24	14.31744	7	52	5,212
AHU-3	1		1	0.7457		0.8	24	14.31744	7	52	5,212
AHU-4	1		3	2.2371		0.8	24	42.95232	7	52	15,635
AHU-5	1		2	1.4914		0.8	24	28.63488	7	52	10,423
AHU-6	1		0.75	0.559275		0.8	24	10.73808	7	52	3,909

unit	Quantity	Cooling Capacity (tons)	Motor Load (hp)	KW	Unit Efficiency	div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
AHU-1	1		1.5	1.11855		0.8	24	21.47616	7	52	7,817
AHU-2	1		1	0.7457		0.8	24	14.31744	7	52	5,212
AHU-3	1		2	1.4914		0.8	24	28.63488	7	52	10,423
AH2-21	1		2	1.4914		0.8	24	28.63488	7	52	10,423
AH2-22 and 23	2		1	1.4914		0.8	24	28.63488	7	52	10,423
AH2-24	1		1.5	1.11855		0.8	24	21.47616	7	52	7,817
AH2-12 and others	5		2	7.457		0.8	24	143.1744	7	52	52,115
AH2-13	1		3	2.2371		0.8	24	42.95232	7	52	15,635
AHU2-15	1		3	2.2371		0.8	24	42.95232	7	52	15,635
AHU2-26 and 27	2		1	1.4914		0.8	24	28.63488	7	52	10,423
AHU-1	1		3	2.2371		0.8	24	42.95232	7	52	15,635
AHU-2	1		1.5	1.11855		0.8	24	21.47616	7	52	7,817
AHU-3	1		5	3.7285		0.8	24	71.5872	7	52	26,058
AHU-R1	1		40	29.828		0.8	24	572.6976	7	52	208,462
AHU-R2	1		30	22.371		0.8	24	429.5232	7	52	156,346
AHU-R3 and others	3		40	89.484		0.8	24	1718.0928	7	52	625,386
AHU-RE1	1		2	1.4914		0.8	24	28.63488	7	52	10,423
AHU-A1-1	1		15	11.1855		0.8	24	214.7616	7	52	78,173
AHU-RE2	1		2	1.4914		0.8	24	28.63488	7	52	10,423
AHU-3-1	1		7.5	5.59275		0.8	24	107.3808	7	52	39,087
AHU Imaging	2		15	22.371		0.8	24	429.5232	7	52	156,346
AHU Imaging	2		10	14.914		0.8	24	286.3488	7	52	104,231
AHU Lab North	2		10	14.914		0.8	24	286.3488	7	52	104,231
AHU Lab South	2		15	22.371		0.8	24	429.5232	7	52	156,346
sf		total	sf/ton								kwh/yr
Total ac 212000		1079.29075	196.4252913	1500.456	kw						6,701,220

Ventilation Systems

system			quanitity	Motor Size	KW	cfm	Div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
EF			1	0.25	0.19	745	1.0	24	4.4742	7	52	1,629
EF			1	0.5	0.37	1860	1.0	24	8.9484	7	52	3,257
EF			1	0.5	0.37	2825	1.0	24	8.9484	7	52	3,257
EF			1	0.166	0.12	630	1.0	24	2.9708688	7	52	1,081
EF			1	1	0.75	2435	1.0	24	17.8968	7	52	6,514
EF-1			1	0.25	0.19	8000	1.0	24	4.4742	7	52	1,629
EF-2			1	0.75	0.56	1400	1.0	24	13.4226	7	52	4,886
EF-3			3	0.167	0.37	910	1.0	24	8.95018968	7	52	3,258
EF-1 and 2			2	5	7.46	7150	1.0	24	178.968	7	52	65,144
EF-3			1	2	1.49	2500	1.0	24	35.7936	7	52	13,029
EF-4			1	0.75	0.56	1500	1.0	24	13.4226	7	52	4,886
PRV-1			1	0.75	0.56	3500	1.0	24	13.4226	7	52	4,886
EF-1			11	0.067	0.55	100	1.0	24	13.21240268	7	52	4,809
EF-2			7	0.091	0.48	100	1.0	24	11.43473396	7	52	4,162
EF-1			24	0.081	1.44	100	1.0	24	34.59247248	7	52	12,592
EF-2			5	0.121	0.45	200	1.0	24	10.81014765	7	52	3,935
EF-3			1	0.134	0.10	125	1.0	24	2.402255034	7	52	874
EEF-1 and others			4	0.376	1.12	600	1.0	24	26.90525638	7	52	9,794
EEF-2 and others			2	0.141	0.21	100	1.0	24	5.04473557	7	52	1,836
EEF-4			1	0.397	0.30	950	1.0	24	7.110674899	7	52	2,588
EEF-6 and 9			2	0.174	0.26	300	1.0	24	6.245863087	7	52	2,273
EEF-8 and 11			2	0.321	0.48	450	1.0	24	11.48277906	7	52	4,180
EXH-1			1	1	0.75	1500	1.0	24	17.8968	7	52	6,514
EXH-2			1	0.291	0.22	450	1.0	24	5.212893423	7	52	1,897
TEH-1			1	0.074	0.06	100	1.0	24	1.321240268	7	52	481
TEH-2 and 3			2	0.193	0.29	300	1.0	24	6.918494497	7	52	2,518
EF-1 and others			6	0.055	0.25	55	1.0	24	5.909547383	7	52	2,151
EF-3 and others			2	0.101	0.15	90	1.0	24	3.60338255	7	52	1,312
EF-8			1	0.187	0.14	170	1.0	24	3.339134497	7	52	1,215
EF-9			1	0.255	0.19	340	1.0	24	4.564284564	7	52	1,661
EF-10			1	0.102	0.08	200	1.0	24	1.825713826	7	52	665
EF-12 and others			4	0.125	0.37	1500	1.0	24	8.9484	7	52	3,257
EF-L1			1	0.040	0.03	240	1.0	24	0.715872	7	52	261
EF-R1 and others			3	0.5	1.12	600	1.0	24	26.8452	7	52	9,772
EF-R3			1	20	14.91	22180	1.0	24	357.936	7	52	130,289
SF-1			1	2	1.49	5720	1.0	24	35.7936	7	52	13,029
SF-2			1	3	2.24	6960	1.0	24	53.6904	7	52	19,543
AC-1 (Air Curtain)			1	1	0.75	5100	1.0	24	17.8968	7	52	6,514
AC-2			1	0.5	0.37	2550	1.0	24	8.9484	7	52	3,257
EF Lab			1	0.5	0.37285		1.0	24	8.9484	7	52	3,257
EF Lab			1	5	3.7285		1.0	24	89.484	7	52	32,572
					kw							kwh/yr
Total ventilation					45.86	kw						400,667

Process Equipment

system			quantity	Motor Size	KW	Capacity	Div factor	hours/day	kwh/day	days/week	weeks/ year	Total kwh/year
Hot water Circulating Pump			1	0.029	0.021625		1.0	24	1	7	52	189
Medical Vaccum Pumps			4	10	29.828		0.8	24	573	7	52	208,462
Medical Compressor 1			1		9.893474		0.8	24	190	7	52	69,144
Medical Compressor 2			1		7.066767		0.8	24	136	7	52	49,388
Medical Air pump			2	15	22.371		0.8	24	430	7	52	156,346
Fire Pump			1	25	18.6425		0.0	24	0	7	52	0
Laundry Dryer			1									
Laundry Dryer new			4									
Laundry Washer			3									
iron machine			1									
incinerator			1									

Appendix 3

PROPOSED ESM'S/ECM'S

Hospital: **Maui Memoerial Medical Center**

ESM-H1-MMMC **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-MMMC **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 diesel energy use	158,021	gallons/year
Energy use with heat pump	0	gallons/year
Diesel Energy savings	158,021	gallons/year
Diesel cost savings =	$632,083.33	per year
Electrical Energy use with heat pump	1,944,587	kwh/year
Electrical Savings for chiller	398,212	kwh/year
Net Electrical use	1,546,374	kwh/year
Elec Energy Cost	604,351	$/year
Net Cost savings =	$27,732.05	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Demolition	hours			
New Heat Pump	each	434.0612	2000	868122.4407
HW pump	each	1	10000	10000
CHW Pump	each	1	10000	10000
piping	lf	200	50	10000
HW tank	each	20,000	15	300000
Controls	ls	1	20000	20000
Test and Balance	ls	1	10000	10000
SubTotal				$1,228,122.44
Total with mark-ups				$1,596,559.17
Simple Payback =				58

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

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

Current energy use	158,021	gallons/year
Energy use with solar	23,703	gallons/year
Energy savings	134,318	gallons/year
cost savings =	$537,270.83	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Reroof	sf	29742.55	10	297425.5128
New Solar Panels	each	619.6365	2500	1549091.212
HW pump	each	2	10000	20000
HW piping	lf	12392.73	50	619636.485
HW tank	each	58,839	15	882580.6452
Controls	ls	1	20000	20000
Test and Balance	ls	1	20000	20000
Electrical	ls	1	20000	20000
SubTotal				$3,428,733.86
Total with mark-ups				$4,457,354.01
Simple Payback =				8

ECM-H4-MMMC **New Cogeneration Heating System**

Absorption Chiller	70	tons
Absorption Chiller COP	0.8	COP
Avoided Electrical Chiller Efficiency	0.62	kw/ton
Generator	800	kw
Generator Electrical Efficiency	0.38	
Genertor Heat Recovery Efficiency	0.45	
cost for electricity	0.390818221	$/kwh
cost for diesel	4	gallon

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

Diesel Heat Requirement for hot water and reheat water	1,666,795	Btu/hr
Additional Heat for Absorption Chiller	945,000	btu/hr
Total Heat Requirement	2,611,795	Btu/hr
Fuel Required to Operate Generator	42	gallons/hr
Annual Fuel Consumption	-368,427	gallons/yr
Annual Fuel Cost	($1,473,708.53)	$/yr
Current Diesel energy use	158,021	gallons/year
Energy use with cogen	15,802	gallons/year
Diesel Energy savings	142,219	gallons/year
Diesel cost savings =	$568,875.00	per year
Avoided Electrical Chiller Energy Use	342,166	kwh/yr
Net Electrical Chiller Cost Savings	$133,724.55	$/yr
Total kwh electricity generated	5660802.476	kwh/yr
Total Avoided Electrical Cost Savings:	$2,212,344.76	$/yr
Additional Maintenance:	($113,216.05)	$/yr
Net Cost Savings:	$1,328,019.72	$/year

Additional Savings if Generator is run 90% of the time

Additional Electrical generated:	646397.524	kwh/yr
Additional avoided electrical cost savings:	$252,623.93	$/yr
Additional Maintenance Cost:	($12,927.95)	$/yr
Additional Fuel Consumption:	-42,070	gallons/yr
Additional Fuel Cost	($168,280.30)	$/yr

ECM-H4-MMMC **New Cogeneration Heating System (cont.)**

Net Additional Cost Savings:	$71,415.68	$/yr
Total Diesel Savings	$568,875.00	gallons/year
Total Electrical Savings	$2,598,693.24	$/yr
Total Fuel Cost	($1,641,988.83)	
Total Maintenance Cost	($126,144.00)	$/yr
Total Cost Savings	$1,399,435.40	$1,399,435.40
Total Net Diesel Savings	142,219	gallons/year
Total Net Electrical Energy Savings	6,649,366	kwh/year 2598693.237
Total Fuel Use	-410,497	gallons/year
Total Fuel Savings	-268278	gallons/year
Net Diesel Savings	($1,073,114)	-1073113.835

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Demolition	hours	3840	100	384000
New Generator	KW	800	3000	2400000
New Generator Heat Recovery	KW	455	1000	455000
New Absorption Chiller	tons	70	4000	280000
New Cooling tower	tons	70	1000	70000
HW pump	each	1	15000	15000
CHW Pump	each	1	15000	15000
CHW Pump	each	1	15000	15000
Fuel Pump	each	1	15000	15000
piping	lf	400	50	20000
HW tank	each	58,839	15	882580.6452
Controls	ls	1	50000	50000
Test and Balance	ls	1	200000	200000
Electrical	ls	1	300000	300000
SubTotal				$5,101,580.65
Total with mark-ups				$6,632,054.84
Simple Payback =				5

ECM-A8-MMMC **Replace existing window units with chilled water fan coil units**

Revised Energy Use

System	unit	Total kwh/year
window un	All	215,255

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	28			0.62	0.4	24	166.656	7	52	60,663
Total											60,663

Energy savings	154,592.26	kwh/year
cost savings =	$60,417.47	per year

Estimated Construction Cost

Description	unit	quantity	unit cost	total ($)	
1 ton fan coil unit	ea	28	1500	42,000	
control valves	ea	28	300	8,400	
CHW piping extension w/insulation	ft	800	50	40,000	2" pipe avg
Electrical power	ea	28	2500	70,000	
controls	ls	28	1000	28,000	
ductwork	lbs	28	700	19,600	
air devices	ea	28	150	4,200	
TAB	ea	28	300	8,400	
misc architetural work	ea	28	3000	84,000	window patch, ceiling work
Subtotal				304,600	
total with mark ups				373,602	
simple payback				6	

ESM-A1-MMMC **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-MMMC **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-MMMC **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-MMMC **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- MMMC **Replace Chiller with Higher Efficiency Unit**

Current energy use for Chiller: 825,552 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	450			0.54	0.35	24	2041.2	7	52	742,997
Total											742,997

Energy savings	82,555.20	kwh/year
cost savings =	$32,264.08	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Chiller Replacement	tons	450	2000	900000

SubTotal	$900,000.00
Total with mark-ups	$1,170,000.00
Simple Payback =	36

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

Current energy use for Chiller: 464,348 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	101.29075			0.62	0.4	24	602.882544	7	52	219,449

Total		219,449
Energy savings	244,898.27	kwh/year
cost savings =	$95,710.71	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total	
Retain existing chiller as back-up unit					
New booster pump	ea	7	10000	70000	multiplying by 7 for 7 new units
existing unit demo	ea	7	1000	7000	
New control valves	ea	28	3000	84000	
Pipe Mods	lf	1000	200	200000	
Electrical Power	ls	7	10000	70000	
Controls	ls	7	10000	70000	
Test and Balance	hours	560	100	56000	
SubTotal				$557,000.00	
Total with mark-ups				$683,179.66	
Simple Payback =				7	

ESM-E1-MMMC **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-MMMC **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 =	$1,176.36	per year
Cost:		
subTotal	$5,778.00	
total with mark-ups	$7,086.92	
simple payback =	6	

ECM-E3-MMMC **Relamp - Replace 32WT8 Fluorescent with 25WT8**

Remove Fluorescent lamps and ballast, replace with 25W T8

Current energy use for 32WT8:	639615	kwh/year
Energy use with 25WT8:	499699	
Energy savings to convert :	139,916	kwh/year
cost savings =	$54,681.72	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Remove Existing T8	ea	2288	$10	$22,880
New Super T8	ea	2288	$120	$274,560
subTotal				$297,440.00
total with mark-ups				$328,052.52
simple payback =				6

ECM-R1-MMMC **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 =								$51,353.51 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

ECM-E5-MMMC **Relamp - Replace 40WT12 Fluorescent with 25WT8**

Remove Fluorescent lamps and ballast, replace with 25W T8

Current energy use for 40WT12:	197031	kwh/year
Energy use with 25WT8:	117280	
Energy savings to convert :	79,751	kwh/year
cost savings =	$31,168.14	per year

Estimated Construction Costs:

description	unit	quantity	unit cost	total
Remove Existing T8	ea	537	$10	$5,370
New Super T8	ea	537	$120	$64,440
subTotal				$69,810.00
total with mark-ups				$76,994.85
simple payback =				2

APPENDIX 2.3

Evaluation Report, Energy Code Training

kolderup CONSULTING

Evaluation Report

To: Elizabeth Raman, DBEDT
Howard Wiig, DBEDT
Mark Unemori, DBEDT
Joe Ellen Nurding, Insynergy

From: Erik Kolderup

Date: March 26, 2012

Subject: Energy Code Training Summary Evaluation Report

This report summarizes the results of training covering the 2009 International Energy Conservation Code (IECC) with Hawaii Amendments. The training sessions were held February 21, 2012 through February 28, 2012.

Attendance

Eleven sessions were held on four islands, with a total of 260 attendees. The following table lists the number of attendees at each location. In general, the attendees at the morning sessions were building officials and other public employees. The afternoon attendees were from the private sector, primarily architects and engineers. On Kauai a single afternoon session was attended primarily by public sector employees.

Continuing education credits were available for architects. A total of 53 architects signed the attendance sheet to receive credit.

TABLE 1 – TRAINING ATTENDANCE

Location	Date	Morning (Public Sector)	Afternoon (Private Sector)	Total
Hilo	2/21/12	26	12	38
Kona	2/22/12	16	19	35
Honolulu	2/23/12	37	31	69
Honolulu	2/24/12	25	30	55
Maui	2/27/12	21	29	50
Kauai	2/28/12	--	14	14
Totals		125	135	260

Training Materials

The following materials were provided to attendees. Electronic copies of each handout have been delivered separately.

- Presentation slides, printed two slides per page, double sided. 280 copies.
- Hawaii State IECC 2009 amendments, as adopted by the State Building Code Council. 280 copies.
- Residential Plan Review Checklist (to building officials). 150 copies.
- Commercial Plan Review Checklist (to building officials). 150 copies.
- Residential Design Checklist (to private sector). 150 copies.
- Commercial Design Checklist (to private sector). 150 copies.
- Frequently Asked Questions. A one-page list of questions and answers related to code motivations and compliance issues. 280 copies.
- Evaluation form. 280 copies.

Major Issues Discussed

This section summarizes issues raised by participants during the training sessions.

Issues Related to Enforcement

The current level of enforcement was a common topic with the private sector. Some designers would like to see better enforcement in order to create a level playing field. The general view was that there is little enforcement of the current code, neither plan review nor inspection.

Some considered future enforcement unlikely for the requirement in Section 101.4.5 that would require a space to be brought into full compliance if AC is added. This would be especially true in the case of small window AC units, which can currently be installed without a permit.

Inspection is challenging because there are many compliance options for the building envelope. A roof does not necessarily need insulation in order to comply. Therefore, the inspector needs to look at the plans for a specific project to ensure that the elements included on the plans are installed in the field.

Few were aware that commissioning requirements are already included in the County amendments to IECC 2006. There appears to be little awareness or enforcement of the current amendments in general. For example, some private sector professionals have copies of the 2006 IECC but are not aware that their County has adopted amendments.

In many cases it will be hard to enforce the requirement that a change in occupancy must comply when peak energy demand increases (Section 101.4.4). The process for determining the peak energy demand is not described in the code.

The residential certificate requirement is generally not being enforced. Section 401.3 requires a label be installed in or on the electrical panel. That label must include information about R-values, SHGCs and equipment efficiency. Awareness of the requirement was low.

Issues Related to 2009 IECC Requirements

Section 101.4.3 requires that roof be upgraded to comply if the sheathing or insulation is exposed during a re-roofing project. There were several issues raised related to this requirement. First, roofs do not necessarily require a building permit in cases where the new roof material is same as existing, so the building department would not necessarily know that the reroofing project was happening. Second, not all roofs have sheathing. Shingle or tile roofs may have battens instead. So the language of the requirement is unclear in those cases. And third, in some cases there would be very significant expense to upgrade the roof insulation, and if it is an unconditioned home then the owner would not get a direct payback. This requirement might create a situation where law-abiding contractors would be at a significant disadvantage to contractors who ignore the requirement. Finally, there is no minimum area threshold in the code, so it appears to apply even when only a small portion of a roof is being repaired.

Section 502.4.6 requires loading dock weather seals. It would make sense to provide an exemption for spaces that are unconditioned.

There was some concern that the exterior lighting requirements might be in conflict with other astronomy-related exterior lighting codes and programs.

The commercial envelope requirement for R-5 block insulation in metal building roofs could create a structural problem if it is a foam block that might degrade over time. It also may be unreasonable to require the thermal block in a non-AC metal building because the extra expense may outweigh the relatively low benefit.

Issues Related to Hawaii Amendments

Some attendees felt strongly that non-air conditioned dwellings in some regions, such as east Hawaii, should be exempt from the building envelope requirements. Or they should at least be exempt from the wall insulation requirements. Hawaii and Kauai Counties currently exempt non-AC residences.

The Hawaii amendment to Section 103.1 requires a design professional to include a signed statement on the plans certifying that the project is in compliance. At least one architect did not feel it is appropriate for an architect, for example, to certify full compliance when some areas of the design may be out of their area of knowledge, such as the mechanical systems. (Kauai amendments do require that each discipline provide their own signature). Others felt that the language should be changed to use the word “design” rather than “project”. They felt that using the word “project” implies that the building complies as constructed. However, the designer does not typically have control over construction. They would be more comfortable certifying that the “design” complies.

Kauai amendments to IECC 2009 are different from the version approved by the State Building Code Council in February 2012. The Kauai amendments were developed earlier.

Some designers felt that dwellings at higher elevations, such as Maui upcountry, should be exempted from the window shading requirements because solar heat is desirable for much of the year.

The amendment to Section 502.2.1 that exempts commercial cool roofs from the insulation requirement is pretty generous. It's likely that a cool roof alone will not be as efficient as the otherwise required insulation for an air conditioned commercial building.

The code does not include specific language allowing the building official to make exemptions for innovative designs or special cases. In Section 101.3 the code states, "This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve the effective use of energy." That section appears to refer to how the code has been written to include tradeoff and whole-building performance options, but those approaches have limitations. Perhaps a section can be added that allows building official discretion for innovative designs.

Per strict reading of the Hawaii amendment to Section 101.5.2, a building or portion of a building that has less than 1 watt per square foot peak demand for space conditioning, which is very small, would be exempt from the envelope requirements. Therefore, while an unconditioned space would have to meet the envelope requirements, a space with a tiny air conditioner would be exempt. This is a potential loophole.

A definition of non-habitable space is not included to accompany the amendment to section 101.5.2, making the envelope exemption a bit unclear. One attendee mentioned that the residential code has definitions that would consider spaces such as corridors to be non-habitable, which would be in conflict with the intent of the energy code.

Other Issues

Rescheck and Comcheck do not include Hawaii amendments.

Frequently Asked Questions

A complete list of questions and answers was compiled during the training by Mark Unemori, DBEDT, and that list is also included later as an attachment to this report. That list of questions has been edited and distilled into a list to be included on the State's energy code web page. Please see the separate document titled "Energy-Code-FAQ_3-26-12.doc" for that edited list of FAQs.

Summary of Attendee Evaluations

A total of 168 evaluation forms were received from 260 total attendees. Table 2 lists the number of surveys received for each of the eleven training sessions.

TABLE 2 – NUMBER OF SURVEYS RECEIVED

Location	Date	Morning (Public Sector)	Afternoon (Private Sector)	Total
Hilo	2/21/2012	21	8	29
Kona	2/22/2012	14	11	25
Honolulu	2/23/2012	14	18	32
Honolulu	2/24/2012	29	20	49
Maui	2/27/2012	4	20	24
Kauai	2/28/2012		9	9
Total		82	86	168

The following pages include a copy of the attendee survey form, followed by graphs that summarize the survey responses. Detailed tables of responses for each of the eleven training sessions are included as an attachment.

Observations from Attendee Responses

- Of all responders, 46% (77 of 168) are from the public sector and 54% (91 of 168) are from the private sector.
- The overall impression of the course was favorable. Attendees survey responses were 27% Excellent, 47% Very Good, 18% Good and 4% Fair.
- Nearly all attendees regarded the topics as either “Useful” or “Very Useful”. Residential topics scored slightly higher than commercial topics.
- Effectiveness of the presenters was also regarded favorably. The most frequent response was “Very Good”, followed by “Excellent” and “Good”.
- For both the presentation slides and printed materials, the most frequent response was “Very Good”, followed by “Excellent” and “Good”.
- Feedback on the quality of the training venues was mixed. The Maui venue at Maui College had poor acoustics due to HVAC noise and the temperature was cold, and that venue received low ratings. The Honolulu training at Blaisdell Center received some complaints about squeaky chairs being a distraction and the room being hard to find. A few attendees suggested coffee be provided. Other venues received reasonable ratings.

Copy of Attendee Survey Form

Training Evaluation Survey

2009 International Energy Conservation Code with Hawaii Amendments

Sponsored by the State of Hawaii Department of Business, Economic Development and Tourism

Date: _____ ☐ Morning session ☐ Afternoon session

1. My role

☐ Building official ☐ Engineer
☐ Other county/state employee ☐ Contractor
☐ Architect ☐ Supplier
☐ Other: _____

2. Overall impression of the training

Poor	Fair	Good	Very Good	Excellent
☐	☐	☐	☐	☐

3. Usefulness of each topic

	Not at all useful	Slightly useful	Useful	Very useful
General requirements	☐	☐	☐	☐
Residential - envelope	☐	☐	☐	☐
Residential - system	☐	☐	☐	☐
Commercial - envelope	☐	☐	☐	☐
Commercial - mechanical systems	☐	☐	☐	☐
Commercial - lighting	☐	☐	☐	☐

4. Effectiveness of each presenter

	Poor	Fair	Good	Very Good	Excellent
Howard Wiig	☐	☐	☐	☐	☐
Erik Kolderup	☐	☐	☐	☐	☐

5. Quality of training materials

	Poor	Fair	Good	Very Good	Excellent
Presentation slides	☐	☐	☐	☐	☐
Printed handouts	☐	☐	☐	☐	☐

6. Quality of training venue

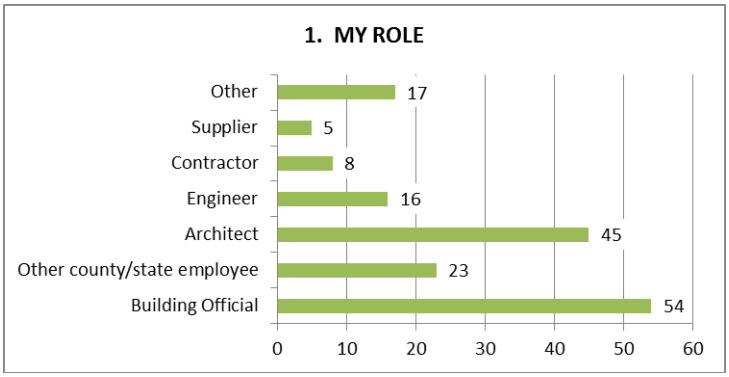
Poor	Fair	Good	Very Good	Excellent
☐	☐	☐	☐	☐

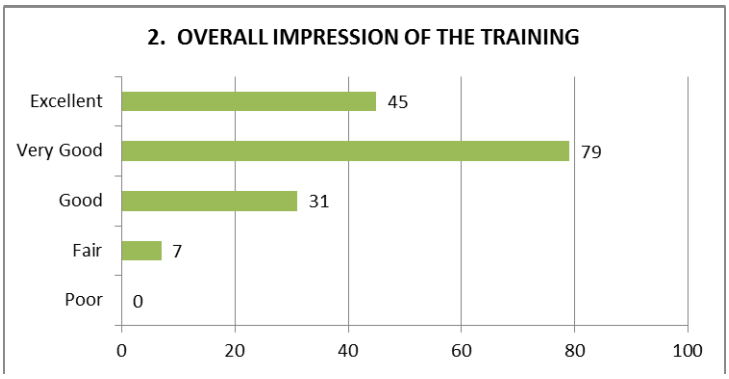
7. Suggestions for future training:

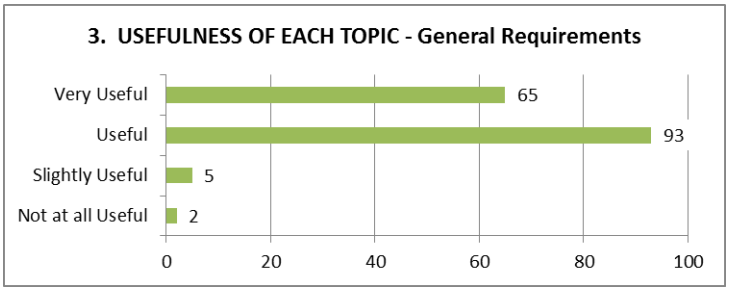
☐ Residential energy efficiency
☐ Commercial energy efficiency
☐ Energy code compliance software
☐ Other: _____

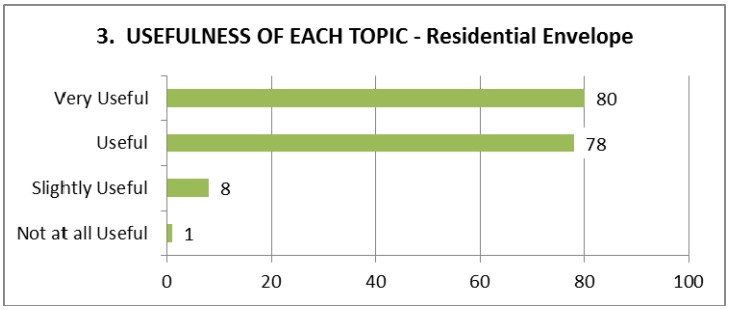
8. Additional comments (please use back if more space is required)**:**

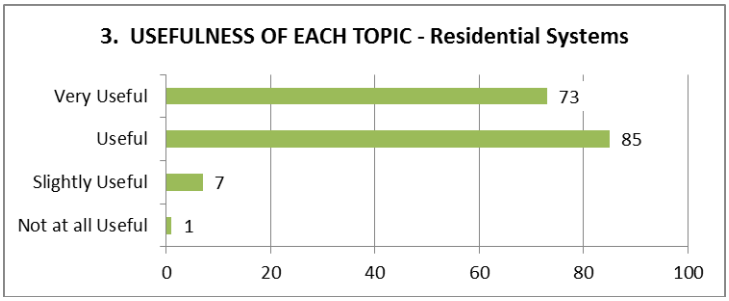
Summary of Attendee Survey Results

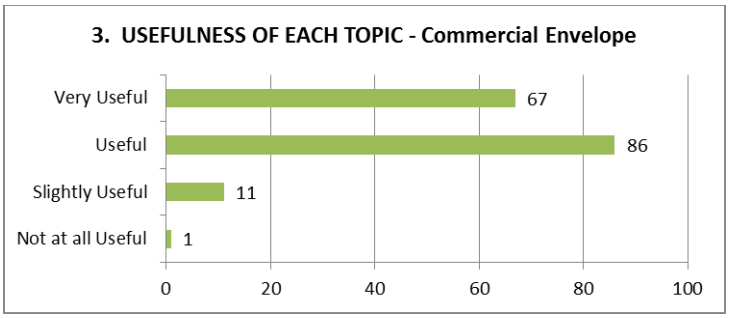


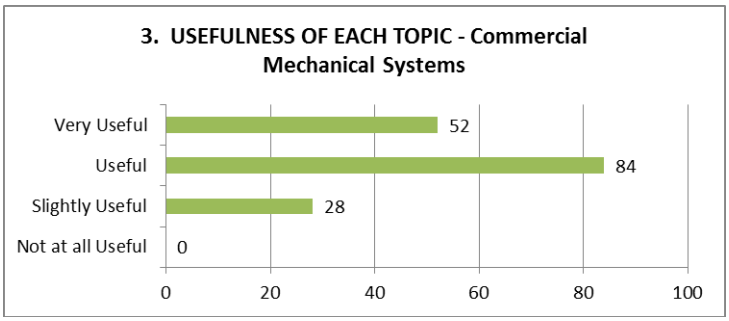









3. USEFULNESS OF EACH TOPIC - Commercial Envelope
Very Useful
Useful
Slightly Useful
Not at all Useful
67
86
11
1
0
20
40
60
80
100


3. USEFULNESS OF EACH TOPIC - Commercial Mechanical Systems
Very Useful
Useful
Slightly Useful
Not at all Useful
52
84
28
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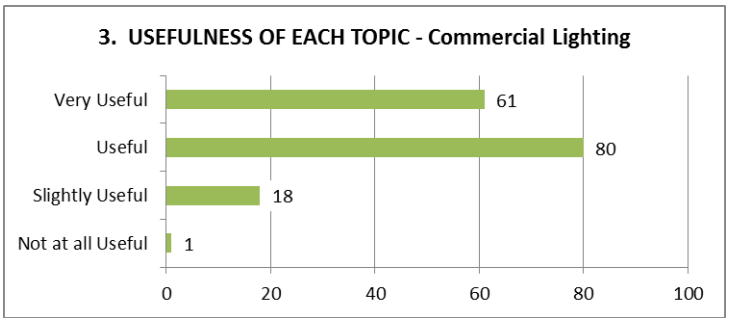
0
20
40
60
80
100


3. USEFULNESS OF EACH TOPIC - Commercial Lighting
Very Useful
Useful
Slightly Useful
Not at all Useful
61
80
18
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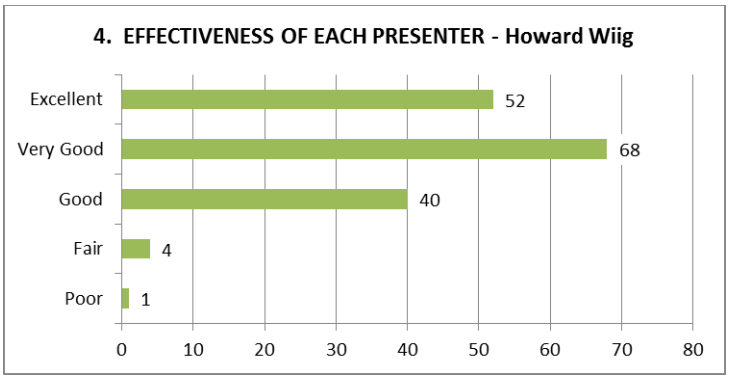
40
60
80
100


4. EFFECTIVENESS OF EACH PRESENTER - Howard Wiig
Excellent
Very Good
Good
Fair
Poor
52
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40
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1
0
10
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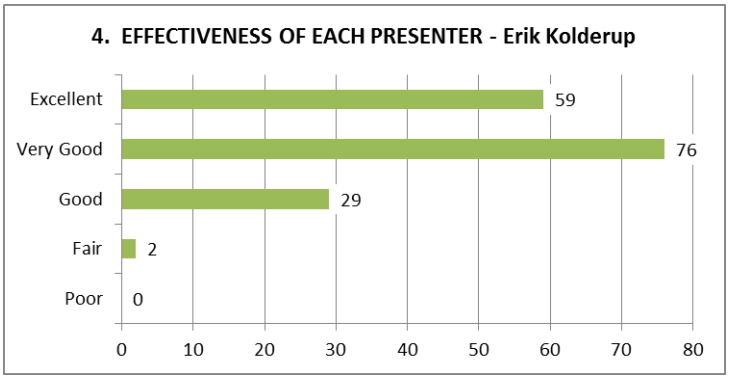
50
60
70
80


4. EFFECTIVENESS OF EACH PRESENTER - Erik Kolderup
Excellent
Very Good
Good
Fair
Poor
59
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29
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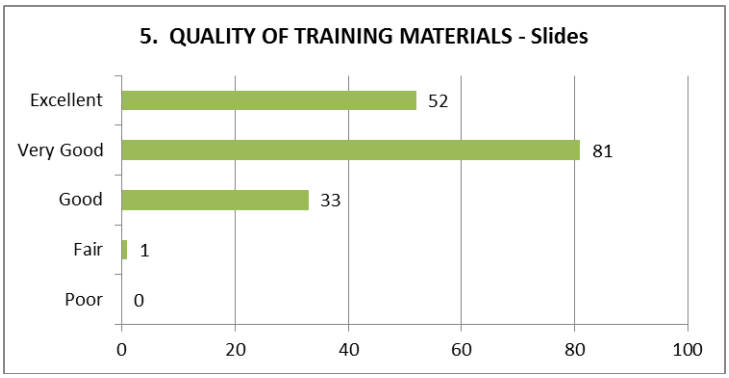
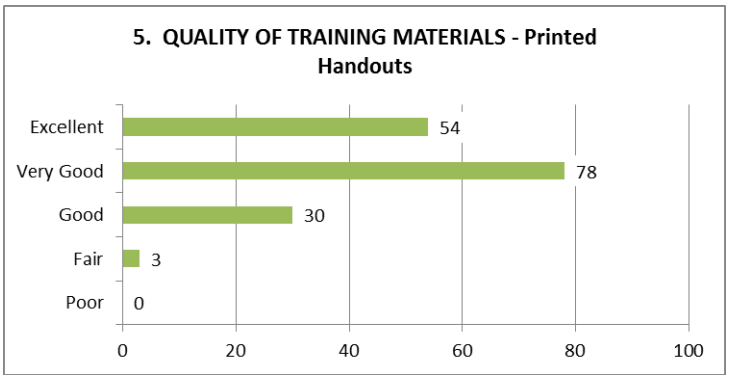
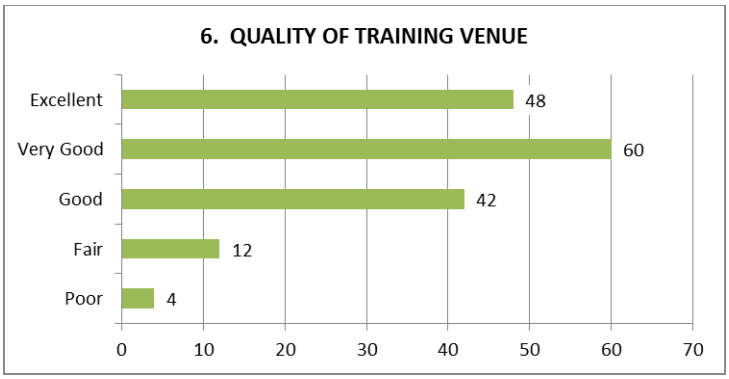
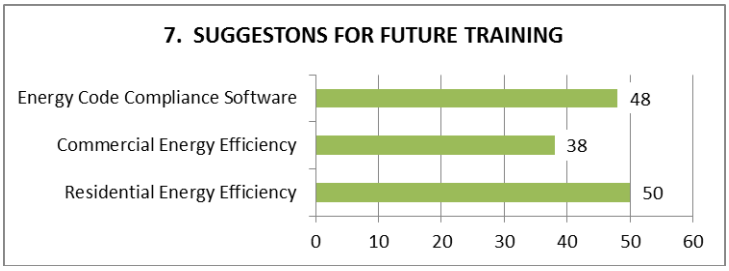
30
40
50
60
70
80


5. QUALITY OF TRAINING MATERIALS - Slides
Excellent
Very Good
Good
Fair
Poor
52
81
33
1
0
0
20
40
60
80
100


5. QUALITY OF TRAINING MATERIALS - Printed Handouts
Excellent
Very Good
Good
Fair
Poor
54
78
30
3
0
0
20
40
60
80
100





Additional Comments from Attendee Surveys

The following comments were provided by attendees in response to Item 8 on the form "Additional Comments".

1. Very informational. Would be great to have a class on code software.
2. More picture association for residential examples.
3. Some slides did not accurately present info in the body of the code or intent; for example –Residential: Bldg. cavities can be used for return air. Overhand Diagram: Measurement should be finish floor not bottom of floor assembly.
4. Energy code compliance software – have website addresses available.
5. Both speakers were very informative and answered most questions. Thank you!
6. Training provided general information…not detailed, not easy to tell all/how this affects current or newly adopted building codes. More detailed explanation would be appreciated.
7. As a civil engineer I don't get into many of these areas, however, the presentation was very interesting, and great for general knowledge, thank you!
16. Room too cold.
17. Squeaky chairs.
18. Coffee will be a good addition.
19. Very good presentation.
20. Should materials be provided.
21. Thanks

22. Pass out books, etc. to read before _____. Need microphone!! Voice too soft. Engineer spoke louder. Calculation requirements are for architects and engineers not plans examiners or interested Individuals.

23. Thank you. It was a comprehensive one view and addressed most issues.

24. Take down class questions to share answers for future training. Very good side info – ex. LED street lights in Honolulu/Hawaii.

25. Was a great presentation. Great resource.

26. Chairs squeak which detracts from presentation.

27. Coffee

28. Some color slides on exemplary local residence & commercial compliance + future design standards (pre-codes) Preparation = Excellent!

Recommendations for Future Training

The attendee survey form included three choices for suggestions for additional training and also included space for additional suggestions. Responses for the three choices were as follows:

- Energy code compliance software, 48 of 168 = 29%
- Commercial energy efficiency, 38 of 168 = 23%
- Residential energy efficiency, 50 of 168 = 30%

Additional suggestions from attendees:

- Review after adopted by the County.
- County amendments administration
- Run through a simple project exercise
- Enforcement
- Simple code training
- Water conservation, Solar PV, Thermal EV, Home Chargers, Wind
- Any additional training to help explain code changes
- LEED

Other potential training topics include:

- Energy code plan review for building officials. Priorities. Exercises. Checklists. Residential and commercial.
- Energy code inspections for building officials.
- Commissioning
- Duct testing

Attachment - Complete FAQ List

Hawaii County

Section	Question	Answer	Reference or Comment
	When will IECC 2009 be formally adopted?	Amendments were approved by the State Building Code Council in February 2012. Governor's signature expected this year. Counties are encouraged to start adoption proceedings.	
	At what point can verification or inspection be required?	Specific inspection requirements from Section 104 are deleted per amendments approved by the State Building Code Council, allowing each County to establish inspection procedures.	Building code official to determine
	How is compliance enforcement dealt with?	Counties are responsible for code enforcement.	Drastic concerns on enforcement and compliance issues
103.1	What is the limit of the professional certification?	Scope dependent on the county language	Some design professionals expressed concern that the language in amended 103.1 that requires the design professional to certify that the "project" complies and felt that they should only be certifying that the "design" complies because they may not have control over construction.
101.4	Are there any shading allowances for PV on roof?	There are no specific credits in the IECC.	
101.4	Is any credit given for PV added to the project?	No. The focus is on efficiency first. However, there are some exemptions in the code for systems with solar water heating.	
101.4.2	Are buildings that are older (50yrs or older) but not on historic register still exempt?	The code includes specific language regarding which buildings qualify for a historic building exemption. Age alone is not sufficient qualification.	Building has to be volunteered for historic consideration
101.4.3	For re-roofing of buildings without roof sheathing, does the code's insulation requirement still apply?	The IECC requires that a roof be brought into compliance with insulation requirements if the sheathing or insulation is exposed during a re-roofing project. The assumption is that there is an opportunity for a cost-effective upgrade at that point, either by filling an exposed cavity with insulation, adding foam board insulation on top of the sheathing, or by some other means such as a combination of a radiant barrier and cool roof. The question is whether this requirement applies to roofs without sheathing, such as tile or shingle roofs with battens. In some of those cases a cost-effective upgrade may be feasible, while in other cases the expense to upgrade the roof may be unreasonable. Therefore, projects without roof sheathing should be judged on a case-by-case basis.	
101.4.3	If insulation is added above the roof sheathing, will fasteners meet wind load requirements?	Structurally sound methods of applying insulation above the roof deck are reasonably available. However, if there are no reasonably feasible means to add insulation to a specific existing roof and still meet wind load requirements, then the wind load requirements should take precedence.	
101.4.3	If unconditioned space is changing from uninhabitable to habitable, does the code apply?	Code applies to change of usage of space	Effect of living comfort in space

Section	Question	Answer	Reference or Comment
101.4.5	Does the air conditioned requirement include wall AC units?	Any addition of cooling to a previously unconditioned space triggers full code compliance for the newly conditioned portion of the building. There is no minimum capacity threshold to trigger code applicability,	
502.1	Is roof insulation still required for unconditioned open metal buildings?	Yes, however there is an exemption available in the amendments for qualifying cool (white) roofs.	
401.3	What are requirements of certificate is on the electrical panel?	For residential projects, the IECC specifies information to be included on a permanent certificate on or in the electrical panel. The format is not specified. Individual Counties may set more specific requirements.	
402.1.1	How are life-cycle concerns addressed with metal joints and similar parts?	Steel Framing industry proposed solution. This is not an energy code issue.	
402.1.6.4	Why is attic ventilation required in combination with insulation?	The energy code does not require attic ventilation, but Hawaii amendments provide several residential roof compliance options, and one of those options is to install a radiant barrier and meet specific ventilation requirements.	Choice is provided to either seal or be vented
402.1.6.6	For high elevation locations, will there be condensation problems?	The possibility of condensation within the attic is an important design consideration. Compliance with the energy code should not hinder proper design.	Hot/cold changes, dew point
402.1.6.6	Why is radiant barrier required for unconditioned spaces?	The envelope requirements apply also to unconditioned homes because they will reduce heat gain and improve occupant comfort. They will also reduce the chance that occupants will install air conditioners. The comfort benefits will vary, and will typically be greater on leeward and sunnier portions of the islands.	East Hawaii to be considered
403.9	How would a pool cover be required to be fastened to an infinity edge pool?	Heated pools without solar heating or waste heat recovery must have covers to reduce heat loss. The code does not specify how the cover is to be fastened.	
404.1	Does the code consider the high efficacy lighting base requirements?	The code does not prohibit standard screw-base high efficacy lighting. It is recommended, however, that high efficacy fixtures be installed that do not allow replacement with incandescent lamps, such as pin-based compact fluorescent lamps.	User can install screw-in compact fluorescent and put in own incandescent
503.2	Will duct leakage testing be required on buildings of all types?	Only required for residential buildings with new duct systems.	
503.2.9	What professional requirements are there for commercial/residential approval?	Any design professional (e.g. architect or engineer) can certify energy code compliance.	See HI amendments, inspection not required, subject to county enforcement
505.2.2.3	Do zones with various adjacent day-lit fixtures have to have individual controls?	Daylight zones can be combined into one large zone to meet the daylight switching requirement. For example, in a large space with multiple skylights, all fixtures within adjacent daylight zones can be switched on the same circuit.	15' perimeter would then extend beyond the bigger combined zone
506	Will the Hawaii amendments be included in the Rescheck software?	Not currently (February 2012), but may be available in the future.	

Honolulu County

Section	Question	Answer	Reference or Comment
101.5.2	Is the definition of HI amendment for uninhabitable consistent with IRC?	Not necessarily. The intent of the amendment is to apply to all portions of residential and commercial buildings that are normally used by people. Non-habitable spaces in the context of the energy code are buildings or portions of buildings such as mechanical rooms or garages that have very intermittent human occupancy.	
101.5.2	Can a small AC unit installation avoid code compliance?	Yes, per strict reading of the Hawaii amendment, a building or portion of a building which has space conditioning with peak energy demand of less than 1 watt per square foot, which is very small, would be exempt from the envelope requirements. However, that is not the intent of the amendment. The intent is that the envelope requirements apply to all habitable spaces. Other requirements, such as lighting, would still apply.	
303.1	Is the label for SHGC required to be kept on the product?	Not beyond purchase and installation - guide for purchasing	
402.1.1	Is the table R-value of the assembly or the insulation?	The table R-value is for the insulation alone, not counting other portions of the assembly such as gypsum board.	
402.1.6.6	Are there any concerns with baking the roof with radiant barrier?	A radiant barrier might cause the roof surface temperature increase somewhat, but the increase should not be enough to cause a problem for roofing materials. And the residential roof radiant barrier compliance option also requires ventilation, which helps mitigate roof heating.	
402.1.6.6	Is an air gap with radiant barrier better than laminated?	A radiant barrier installation that includes an air gap above and below might provide somewhat better performance than a radiant barrier laminated under the roof deck, but either choice is acceptable for compliance.	
402.3	Is insulation required for skylights?	Skylights fall under fenestration requirements	
402.3	If a skylight is installed - will entire roof need to be brought to code?	The code requirement for a skylight applies to that newly installed portion.	
405	How are a location's conditions accounted for, such as adjacent buildings, trees or geographical features?	The code does not provide credit for shading from adjacent objects. Of course, such shading can be beneficial and should be considered in the design of the building, as long as the objects are expected to exist for the life of the building.	Discussed at Nat'l, but too variable
502.1	Is the intent code for roof insulation on steel structures for hot or cold?	Insulation of metal buildings provides benefits in both cold and warm climates.	
502.2.1	What is the current amendment for cool roofs?	There is no cool roof credit in the Honolulu code currently in place. The Hawaii amendments to the 2009 IECC include an insulation exemption for cool roofs.	HW to answer
502.3.2	Are louvered shades included as an overhang for projection factor?	Yes, if the shades are blocking the sun. The projection factor for the louvers can be calculated using the same geometric ratio as for normal overhangs.	
505.2.3	Are DDC considered in this scheme for sleeping unit controls?	DDC systems (direct digital controls) can meet the requirements for automatic control of hotel sleeping units if they have means of detecting when the room is occupied (option 3 of the Hawaii amendment to 502.2.3).	

Maui County

Section	Question	Answer	Reference or Comment
101.4	Do the general requirements apply to both commercial and residential?	Yes	
103.1	What is the intent of HI amendment specifying signature on plans for compliance?	Intent is to ensure that the energy code has been applied to the design. Building departments have limited resources for plan review.	Already in place with IECC 2006
402.1.6.6	On an exposed ceiling, where should the radiant barrier be installed?	Install within layer that meets minimum 3/4" air gap	
402.1.6.7	Is SRI (solar reflectance index) considered when looking at cool roof requirements?	Not explicitly by the IECC, which sets criteria based on reflectance and emittance, but SRI is a good indicator of cool roof performance.	
402.4.2	Are exemptions for specific conditions, such as elevations, required?	The residential air leakage requirements do not include exemptions based on elevation or other specific conditions. However, the Hawaii amendments do set different requirements for air conditioned dwellings and naturally ventilated dwellings.	It might be considered in future drafts of the amendment
402.4.2.2	What are the requirements for inspections?	The inspection requirements for residential air leakage measures are listed in the IECC Table 402.4.2.	
505.7	How to handle submetering for grouped sub-tenants that add up to 1k?	The submetering requirement is intended to apply where a tenant occupies at least 1,000 sf of adjacent space within a building. If a tenant occupies multiple non-adjacent spaces that are each smaller than 1,000 sf, such as several small shops in different portions of a mall, then those individual spaces do not require submetering.	

Kauai County

Section	Question	Answer	Reference or Comment
HI Amd	Will the amendments for IECC 2009 be adopted into the Kauai County?	Kauai County is open to including IECC 2009 Amendments in 2012	
103.1	How do Kauai County handle signing and certification?	Kauai County specifies that each discipline (Mechanical Engineer, etc.) sign for compliance with applicable portions of the energy code.	
303.1	How does the label and identification apply with shading coefficient?	It does not apply to individual windows if they are exempt from SHGC requirements.	
402.1	Can you lay decking with a radiant barrier and roofing directly on top?	It requires at least a 3/4" air gap, can be placed on ceiling of attic or under roof, but preferred application is with shiny side down and facing an air gap.	Can be on floor but upkeep messy
402.1	What is the difference between radiant barrier and cool roof?	A cool roof is the exterior roofing surface, with high reflectance to reduce the absorption of solar radiation and high emittance to promote radiation of heat to the sky. A radiant barrier is a layer within the roof construction with a low emittance that reduces the radiant heat transfer within the roof/attic construction.	heat radiated directly off roof vs. under it
402.1	How is fiberglass insulation covered in code?	There are no specific requirements for choice of insulation material or method of installation. In some other states there are specific requirements on installation quality to ensure that the building owner gets the full benefit of the insulation.	Goes in sloppy

Section	Question	Answer	Reference or Comment
402.1.1	What does the R-30 insulation apply to?	In Kauai, the residential envelope requirements are applied only to air conditioned homes. Typically higher end residences with central AC require R-30 insulation along with other envelope requirements.	Only high end can afford it
402.1.6.7	What is the current reflectance requirement for IECC in Kauai County?	Kauai county does not specify a value for minimum cool roof reflectance in current code. However, the Hawaii state amendments call for a minimum reflectance of 0.70.	
402.3	Is there any way to account for mountainous or other shading?	Falls under innovative category, and changeable	
502.1	Are there any restrictions for commercial buildings that are residential-type structures?	Condition covered at the beginning of the Kauai code	
502.3.2	How would you apply an overhang requirement for a group of windows?	The spreadsheet offers ability to list compliance per window	
503.2.9	Why is commissioning required?	Provides third party check and is a big value add	Systems work much better installed

Attachment – Detailed Attendee Survey Results

1. MY ROLE

Location	Date	Sector	Building Official	Other county/state employee	Architect	Engineer	Contractor	Supplier	Other	Total
Hilo	2/21/2012	Public	6	11		2			2	21
Hilo	2/21/2012	Private			1	6		1		8
Kona	2/22/2012	Public	8	5	1					14
Kona	2/22/2012	Private			7	1	2	1		11
Honolulu	2/23/2012	Public	10	4						14
Honolulu	2/23/2012	Private		1	9	2	2	1	3	18
Honolulu	2/24/2012	Public	18	1	1		2		7	29
Honolulu	2/24/2012	Private			13	4	1	2		20
Maui	2/27/2012	Public	3	1						4
Maui	2/27/2012	Private			13	1	1		5	20
Kauai	2/28/2012	Public	9							9
Total			54	23	45	16	8	5	17	168

2. OVERALL IMPRESSION OF THE TRAINING

Location	Date	Sector	Poor	Fair	Good	Very Good	Excellent	No Comment		Total
Hilo	2/21/2012	Public		1	8	7	5			21
Hilo	2/21/2012	Private			1	6	1			8
Kona	2/22/2012	Public		1	3	5	4	1		14
Kona	2/22/2012	Private			3	6	1	1		11
Honolulu	2/23/2012	Public		2	4	3	4	1		14
Honolulu	2/23/2012	Private			1	11	6			18
Honolulu	2/24/2012	Public		2	5	12	8	2		29
Honolulu	2/24/2012	Private		1		11	7	1		20
Maui	2/27/2012	Public			1	2	1			4
Maui	2/27/2012	Private			3	11	6			20
Kauai	2/28/2012	Public			2	5	2			9
Total			0	7	31	79	45	6	0	168

3. USEFULNESS OF EACH TOPIC - General Requirements

Location	Date	Sector	Not at all Useful	Slightly Useful	Useful	Very Useful		No Comment		Total
Hilo	2/21/2012	Public			12	9				21
Hilo	2/21/2012	Private		1	6	1				8
Kona	2/22/2012	Public		1	8	4		1		14
Kona	2/22/2012	Private		1	7	3				11
Honolulu	2/23/2012	Public	1	2	6	5				14
Honolulu	2/23/2012	Private	1		9	8				18
Honolulu	2/24/2012	Public			15	14				29
Honolulu	2/24/2012	Private			9	11				20
Maui	2/27/2012	Public			3	1				4
Maui	2/27/2012	Private			12	6		2		20
Kauai	2/28/2012	Public			6	3				9
Total			2	5	93	65	0	3	0	168

3. USEFULNESS OF EACH TOPIC - Residential Envelope

Location	Date	Sector	Not at all Useful	Slightly Useful	Useful	Very Useful		No Comment		Total
Hilo	2/21/2012	Public		1	12	8				21
Hilo	2/21/2012	Private			7	1				8
Kona	2/22/2012	Public		1	9	4				14
Kona	2/22/2012	Private		1	6	4				11
Honolulu	2/23/2012	Public		3	6	5				14
Honolulu	2/23/2012	Private	1	2	4	11				18
Honolulu	2/24/2012	Public			12	17				29
Honolulu	2/24/2012	Private			6	14				20
Maui	2/27/2012	Public			2	2				4
Maui	2/27/2012	Private			9	10	1			20
Kauai	2/28/2012	Public			5	4				9
Total			1	8	78	80	1	0	0	168

3. USEFULNESS OF EACH TOPIC - Residential Systems

Location	Date	Sector	Not at all Useful	Slightly Useful	Useful	Very Useful		No Comment		Total
Hilo	2/21/2012	Public		1	12	8				21
Hilo	2/21/2012	Private			7	1				8
Kona	2/22/2012	Public		1	9	4				14
Kona	2/22/2012	Private			7	4				11
Honolulu	2/23/2012	Public		3	7	4				14
Honolulu	2/23/2012	Private	1	2	3	12				18
Honolulu	2/24/2012	Public			14	15				29
Honolulu	2/24/2012	Private			6	13		1		20
Maui	2/27/2012	Public			3	1				4
Maui	2/27/2012	Private			12	7		1		20
Kauai	2/28/2012	Public			5	4				9
Total			1	7	85	73	0	2	0	168

3. USEFULNESS OF EACH TOPIC - Commercial Envelope

Location	Date	Sector	Not at all Useful	Slightly Useful	Useful	Very Useful		No Comment		Total
Hilo	2/21/2012	Public		1	11	9				21
Hilo	2/21/2012	Private			7	1				8
Kona	2/22/2012	Public		1	7	6				14
Kona	2/22/2012	Private		3	7			1		11
Honolulu	2/23/2012	Public		3	6	5				14
Honolulu	2/23/2012	Private	1	2	6	9				18
Honolulu	2/24/2012	Public		1	17	11				29
Honolulu	2/24/2012	Private			8	12				20
Maui	2/27/2012	Public			2	2				4
Maui	2/27/2012	Private			10	8		2		20
Kauai	2/28/2012	Public			5	4				9
Total			1	11	86	67	0	3	0	168

3. USEFULNESS OF EACH TOPIC - Commercial Mechanical Systems

Location	Date	Sector	Not at all Useful	Slightly Useful	Useful	Very Useful		No Comment		Total
Hilo	2/21/2012	Public		5	8	8				21
Hilo	2/21/2012	Private		1	5	2				8
Kona	2/22/2012	Public		3	8	3				14
Kona	2/22/2012	Private		3	7			1		11
Honolulu	2/23/2012	Public		5	5	4				14
Honolulu	2/23/2012	Private		3	8	7				18
Honolulu	2/24/2012	Public		3	15	10	1			29
Honolulu	2/24/2012	Private		2	10	8				20
Maui	2/27/2012	Public		1	2	1				4
Maui	2/27/2012	Private		2	11	5		2		20
Kauai	2/28/2012	Public			5	4				9
Total			0	28	84	52	1	3	0	168

3. USEFULNESS OF EACH TOPIC - Commercial Lighting

Location	Date	Sector	Not at all Useful	Slightly Useful	Useful	Very Useful		No Comment		Total
Hilo	2/21/2012	Public		3	10	8				21
Hilo	2/21/2012	Private			6	2				8
Kona	2/22/2012	Public		3	7	3		1		14
Kona	2/22/2012	Private		2	6	2		1		11
Honolulu	2/23/2012	Public		4	6	3		1		14
Honolulu	2/23/2012	Private		1	8	9				18
Honolulu	2/24/2012	Public	1	3	12	12		1		29
Honolulu	2/24/2012	Private		1	8	10		1		20
Maui	2/27/2012	Public		1	2	1				4
Maui	2/27/2012	Private			9	8		3		20
Kauai	2/28/2012	Public			6	3				9
Total			1	18	80	61	0	8	0	168

4. EFFECTIVENESS OF EACH PRESENTER - Howard Wiig

Location	Date	Sector	Poor	Fair	Good	Very Good	Excellent	No Comment		Total
Hilo	2/21/2012	Public			9	7	5			21
Hilo	2/21/2012	Private			1	5	2			8
Kona	2/22/2012	Public			4	5	5			14
Kona	2/22/2012	Private		1	2	6	2			11
Honolulu	2/23/2012	Public		2	1	7	3	1		14
Honolulu	2/23/2012	Private		1	3	8	6			18
Honolulu	2/24/2012	Public			6	10	12	1		29
Honolulu	2/24/2012	Private	1			10	8	1		20
Maui	2/27/2012	Public			2	1	1			4
Maui	2/27/2012	Private			10	3	7			20
Kauai	2/28/2012	Public			2	6	1			9
Total			1	4	40	68	52	3	0	168

4. EFFECTIVENESS OF EACH PRESENTER - Erik Kolderup

Location	Date	Sector	Poor	Fair	Good	Very Good	Excellent	No Comment		Total
Hilo	2/21/2012	Public			9	7	5			21
Hilo	2/21/2012	Private			1	5	2			8
Kona	2/22/2012	Public			2	7	5			14
Kona	2/22/2012	Private			3	6	2			11
Honolulu	2/23/2012	Public		1	2	7	4			14
Honolulu	2/23/2012	Private			3	6	9			18
Honolulu	2/24/2012	Public			4	12	12	1		29
Honolulu	2/24/2012	Private		1		10	9			20
Maui	2/27/2012	Public			1	2	1			4
Maui	2/27/2012	Private			2	9	9			20
Kauai	2/28/2012	Public			2	5	1	1		9
Total			0	2	29	76	59	2	0	168

5. QUALITY OF TRAINING MATERIALS - Slides

Location	Date	Sector	Poor	Fair	Good	Very Good	Excellent	No Comment		Total
Hilo	2/21/2012	Public			7	7	6	1		21
Hilo	2/21/2012	Private			1	6	1			8
Kona	2/22/2012	Public			2	8	4			14
Kona	2/22/2012	Private			5	5	1			11
Honolulu	2/23/2012	Public			2	8	4			14
Honolulu	2/23/2012	Private			4	7	7			18
Honolulu	2/24/2012	Public			5	12	12			29
Honolulu	2/24/2012	Private		1	1	8	10			20
Maui	2/27/2012	Public			1	2	1			4
Maui	2/27/2012	Private			2	13	5			20
Kauai	2/28/2012	Public			3	5	1			9
Total			0	1	33	81	52	1	0	168

5. QUALITY OF TRAINING MATERIALS - Printed Handouts

Location	Date	Sector	Poor	Fair	Good	Very Good	Excellent	No Comment		Total
Hilo	2/21/2012	Public			6	8	6	1		21
Hilo	2/21/2012	Private			1	6	1			8
Kona	2/22/2012	Public			2	8	4			14
Kona	2/22/2012	Private			5	5	1			11
Honolulu	2/23/2012	Public			2	7	4	1		14
Honolulu	2/23/2012	Private		1	2	8	7			18
Honolulu	2/24/2012	Public		1	4	11	13			29
Honolulu	2/24/2012	Private		1	2	7	10			20
Maui	2/27/2012	Public			1	2	1			4
Maui	2/27/2012	Private			2	13	5			20
Kauai	2/28/2012	Public			3	3	2	1		9
Total			0	3	30	78	54	3	0	168

6. QUALITY OF TRAINING VENUE

Location	Date	Sector	Poor	Fair	Good	Very Good	Excellent	No Comment		Total
Hilo	2/21/2012	Public			6	7	6	2		21
Hilo	2/21/2012	Private			1	6	1			8
Kona	2/22/2012	Public			2	7	5			14
Kona	2/22/2012	Private			2	5	4			11
Honolulu	2/23/2012	Public		2	2	5	5			14
Honolulu	2/23/2012	Private	1		6	6	5			18
Honolulu	2/24/2012	Public		3	5	11	10			29
Honolulu	2/24/2012	Private	1	1	5	6	7			20
Maui	2/27/2012	Public		1	3					4
Maui	2/27/2012	Private	2	5	8	3	2			20
Kauai	2/28/2012	Public			2	4	3			9
Total			4	12	42	60	48	2	0	168

7. SUGGESTONS FOR FUTURE TRAINING

Location	Date	Sector	Residential Energy Efficiency	Commercial Energy Efficiency	Energy Code Compliance Software					Total
Hilo	2/21/2012	Public	7	6	7					20
Hilo	2/21/2012	Private		2	2					4
Kona	2/22/2012	Public	2	3	5					10
Kona	2/22/2012	Private	5	4	2					11
Honolulu	2/23/2012	Public	5	3	1					9
Honolulu	2/23/2012	Private	7	5	6					18
Honolulu	2/24/2012	Public	6	3	8					17
Honolulu	2/24/2012	Private	8	5	8					21
Maui	2/27/2012	Public	1	1	1					3
Maui	2/27/2012	Private	7	6	6					19
Kauai	2/28/2012	Public	2		2					4
Total			50	38	48	0	0	0	0	136

Other Suggestions:

1. Review after adopted by COH.
2. County Amendments Administration
3. Run through a simple project exercise.
4. Enforcement
5. Simple code training.
6. Water conservation, Solar PV, Thermal EV, Home Chargers, Wind
7. Any additional training to help explain code changes
8. LEED

APPENDIX 2.4

Energy Code FAQ

IECC 2009 with Hawaii Amendments

FREQUENTLY ASKED QUESTIONS

March 26, 2012

GENERAL QUESTIONS

		Code Reference
Q.	When will IECC 2009 be formally adopted?	
A.	Amendments were approved by the State Building Code Council in February 2012. The Governor's signature is expected this year. Counties are encouraged to start adoption proceedings, with the expectation that IECC 2009 will be in effect in each county at some point during 2012.	
Q.	Are the Hawaii amendments included in the ResCheck and ComCheck compliance software?	
A.	Not currently (as of March 2012), but may be available in the future.	*405 & 506*

ENVELOPE QUESTIONS

		Code Reference
Q.	Why do the envelope requirements apply to unconditioned space?	
A.	The Hawaii amendments extend the scope of the envelope requirements to include habitable unconditioned space. The amendments also add several envelope compliance options that are targeted at reducing solar heat gain. The motivation for these changes is to improve occupant comfort and to reduce the chance that occupants will install air conditioners. The comfort benefits will vary and will typically be greater on leeward and sunnier portions of the islands.	*HI amendment to 101.5.2*
Q.	Is the definition of non-habitable space in the Hawaii amendments consistent with the International Residential Code (IRC)?	
A.	Not necessarily. The intent of the Hawaii amendment is to apply the envelope requirements to all portions of residential and commercial buildings that are normally used by people. Non-habitable exempt spaces in the context of the energy code are buildings or portions of buildings such as mechanical rooms or garages that have very intermittent human occupancy.	*HI amendment to 101.5.2*

Q.	Is credit given for the shading impact of a photovoltaic system on the roof?	
A.	No. The focus is on efficiency first. However, there are some exemptions in the code for systems with solar water heating.	*402.1*
Q.	For re-roofing of buildings that do not have roof sheathing, does the code's insulation requirement still apply?	
A.	The IECC requires that a roof be brought into compliance with insulation requirements if the sheathing or insulation is exposed during a re-roofing project. The assumption is that there is an opportunity for a cost-effective upgrade at that point, either by filling an exposed cavity with insulation, adding foam board insulation on top of the sheathing, or by some other means such as a combination of a radiant barrier and cool roof. The question is whether this requirement applies to roofs without sheathing, such as tile or shingle roofs with battens. In some of those cases a cost-effective upgrade may be feasible, while in other cases the expense to upgrade the roof may be unreasonable. Therefore, projects without roof sheathing should be judged by the building department on a case-by-case basis.	*101.4.3*
Q.	If I am repairing a small portion of my roof and exposing the roof sheathing of that portion, do I need to upgrade the insulation?	
A.	The code does not specify a minimum area threshold for triggering the requirement to upgrade roof insulation. However, it may not be practical to, for example, add foam board insulation on top of the sheathing on only a small portion of an existing roof. Therefore, a reasonable interpretation of the requirement is that it applies when the whole roof is being re-roofed.	*101.4.3*
Q.	If I install my roof insulation under the roof deck rather than on the floor of the attic, do I need to also include attic ventilation openings, which might penetrate the insulation?	
A.	The energy code does not require attic ventilation in combination with insulation. However other building code requirements may apply. Check with your building department.	*HI amendment 402.1.6*
Q.	In the table of R-value requirements for roof and walls, is the R-value for the insulation or the whole assembly?	
A.	The R-value listed in the table is for the insulation alone, not counting other portions of the assembly such as gypsum board.	*402.1.2 & 502.1*
Q.	Can you lay decking with a radiant barrier and roofing directly on top?	
A.	A radiant barrier requires at least a 3/4" air gap on the shiny side. The radiant barrier can be placed on the floor of the attic or under the roof, but preferred	*HI amendment 402.1.6.6*

application is with shiny side down and facing an air gap.

Q.	What is the difference between a radiant barrier and a cool roof?	
A.	A cool roof is the exterior roofing surface, with high reflectance to reduce the absorption of solar radiation and high emittance to promote radiation of heat to the sky. A cool roof helps prevent the roof surface from heating up in the sun. A radiant barrier is a layer within the roof construction with a low emittance, typically a shiny metallic foil. The radiant barrier reduces the radiant heat transfer within the roof/attic construction.	*HI amendment 402.1.6 & 502.2.1*
Q.	Are there any concerns with baking the roof with a radiant barrier?	
A.	A radiant barrier might cause the roof surface temperature increase somewhat, but the increase should not be enough to cause a problem for roofing materials. And the radiant barrier compliance option for residential roofs also requires ventilation, which helps mitigate roof heating.	*HI amendment 402.1.6.6*
Q.	Is roof insulation still required for unconditioned open metal buildings?	
A.	Yes, however there is an exemption available in the amendments for qualifying cool (white) roofs on commercial buildings.	*HI amendment 502.2.1*
Q.	Is the manufacturer's label for window solar heat gain coefficient (SHGC) required to be kept on the product?	
A.	Not beyond inspection.	*303.1.3*
Q.	If a skylight is installed - will the entire roof need to be brought to code?	
A.	Only the skylight itself must meet the performance requirements in the code. The remainder of the roof does not need to be upgraded.	*101.4.3*
Q.	How are a location's conditions accounted for, such as adjacent buildings, trees or geographical features?	
A.	The code does not provide credit for shading from adjacent objects. Of course, such shading can be beneficial and should be considered in the design of the building as long as the objects are expected to exist for the life of the building.	*502.3.2*

LIGHTING AND ELECTRICAL QUESTIONS

		Code Reference
Q.	Does the code specify the type of base required for residential high-efficacy lighting?	
A.	The code does not prohibit standard screw-base high efficacy lighting. It is recommended, however, that high-efficacy fixtures be installed that do not	*404.1 & 505.1*

	allow occupants to replace the high-efficacy lamps with incandescent lamps. An appropriate example is a fixture that requires pin-based compact fluorescent lamps rather than standard screw-based compact fluorescent lamps.	
Q.	Do zones with various adjacent day-lit fixtures have to have individual controls?	
A.	Daylight zones can be combined into one large zone to meet the daylight switching requirement. For example, in a large space with multiple skylights, all fixtures within adjacent daylight zones can be switched on the same circuit.	*505.2.2.3*
Q.	How do the submetering requirements of Section 505.7 apply to grouped sub-tenants that add up to 1,000 sf?	
A.	The submetering requirement is intended to apply where a tenant occupies at least 1,000 sf of adjacent space within a building. If a tenant occupies multiple non-adjacent spaces that are each smaller than 1,000 sf, such as several small shops in different portions of a mall, then those individual spaces do not require submetering.	*HI amendment 505.7*

SYSTEMS QUESTIONS

		Code Reference
Q.	If an air conditioner is added to a previously unconditioned space, how does the code apply?	
A.	Any addition of cooling to a previously unconditioned space triggers full code compliance for the newly conditioned portion of the building. There is no minimum capacity threshold to trigger code applicability.	*101.4.5*
Q.	Will duct leakage testing be required on buildings of all types?	
A.	Duct leakage testing is required for only residential buildings with new duct systems.	*403.2.2*
Q.	Why is commissioning required?	
A.	Commissioning as defined in the Hawaii amendment Section 503.2.9 is a process to ensure that the HVAC system is installed and operated per the design intent. Commissioning has been shown to improve efficiency and comfort performance.	*HI amendment to 503.2.9*

APPENDIX 2.5

Technical Assistance Log

Hawaii Energy Code Technical Assistance Log
Version 3, 5/18/2012
(Task Order 2B)

Case	Date	Questioner (contact info)	Company Address Phone	email address	County/State	Code Citation	Question	Responder	Response	Followup required? (y/n)	Comments/ Action assigned to
1	5/16/2012	Tom Brennan	XYZ COMPANY, 2121 xxxxx Road, phone: 808 xxx-xxxx		Honolulu	NEC	Which version of the NEC is Honolulu using?	HCW	NEC 2008	no	N/A
2	5/11/2012	Ron Kurohara			Kauai	IECC 2009	Does IECC 2009 include the use of LED lamps?	HCW	yes--the LPD's are getting tighter, and Kauai's shilding law lends itself to LED's	no	N/A
3	5/10/2012	Fred Spain			Washington DC	IECC 2009	Would Hawaii be amenable to building facilities better than IECC, powered by hydrogen, fully funded?	HCW/COS	Hawaii cannot utilize sole source applications	no	N/A
4	5/15/2012	Hannah Wallace			Winconsin	IECC 2009	Did the Lorman seminar achieve its code education goals?	HCW	Yes--requested questions frequently; positive post-seminar sidewalk response	no	N/A
5	5/10/2012	Mike Moore			Rhoad island	IECC 2012	Please consider three proposed amendments to IECC 2012	HCW	Building Code Council's energy Committee had favorable response	yes	HCW/committee
6	5/9/2012	Deborah Burnett			California	IECC 2012	Conduct seminar on lighting efficiencies exceeding IECC 2012?	HCW	Excellent qualifications, but SEO has no funding	yes	Hawaii Energy provide funding?
7	4/13/2012	Bill Brenham			Honolulu	IECC 2009	Best practices for bringing school windows into conformance with IECC 2009?	HCW	There are several window films that achieve 0.30 SHGC with good VLT	yes	three film distributors
8	4/16/2012	Jo Bautista	HCW		Honolulu	solar	Which is better-solar or gas?	HCW	Instant-on heaters are cheaper initially but SWH has a much better long-term payback	no	N/A
9	4/20/2012	Sharon Williams	HCW		Honolulu	IECC 2009	Please provide the shading formula template for windows	HCW	Attached	no	N/A
10											
11											
12											
13											
14											
15											

APPENDIX 2.6

Energy Code 2006 vs. 2009

IECC 2009 with Hawaii Amendments

HIGHLIGHTS OF CHANGES BETWEEN 2006 & 2009

Hawaii amendments indicated in italics[1]

General Requirements

- Roof insulation compliance is now required when the sheathing or insulation is exposed during a re-roofing project (101.4.3)
- Commercial lighting compliance is triggered with a change in occupancy if the space usage changes (101.4.4)
- Full compliance is triggered by a change from unconditioned to conditioned space (101.4.5)
- *Envelope requirements apply also to unconditioned, habitable spaces (HI amendment to 101.5.2)*

Residential Requirements

- Residential window solar heat gain coefficient (SHGC) limit is reduced from 0.40 to 0.30 (402.3)
- *Hawaii amendments provide alternatives for residential envelope compliance:*
    - *Wall insulation tradeoffs (HI amendment to Table 402.1.1)*
    - *Ceiling insulation alternatives (new section 402.1.4)*
    - *Steel-frame wall insulation alternatives (HI amendment to 402.2.5)*
    - *Exemption for north-facing and well-shaded windows (HI amendment to 402.3.3)*
    - *Air leakage exemption for unconditioned dwellings (HI amendment to 402.4.1.1)*
    - *Air leakage allowance for jalousie windows (HI amendment to 402.4.4)*
- Building envelope tightness verification is required for air-conditioned dwellings (402.4.2)
- Duct leakage pressure testing is required for new duct systems (403.2)
- High-efficacy lighting is required for a minimum of 50% of the lamps in permanently installed lighting fixtures (404.1)
- Pool covers are required for heated pools without solar heating or waste heat recovery (403.9)

Commercial Requirements

- The commercial compliance alternative has been updated from ASHRAE Standard 90.1-2004 to 90.1-2007 (501.1)

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[1] Hawaii amendments referenced in this document were approved by the Hawaii State Building Code Council in February 2012. Individual County amendments may be different.

- Separate opaque envelope insulation requirements are added for high-rise residential buildings vs. other commercial buildings (502.1.1)
- *No roof insulation is required in a commercial building roof that has a qualifying cool roof membrane, at elevations below 2,400 ft. (HI amendment to 502.2.1)*
- *An area weighted average is allowed for commercial window SHGC compliance (HI amendment to 502.3.3)*
- Skylight requirements are more stringent. New requirements for all skylights are U-factor of 0.75 and SHGC of 0.35. Requirements in 2006 were 1.9/0.40 for glass skylights and 1.9/0.35 for plastic skylights (502.3)
- HVAC equipment efficiency tables are updated with greater stringency in most cases (503.2.3)
- Demand control ventilation is now required for systems serving some spaces such as theaters (503.2.5.1)
- *Mechanical systems commissioning and completion requirements. The designer is required to provide a written statement of system completion (HI amendment to 503.2.9)*
- HVAC fan power limits are established for systems with total fan motor size greater than 5hp (503.2.10)
- Supply air temperature reset is required for variable air volume (VAV) systems (503.4.5.4)
- High-efficacy lighting is required for a minimum of 50% of the permanently installed lighting fixtures in dwelling units (505.1)
- Separate control is now required for lighting fixtures located in daylight zones, in order to allow occupants to turn off lights during the day (505.2.2.3)
- *Hotel thermostat and lighting controls. Automatic controls are required that detect whether the room is occupied and adjust the thermostat and lighting accordingly. Interlock switches are also required on lanai doors to shut off AC when the door is open (HI amendment to 505.2.3)*
- An expanded list of indoor lighting applications are now exempted from the lighting power requirements (505.5.1)
- The additional retail lighting power allowance is revised (505.5.2)
- Exterior lighting power limits are significantly revised, including different limits for rural and urban areas (505.6.2)
- *Tenant electrical submetering is required for tenants occupying 1,000 ft^2 or more (HI amendment to 505.7)*
- The calculation rules for commercial Total Building Performance calculations have been revised and expanded (506)

APPENDIX 2.7

Energy Code Webpage Content

kolderup CONSULTING

Memorandum

To: Elizabeth Raman, DBEDT
Howard Wiig, DBEDT
Mark Unemori, DBEDT
Joe Ellen Nurding, Insynergy

From: Erik Kolderup

Date: June 14, 2012

Subject: Energy Code Website Content

The following content is intended to be included on the DBEDT website. Please see also a separate zip file containing the documents referenced as links below.

Please note that some of those linked documents are also included on other websites, which could create a problem with conflicting versions. One example is the Hawaii energy code amendments. I have included the January 30, 2012 version 9, which I believe is the most recent version. There is an older version on the Building Code Council website at http://hawaii.gov/dags/bcc/comments/comments-submitted-on-proposed-building-code-amendments. Another example is the window compliance spreadsheet, which is also on the Building Code Council website at http://hawaii.gov/dags/bcc/comments and the Kauai County website at http://www.kauai.gov/default.aspx?tabid=64. My suggestion is that we still include the files on the DBEDT website, because the links might get broken if we decide instead to link to the files on other sites.

Hawaii Energy Code Website Content

In February 2012 the Hawaii State Building Code Council approved the 2009 International Energy Conservation Code (IECC) with amendments. The code sets energy efficiency requirements for both residential and nonresidential buildings. For the status of individual county code adoptions follow the links below.

Instructions to Purchase the 2009 IECC

The 2009 IECC is available for purchase online from the International Code Council at www.iccsafe.org; follow links to "Store"and "2009 International Codes". The document may also be available at other online retailers.

Hawaii State Amendments

The State Building Code Council approved amendments to the 2009 IECC to add compliance flexibility and adapt the requirements to Hawaii's unique climate.

> Download the approved amendments (January 30, 2012 version) *[Link to 2009 IECC amendments v9 2012-01-30.pdf]*

County Energy Codes

Energy codes are adopted and enforced at the county level. Use the following links to check current status.

Hawaii County

Webpage: www.hawaiicounty.gov/public-works-building

Contact: Jai Ho Cheng, jcheng@co.hawaii.hi.us

Honolulu County

Webpage: www1.honolulu.gov/council/ocs/roh/ (see Chapter 32)

Contact: Tim Hiu, t.hiu@honolulu.gov

Kauai County

Webpage: www.kauai.gov/default.aspx?tabid=64

Contact: Doug Haigh, dhaigh@kauai.gov

Maui County

Webpage: www.co.maui.hi.us/index.aspx?nid=1208

Contact: Ralph Nagamine, Ralph.Nagamine@co.maui.hi.us

Support Information

Frequently asked questions

FAQs *[link to Energy-Code_FAQ_05-05-12.pdf]*

What's changed?

Changes between 2006 IECC and the 2009 IECC, including Hawaii amendments

Summary of changes *[link to Energy-Code_2006-vs-2009_v2.pdf]*

Window area-weighted average calculation tool

This spreadsheet implements compliance calculations for window solar heat gain coefficient (SHGC), including shading credit for overhangs and screens.

Spreadsheet *[link to Hawaii AWASHGC Template 110210 protected.xls]*

Instructions *[link to AWASHGC-template-instructions-july-2011.pdf]*

Energy code training presentation

Training in all four counties covered the 2009 IECC with Hawaii amendments in February 2012

Presentation (6 MB) *[link to Hawaii_2009_IECC_Training_v2-with_cover.pdf]*

Plan review checklists and design checklists

These voluntary checklists provide building designers and plan reviewers with a list of requirements and references to code sections. These checklists are based on the 2009 IECC with Hawaii amendments.

Residential design checklist *[link to Checklist_Residential-Designer_v2.pdf]*

Residential plan review checklist *[link to Checklist_Residential-Bldg-Official_v2.pdf]*

Commercial design checklist *[link to Checklist_Commercial-Designer_v2.pdf]*

Commercial plan review checklist *[link to Checklist_Commercial-Bldg-Official_v2.pdf]*

Related Resources

Hawaii State Building Code Council

http://hawaii.gov/dags/bcc

International Code Council

Producer of the International Energy Conservation Code (IECC)

www.iccsafe.org

ASHRAE

Producer of ASHRAE Standard 90.1-2007 Energy Standard for Buildings Except Low-Rise Residential Buildings

www.ashrae.org

REScheck™ software

Compliance software for the residential portion of the 2009 IECC. At present it does not implement the envelope compliance options that are included in the Hawaii amendments. Both online and desktop versions are available.

www.energycodes.gov/rescheck

COMcheck™ software

Commercial building compliance software for the 2009 IECC. Both online and desktop versions are available.

www.energycodes.gov/comcheck

Building Energy Code University

Online training, including presentations, webcasts and self-paced training related to energy codes, including the IECC and ASHRAE 90.1

www.energycodes.gov/becu

Building Codes Assistance Project

A nonprofit organization that promotes the adoption and advancement of energy codes.

www.bcap-energy.org

Hawaii energy efficiency guidelines

Hawaii Homeowner's Guide to Energy Comfort and Value

http://energy.hawaii.gov/wp-content/uploads/2011/10/Hawaii-Homeowners-Guide.pdf

Field Guide for Energy Performance, Comfort, and Value in Hawaii Homes

http://energy.hawaii.gov/wp-content/uploads/2011/10/Field-Guide-2.pdf

Hawaii Commercial Building Guidelines for Energy Efficiency

http://kolderupconsulting.com/files/Hawaii-Comm-Bldg-Guide-for-Energy-Efficiency.pdf *[Note: I didn't see this on the DBEDT website, so I included a link to my own website. Would be better if it were on the DBEDT website]*

Hawaii Energy

Energy conservation and efficiency program. Provides resources and incentives.

www.hawaiienergy.com

Contacts

State contact for energy code issues: Howard Wiig, hwiig@dbedt.hawaii.gov

State contact for website issues: Jonathan Chin, johnathan.r.chin@dbedt.hawaii.gov

APPENDIX 2.8

Summary Report for Solar Photovoltaic Training for Building Code Officials, Including FAQ

Summary Report on the Photovoltaic Training Seminar for Local Building Code Officials

Christy Imata
Hawaii Solar Energy Association

Training Overview

The Hawaii Solar Energy Association, in collaboration with the Department of Business, Economic Development and Tourism, conducted a series of photovoltaic (PV) training sessions funded by Department of Energy Award Number DE-EE0000216. The purpose of the seminar was to provide in-depth training for local building code officials on PV, including best practices for the structural and electrical review of PV systems in the field.

The seminars were conducted in one-day, 8-hour training sessions in each of the counties as follows: Hilo (February 15, 2012), Kauai (February 16, 2012), Maui (February 17 & 20, 2012), Honolulu (February 27, 2012).[1] Bill Brooks of Brooks Engineering led each session.

670 people registered for the training, with a total of 619 actually attending[2]. Training materials were distributed to attendees via compact discs (CD). Included on each CD was a copy of the power point presentation, Field Inspection Guidelines & Checklist for PV Systems, Expedited Permit Process for PV Systems, and FAQs.

Each session began with a brief overview of PV system basics, including the identification of all applicable codes and standards for PV systems, such as UL Standards, the National Electric Code (NEC), IEEE 1547, and Building Codes. Special attention was paid to NEC Article 690, including an in-depth review of the upcoming changes to the NEC that will affect the proper installation of PV systems. Best practices for inspecting PV systems for code compliance with the NEC was also reviewed in detail, utilizing real-world pictures to demonstrate proper and improper installations. Due to timing, Expedited Permit Processing was not fully covered in any of the sessions.

Common Issues Discussed

The following Frequently Asked Questions (FAQs) have been revised to reflect common issues discussed across all sessions.

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[1] The building code officials in each of the respective counties had the option of inviting the private sector to their training session. Kauai and Honolulu opted to include the private sector. Hilo and Maui opted to not include the private sector; a separate session for Maui Contractors was held on February 20, 2012.

[2] Hilo: 31; Kauai: 86; Maui Code Officials: 12; Maui Contractors: 54; Honolulu: 436

1. **What are the wordings on the labels for different apparatus? Meter can, disconnect switch, junction boxes, and load center.**

   Answer: The Expedited Permit Process covers the minimum markings required by the National Electrical Code. These signs include:
   a) Sign on dc PV power source disconnecting means according to 690.17—
   Warning: line and load may be energized in the open position.
   b.) Sign on dc PV output circuit disconnecting means according to 690.53—
   Photovoltaic Power Source:
   (1) Rated maximum power-point current
   (2) Rated maximum power-point voltage
   (3) Maximum system voltage
   FPN to (3): See 690.7(A) for maximum photovoltaic system voltage.
   (4) Short-circuit current
   FPN to (4): See 690.8(A) for calculation of maximum circuit current.
   (5) Maximum rated output current of the charge controller
   (if installed).
   These items are described in detail in the Expedited Permit Process available online at www.solarabcs.org/permitting.

2. **When should contractors use correction factors for wires in conduits on the roof? At what heights off the roof, how long the conduit on the roof, number of conductors in the conduit.**

   Answer: Conductors in conduit where the conduit is in direct sunlight for a length greater than 10 feet or 10% of the conductor length should have correction factors applied. Height of the conduit off of the roof impacts the ambient temperature adder found in the 2008 NEC in Table 310.15(B)(2)(c). Adjustment factors are required whenever more than 3 conductors are in a raceway for more than 24 inches.

3. **Must the drawing submitted to DPP be the same as what is actually installed?**

   Answer: Allowing small variations for products that are essentially equivalent should be allowed. For instance, a common PV module today is the 60-cell crystalline silicon module. These modules are typically rated between 220 and 250 Watts. There are at least 100 manufacturers exist in the world today that manufacture these nearly identical modules. Switching among these products, provided the number of modules is not significantly changed, should be allowed.

4. **Can the disconnect switches and load center be located away from the meter due to the lack of space…say…20 feet or so?**

Answer: Occasionally there is no area near the service meter where a disconnecting means can be installed and still meet the clearance requirements of the NEC in section 110.26. If the disconnecting means is intended to meet utility isolation requirements, then any location other than near the meter would have to be approved by the utility. The NEC allows the PV inverter output disconnect to be located remote from the service disconnect provided that a plaque or directory clearly identifies the location of the disconnect [690.56].

5. **Should the disconnect switch from micro-inverter PV systems be made to break the neutral conductor when the switch is turned off?—terminate it?**

Answer: In general, neutral conductors on the ac side of PV system should not be broken in the disconnecting means. The section cited by some AHJs to require breaking the neutral comes from 690.13 where the 2008 NEC states the following:

"690.13 **All Conductors.** Means shall be provided to disconnect all current-carrying conductors of a photovoltaic power source from all other conductors in a building or other structure. A switch, circuit breaker, or other device, either ac or dc, shall not be installed in a grounded conductor if operation of that switch, circuit breaker, or other device leaves the marked, grounded conductor in an ungrounded and energized state."

690.2 Clearly defines the photovoltaic power source as the dc portion of a PV system:

Photovoltaic Power Source. An array or aggregate of arrays that generates dc power at system voltage and current."

The second sentence of 690.13 reiterates the general intent of the NEC in not installing switches in a grounded conductor, prohibiting such a switch if that circuit remains energized after the disconnect is opened. While most inverters instantly shut down when the ac inverter output disconnect is opened, there are some battery-based systems that remain energized after the switch is opened. Internally, these inverter isolate the ungrounded conductors on the utility side of the inverter so that they can power loads on the stand-alone side of the inverter. However, the neutral is not opened internally and must be solidly connected to the utility-powered distribution panel that feeds the inverter. Opening this neutral in this situation not only violates 690.13, but also creates a potentially dangerous ac system that is no longer grounded. Without a neutral to ground connection in the stand-alone circuit will cause overcurrent protection devices to fail to operate properly in response to ground faults.

6. **The splice is on the load side of the 100a main breaker in the meter. At 120% what size can the fuse be in the fusible disconnect if the system has 18 panels? What if the PV system has 40 panels, 60 panels…how should the PV system be installed to meet the minimum requirements if the meter is 100a or 125a?**

Answer: If the conductors are spliced on the load side of the 100-amp main breaker in order to make an electrical connection for PV system inverter output circuit, then a new 100-amp breaker or fusible disconnect would need to be installed between the PV system connection and the main lug distribution panel for the building. If the distribution panel has a main breaker, no new 100-amp device would necessary. By placing the new 100-amp overcurrent protection device (OCPD) in between the PV system connection and the main lug panel, it prevents the PV system from providing overcurrent to the 100-amp feeder conductors or panel busbars.

The maximum PV system OCPD in this example is actually 100-amps. This is due to the fact that the section of the feeder between the 100-amp main breaker and the second 100-amp OCPD contains no loads so the limitation in 690.64(B) of 120% of OCPDs feeding power to a busbar or conductor does not apply. The NEC requires that the output of the PV system be no greater than the ampacity of the supply conductors, which are rated for 100-amps in this case. I PV system with a 100-amp OCPD is limited to 80% of that current for maximum continuous current—80amps [690.8(A)(3)].

A 18 panel Enphase system with M215 micro-inverters requires at least two 15-amp or 20-amp circuit breakers. Both circuit breaker options are well within the 100-amp limitation of the service conductors. The maximum number of micro-inverters allowed on a 100-amp service with this wiring configuration is 85 M215 inverters, or five 20-amp breakers each with 17 micro-inverters connected. This would be a total ac power output of 18,275 Watt—an extremely large PV system—but completely code compliant.

Another way to look at this wiring scenario is that the second 100-amp OCPD at the distribution panel or added next to the existing 100-amp service breaker becomes a new service disconnect for the building making the PV connection a supply side connection [690.64(A)] where the 120% rules does not apply.

In old meters there are no provisions for additional terminations to ground. Contractors have been clamping their ground wires to the existing grounded wire for this purpose.

7. **If there is a properly installed continuous conductor running from the meter to the grounding electrode, is an irreversible splice an acceptable method of connecting the existing grounding electrode conductor.**

   Answer: For small PV systems where there is only a single ac grounding electrode conductor, connecting the dc grounding electrode to the ac grounding electrode with an irreversible splice would be fine. Larger ac systems would allow the dc grounding electrode to be irreversibly spliced to the ac grounding electrode conductor that is sized for the ac grounding electrode system.

8. **In a 200 amp meter, contractors have been clamping their systems to the load side of the 200 amp main breaker to feed their distribution panel. This increases the load to the 200 amp main breaker. Is this acceptable?**

Answer: This common practice is acceptable as long as a new subpanel overcurrent device is placed between the inverter connection point and the subpanel. As long as the section that the inverter is connected to does not contain loads, the summation of supply breakers to the conductor or busbar is not relevant. The limitation on the size of the PV system is ultimately the conductor size, the main breaker size, and the service conductor size. A 200 amp service would be capable of accepting a 200 amp PV system as long as a new 200 amp breaker was installed prior to the 200 amp subpanel. The new 200 amp breaker prevents overcurrent of the subpanel busbar.

9. When should the field inspector question a change in the submitted plans?

Answer: It is important that number of modules agree with the provided plans since the ratings of equipment, both for voltage and current depend on the proper configuration. It is common for suppliers to substitute different product between when the permit is pulled and the final installation. Although this is understandable, the new array configuration must be provided in supplied as-built plans, and the alternative calculations made for changes in the photovoltaic power source sign (see section 3 of Field Inspection guide).
Occasionally, module model numbers can change between the time that the permit documents are approved and the final inspection. For products that are substantially identical, the different module model number can be substituted without being considered a product difference, provided documentation shows that the products are the same.

10. How does the field inspector confirm the model number of the PV modules?

Answer: Confirming the model number of a module can be a challenge. For residential rooftop PV systems, the listing labels supplied by the testing laboratory are on the back side and difficult or impossible to view. One option is for a digital photo to be taken of the PV module label, and a copy of the photo supplied at the time of inspection. An alternative to a printed version would be for the contractor take a picture of the back side of the module and show the picture to the inspector. If neither of these methods can be accomplished, a single representative module could be moved to provide a visual inspection of the label.

11. What is the most important safety issue for a PV system installation?

Answer: One of the most important safety issues with a PV array is that the conductors are properly supported. It is unacceptable for conductors to lie on roofing materials or come in contact with sharp or abrasive surfaces. The installation methods for the exterior USE-2 conductors, commonly used in PV arrays, is stated in *NEC* 338.10(B)(4). This section refers the installer on to Article 334.30 for support methods. Article 334 is entitled Non-Metallic

Sheathed Cable (often referred to by the trade name Romex). The requirements for fastening NM cable are well understood by jurisdictions.

12. Why is wire management so important?

Answer: Wire management is one of the quickest ways to read the competence of a contractor or installation team. Properly installed conductors should be virtually invisible from the ground level with no conductors hanging unsupported. Branches and leaves, and snow and ice in cold climates, have a tendency of collecting under arrays and occasionally pull loose conductors from their supports, damaging the conductors or the module. When conductors are run between support rails, or on the upper edge of a PV array, getting visual confirmation of the quality of wire management may require the inspector getting onto the roof or positioning a ladder at the side of the array to view underneath the array. Many wiring sins are covered by PV modules, but these wiring mistakes can eventually turn into system failure or even arcing fires.

13. What are typical installation mistakes with exterior cabling systems?

Answer: The inspector should inspect a sample of plug-and-receptacle connectors to ensure that they are fully engaged. Often installers are not properly trained on how to make these connections and don't get them fully engaged. Another problem that relates to connectors and conductors is bending the conductor too close to the outlet of a plug or receptacle, potentially damaging the connector. Also the bending radius of USE-2 cable must be observed. As with many cable, the minimum bending radius is 5 times the diameter. If the diameter is 0.2", the minimum RADIUS is 1" (2" bend).

14. When looking at the grounding of a PV installation, what should the field inspector focus on?

Answer: The key to module grounding is creating an electrical connection between the module frame, most often an aluminum extrusion, with the equipment grounding conductor (EGC). Creating this connection can be handled several ways. The module manufacturer and the support structure manufacturer may have specific methods to accommodate effective grounding of the exposed metal parts.

15. How should a PV installation comply with 2008 NEC provisions in 690.47(D) for additional array electrodes?

Answer: The 2008 NEC in 690.47(D) requires array structures to be connected to a grounding electrode. The provision, which was removed from 2011 NEC, is most relevant to ground-mounted structures. This additional grounding is primarily for lightning and surge grounding. For ground-mounted systems, this is typically a driven ground rod with a Grounding Electrode Conductor (GEC)

sized according to 250.166 (minimum 8 AWG). The support structure may comply as an electrode, provided the steel is buried at least 8 feet in the earth just like a ground rod.

16. What are some of the more common mistakes with electrical equipment and wiring between the PV modules and the inverter?

Answer:

a.) Installing disconnects rated for vertical installation in a non-vertical application.
b.) Installing improperly rated fuses in source combiners and fused disconnects.
c.) Not following manufacturer's directions for wiring disconnect for 600 Vdc ratings.
d.) Installing dry wire nuts in wet locations and inside boxes that get wet routinely.
e.) Using improper fittings to bring conductors into exterior boxes.

17. What is necessary to make sure roof penetrations are properly installed?

Answer: The attachment detail should be supplied with the mounting system manufacturer's information. The contractor should supply this detail with an explanation of the sealing process used to preclude roof leakage, should the array be mounted on a roof surface. Typical sealing of roof penetrations are done with flashing at round pipe penetrations, special lag screw flashings (see QuickMount.com and ttisolar.com), and various caulking materials to seal lag screw holes using caulk that is compatible with the roofing material. Leaking roofs are of primary concern to homeowners and can cause significant property damage. Sloppy or improper installation of penetrations should not be tolerated.

18. How can a field inspector verify that an attachment is secure?

Answer: While examining the roof attachments, a simple test can be done if the inspector is on the roof. With protective gloves to prevent cuts on sharp edges, pull up on a PV module near one of the supports. If the support moves a significant amount, it is likely not attached properly. Several years ago in Southern California, a PV system blew off a roof during high winds since it was attached to the roof tile with plastic anchors rather than being properly attached to the roof rafters or trusses. A simple pull test would have quickly identified that the array was not properly attached to the roof.

Even if the proper lag screws are used for the mounting system, installers can poorly install the lag screws. Proper lag screw mounting requires a pilot hole in the center of the roofing member at approximately 75% of the diameter of the

lag. Any unthreaded shank must be piloted at the full diameter of the lag to the full depth of the unthreaded shank. It is difficult to inspect for lag screw mounting with other than the simple pull test mentioned earlier. Another option to inspect lag screws is to enter the attic under the PV array and see if any lag screws are showing or there is any evidence of improper pilot holes such as split rafters or trusses.

19. How can the field inspector be sure that the conductors used between the array and combiner box are properly sized?

Answer: 10AWG conductors that are 90°C temperature rated will suffice for all source circuit wiring in a PV array provided that the conductors are not bundled with more than a total of 8 conductors on a rooftop. Should more than 8 conductors be bundled or run in a raceway, the ampacity of the conductor would have to be calculated to check if the wire is sufficient (see section 1(f) in the Field Inspection guide).

20. For PV arrays at ground level, what are some reasonable methods to prevent ready access to conductors?

Answer: The safety hazard of allowing children to touch wiring in a 600 Volt PV system is extreme. If an array is mounted close to the ground with readily accessible wiring, the easiest and generally most cost effective method to render the wiring not readily accessible is to place non-metallic lattice work around the back, sides, and under the front of the PV array. By enclosing the array with non-metallic guards, the guards require no grounding but allow air to flow to the backside of the array for cooling. Other methods of building a ground-mounted PV arrays that are not readily accessible is to put the array on a shade structure a minimum of 8' above the ground, or pole-mounting the array and placing guards over any wiring that is below 8'.

21. What are some examples of proper materials for signs required in PV systems?

Answer: The signs should be of sufficient durability to withstand the environment involved. For outdoor signs, the sign should be either metal or plastic with engraved or machine printed letters, or electro-photo plating, in a contrasting color to the sign background. Outdoor rated vinyl signs exist that are UV stabilized and are certified to UL 969. Vinyl signs may be necessary for labeling conduit on rooftops in inside buildings. Plexiglas-covered paper or laminated paper directories may also be acceptable provided that the signs are sufficiently protected from the environment involved or used indoors. The signs or directories should be attached to the electrical equipment or located adjacent to the identified equipment (see section 3 in the Field Inspection guide).

22. How can the field inspector be sure that the equipment in PV system is being installed so that the system will not exceed the voltage and current ratings of the equipment?

Answer: Check that inverter has a rating as high as max voltage on PV Power Source sign. Check that circuit breakers or fuses in combiner or fused disconnect are dc rated at least as high as max voltage on sign (see section 4 of the Field Inspection guide for more information).

Summary of Evaluations & Recommendations for Future Training Activities in Hawaii

Evaluation forms were handed out to participants at each of the respective sessions. A total of 206 forms were collected: 19 from the Hilo session; 46 from Kauai; 5 from the Maui Code Official's session; 31 from the Maui Contractor's session; and 105 from Honolulu[3]. Of these, 71 percent of the attendees felt the training met their expectations; 78 percent felt they would be able to apply the knowledge learned; 96 percent felt the trainer was knowledgeable; and 79 percent felt the quality of instruction was good. In terms of training objectives for each topic being identified and followed, and content being organized and easy to follow, only 64 percent and 66 percent agreed, respectively. The most common areas for improvement identified were: 1) To have a longer training session, and 2) To follow the agenda more closely.

The evaluation forms also identified topics of interest for future PV trainings. The top five most common topics identified were: 1) County building & permitting process; 2) Fire safety; 3) Electrical system design; 4) New product information; and 5) Service and maintenance of systems.

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[3] Evaluation form breakdown by sector: 36 Inspectors, 91 Contractors, 73 Other (Engineers, Architects, Electricians, Consultants, Fire Dept), 6 Blank.

APPENDIX 2.9

Evaluation, Report Energy Code Training

REPORT

November 2012 Energy Code Training Evaluation Report

Prepared for
Department of Business, Economic Development, and Tourism
State of Hawaii

December 17, 2012

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Acknowledgment: This material is based upon work supported by the Department of Energy under Award Number DE-EE0000216

Sponsor: State of Hawaii, Department of Business, Economic Development and Tourism

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Contract No. 59499; Task Order Number 2.F

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Introduction

This report summarizes the results of technical training covering the 2009 International Energy Conservation Code (IECC) with Hawaii Amendments and Design Strategies for Code Compliance. The training sessions were held November 13 through November 20, 2012.

Each session included two portions: 1) a morning section covering the 2009 IECC with Hawaii amendments and 2) an afternoon section covering design strategies for compliance. Lunch was provided for attendees who attended the morning session or both sessions.

Attendance

Six sessions were held on four islands, with a total of 268 attendees. The following table lists the number of attendees at each location.

Table 1 – Training Attendance

Location	Venue	Date	Attendance
Oahu	Pagoda Hotel	11/13/12	62
Oahu	Pagoda Hotel	11/14/12	59
Kauai	4444 Rice Street	11/15/12	40
Maui	Maui College	11/16/12	59
Hilo	Hilo Hawaiian Hotel	11/19/12	27
Kona	NELHA Visitor Center	11/20/12	21
Total			268

Training Materials

The following materials were provided to attendees. Electronic copies of each handout have been delivered separately. Some of these materials may be found on DBEDT's website: http://energy.hawaii.gov/programs/achieving-efficiency/hawaii-energy-building-code.

- Compact disk including the following electronic files:
    - Presentation slides, morning session, in pdf format, both full-page and two-per-page.
    - Presentation slides, afternoon session, in pdf format, both full-page and two-per-page.
    - Agenda, pdf format
    - Hawaii code amendments, 3/20/2012 version
    - Kauai code amendments
    - Comparison of 2006 vs. 2009 IECC and Hawaii amendments
    - Window compliance spreadsheet and instruction document
    - Checklist – Residential design

  - Checklist – Residential plan review
  - Checklist – Commercial design
  - Checklist – Commercial plan review
  - FAQs, 11/1/12 version
- Printed handouts included the following
  - Agenda
  - Evaluation form
  - Checklist – residential design
  - Checklist – commercial design

Major Issues Discussed

This section summarizes issues raised by participants during the November 2012 training sessions.

Attic moisture management. Several attendees raised questions regarding vented vs. unvented attic construction and insulation requirements. The energy code is silent on whether the attic needs to be sealed (i.e. not vented) if insulation is installed under the roof rather than at the attic floor. Some designers use a sealed and insulated attic approach, often with spray foam insulation under the roof. One attendee noted that some building officials require that the attic be vented if combustible material such as wood is used for the structure. Ideally the Hawaii amendments would clearly address unvented attic compliance options.

Site-built windows. The IECC does not define "site-built" windows and doors. Therefore there is some ambiguity about air leakage certification for locally fabricated products. In general, residential windows and doors must be tested for air leakage per Section 402.4.4, but there is an exception for site-built products. One attendee sells hardware for multi-sliding doors, which are fabricated locally. It is not clear whether these would be considered "site-built".

Commissioning. There was discussion regarding whether the commissioning required by the Hawaii amendment to Section 503.2.9 must be performed by a third party, i.e. not the designer or contractor. The code does not specify who must perform the work, only that the designer must provide written certification. This issue has been added to the FAQ document.

Envelope requirements for non-AC spaces. Several attendees felt that wall insulation requirements should not apply to shaded walls in homes without air conditioning. This issue is also listed in the following section with issues raised during earlier trainings.

Issues Discussed in Previous February 2012 Training

The following list of issues was recorded following training in February 2012, and these issues are still relevant. Many of these issues were raised again. Therefore the list is repeated here.

Issues Related to Enforcement

The current level of enforcement was a common topic with the private sector. Some designers would like to see better enforcement in order to create a level playing field. The general view was that there is little enforcement of the current code, neither plan review nor inspection.

Some considered future enforcement unlikely for the requirement in Section 101.4.5 that would require a space to be brought into full compliance if AC is added. This would be especially true in the case of small window AC units, which can currently be installed without a permit.

Inspection is challenging because there are many compliance options for the building envelope. A roof does not necessarily need insulation in order to comply. Therefore, the inspector needs to look at the plans for a specific project to ensure that the elements included on the plans are installed in the field.

Few were aware that commissioning requirements are already included in the County amendments to IECC 2006. There appears to be little awareness or enforcement of the current amendments in general. For example, some private sector professionals have copies of the 2006 IECC but are not aware that their County has adopted amendments.

The code requires that an existing building must comply with the code if a change in occupancy will result in an increase in peak energy demand (Section 101.4.4). That requirement may be hard to enforce because the process for determining the peak energy demand is not described in the code. The building department may not have the expertise to judge whether or not a change will cause an increase in peak demand.

The residential certificate requirement is generally not being enforced. Section 401.3 requires a label be installed in or on the electrical panel. That label must include information about R-values, SHGCs and equipment efficiency. Awareness of the requirement was low.

Issues Related to 2009 IECC Requirements

Section 101.4.3 requires that roof be upgraded to comply if the sheathing or insulation is exposed during a re-roofing project. There were several issues raised related to this requirement. First, roofs do not necessarily require a building permit in cases where the new roof material is same as existing, so the building department would not necessarily know that the reroofing project was happening. Second, not all roofs have sheathing. Shingle or tile roofs may have battens instead. So the language of the requirement is unclear in those cases. And third, in some cases there would be very significant expense to upgrade the roof insulation, and if it is an unconditioned home then the owner would not get a direct payback. This requirement might create a situation where law-abiding contractors would be at a significant disadvantage to contractors who ignore the requirement. Finally, there is no minimum area threshold in the code, so it appears to apply even when only a small portion of a roof is being repaired.

Section 502.4.6 requires loading dock weather seals. It would make sense to provide an exemption for spaces that are unconditioned.

There was some concern that the exterior lighting requirements might be in conflict with other astronomy-related exterior lighting codes and programs.

The commercial envelope requirement for R-5 block insulation in metal building roofs could create a structural problem if it is a foam block that might degrade over time. It also may be unreasonable to require the thermal block in a non-AC metal building because the extra expense may outweigh the relatively low benefit.

Issues Related to Hawaii Amendments

Some attendees felt strongly that non-air conditioned dwellings in some regions, such as east Hawaii, should be exempt from the building envelope requirements. Or they should at least be exempt from the wall insulation requirements. Hawaii and Kauai Counties currently exempt non-AC residences.

The Hawaii amendment to Section 103.1 requires a design professional to include a signed statement on the plans certifying that the project is in compliance. At least one architect did not feel it is appropriate

for an architect, for example, to certify full compliance when some areas of the design may be out of their area of knowledge, such as the mechanical systems. (Kauai amendments do require that each discipline provide their own signature). Others felt that the language should be changed to use the word “design” rather than “project”. They felt that using the word “project” implies that the building complies as constructed. However, the designer does not typically have control over construction. They would be more comfortable certifying that the “design” complies.

Kauai amendments to IECC 2009 are different from the version approved by the State Building Code Council in February 2012. The Kauai amendments were developed earlier.

Some designers felt that dwellings at higher elevations, such as Maui upcountry, should be exempted from the window shading requirements because solar heat is desirable for much of the year.

The amendment to Section 502.2.1 that exempts commercial cool roofs from the insulation requirement is pretty generous. It’s likely that a cool roof alone will not be as efficient as the otherwise required insulation for an air conditioned commercial building.

The code does not include specific language allowing the building official to make exemptions for innovative designs or special cases. In Section 101.3 the code states, “This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve the effective use of energy.” That section appears to refer to how the code has been written to include tradeoff and whole-building performance options, but those approaches have limitations. Perhaps a section can be added that allows building official discretion for innovative designs.

Per strict reading of the Hawaii amendment to Section 101.5.2, a building or portion of a building that has less than 1 watt per square foot peak demand for space conditioning, which is very small, would be exempt from the envelope requirements. Therefore, while an unconditioned space would have to meet the envelope requirements, a space with a tiny air conditioner would be exempt. This is a potential loophole.

A definition of non-habitable space is not included to accompany the amendment to section 101.5.2, making the envelope exemption a bit unclear. One attendee mentioned that the residential code has definitions that would consider spaces such as corridors to be non-habitable, which would be in conflict with the intent of the energy code.

Other Issues

Rescheck and Comcheck do not include Hawaii amendments.

Frequently Asked Questions

Please see Appendix 3 for the current list of FAQs.

Summary of Attendee Evaluations

A total of 152 evaluation forms were received from 268 total attendees. Table 2 lists the number of surveys received for each of the six training sessions.

Table 2 – Number of Surveys Received

Location	Date	Surveys Received	Attendance	Response Rate
Oahu	11/13/12	34	62	55%
Oahu	11/14/12	31	59	53%
Kauai	11/15/12	18	40	45%
Maui	11/16/12	36	59	61%
Hilo	11/19/12	22	27	81%
Kona	11/20/12	11	21	52%
Total		152	268	57%

The following pages include a copy of the attendee survey form, followed by graphs that summarize the survey responses. Detailed tables of responses are included as an attachment.

Observations from Attendee Responses

- Of all responders, 28% (42 of 152) are from the public sector.
- The overall impression of the course was favorable. Attendees survey responses were 20% Excellent, 56% Very Good, 21% Good and 2% Fair.
- Nearly all attendees regarded the topics as either “Useful” or “Very Useful”. The morning sessions were rated very slightly more useful than the afternoon sessions.
- Effectiveness of the presenters was also regarded favorably. The most frequent response was “Very Good”, followed by “Excellent” and “Good”.
- For the presentation slides, the most frequent response was “Very Good”, followed by “Good” and “Excellent”.
- For the printed materials, the responses were a little less positive (printed slides were not provided). The most frequent response was “Very Good”, followed by “Good” and “Excellent”.
- Feedback on the quality of the training venues was generally good. Honolulu (Pagoda Hotel) rated slightly lower than the other venues. There were a few complaints about the seats at the Maui College lecture hall.
- A few attendees would have preferred to receive printed slides in order to take notes. Some suggested distributing slides by email in advance.

Copy of Attendee Survey Form

Training Evaluation Survey

2009 International Energy Conservation Code with Hawaii Amendments

Sponsored by the State of Hawaii Department of Business, Economic Development and Tourism

Date: _____ ☐ Morning session only ☐ Afternoon session only ☐ Both

1. My role

☐ Building official ☐ Engineer
☐ Other county/state employee ☐ Contractor
☐ Architect ☐ Supplier
☐ Other: _____

2. Overall impression of the training

Poor	Fair	Good	Very Good	Excellent
☐	☐	☐	☐	☐

3. Usefulness of each topic

	Not at all useful	Slightly useful	Useful	Very useful
Morning – residential	☐	☐	☐	☐
Morning - commercial	☐	☐	☐	☐
Morning – incentives				
Afternoon – residential design	☐	☐	☐	☐
Afternoon – commercial design	☐	☐	☐	☐

4. Effectiveness of each presenter

	Poor	Fair	Good	Very Good	Excellent
Howard Wiig	☐	☐	☐	☐	☐
Erik Kolderup	☐	☐	☐	☐	☐
_____	☐	☐	☐	☐	☐

5. Quality of training materials

	Poor	Fair	Good	Very Good	Excellent
Presentation slides	☐	☐	☐	☐	☐
Printed handouts	☐	☐	☐	☐	☐

6. Quality of training venue

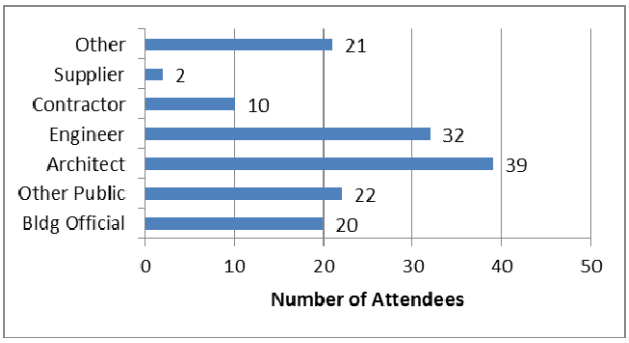
Poor	Fair	Good	Very Good	Excellent
☐	☐	☐	☐	☐

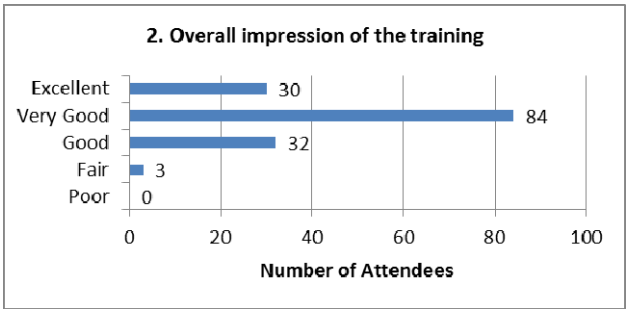
7. Suggestions for future training:

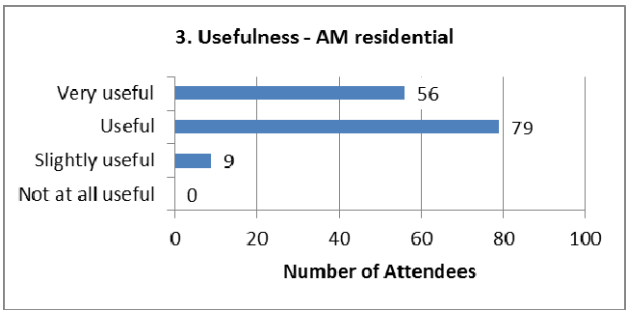
☐ Residential energy efficiency
☐ Commercial energy efficiency
☐ Energy code compliance software
☐ Other: _____

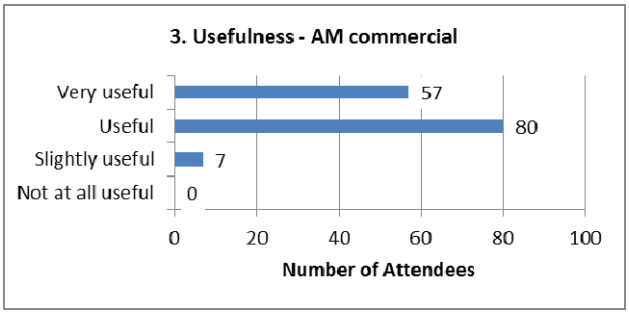
8. Additional comments (please use back if more space is required):

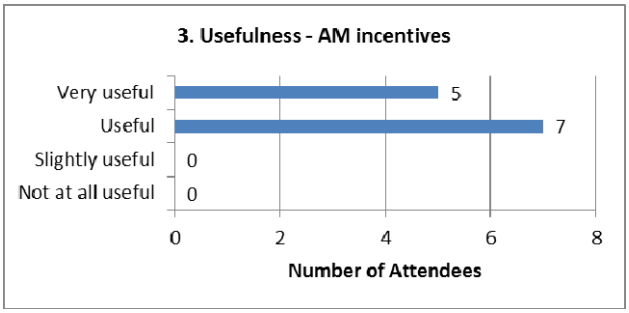
Summary of Attendee Survey Results

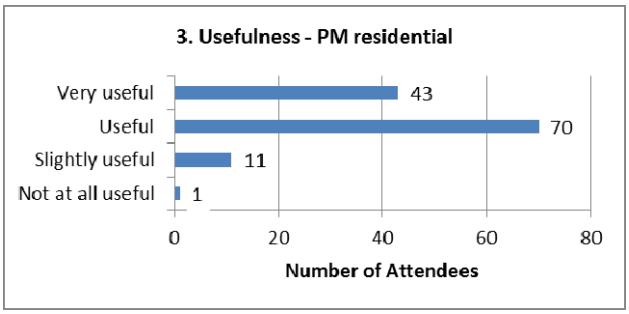


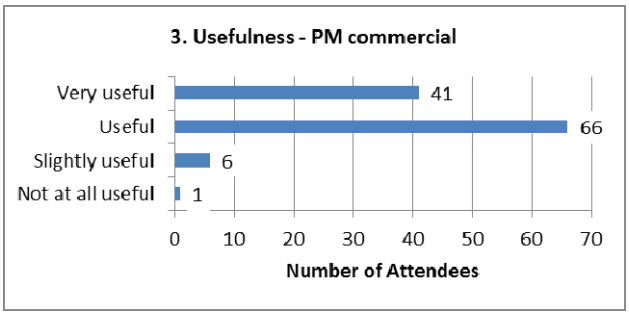


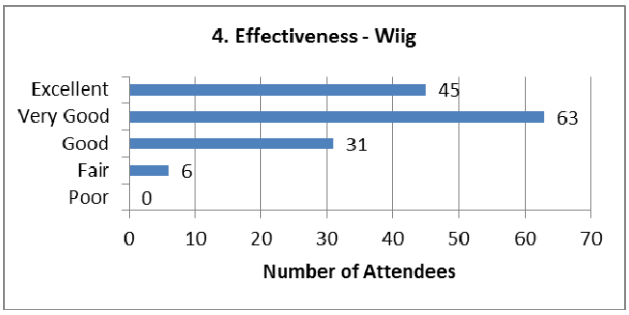


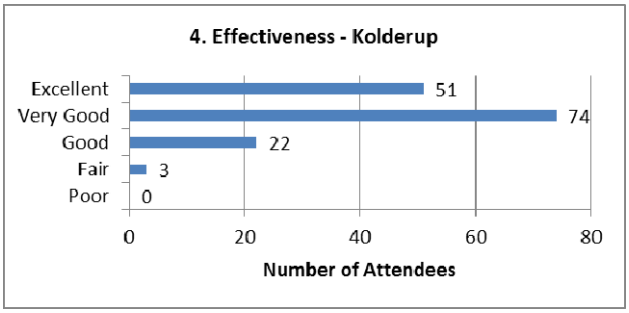





3. Usefulness - PM residential
Very useful
Useful
Slightly useful
Not at all useful
43
70
11
1
0
20
40
60
80
Number of Attendees


3. Usefulness - PM commercial
Very useful
Useful
Slightly useful
Not at all useful
41
66
6
1
0
10
20
30
40
50
60
70
Number of Attendees


4. Effectiveness - Wiig
Excellent
Very Good
Good
Fair
Poor
45
63
31
6
0
0
10
20
30
40
50
60
70
Number of Attendees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Very Good
Good
Fair
Poor
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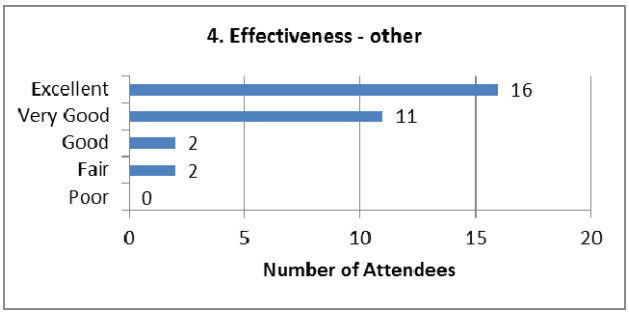
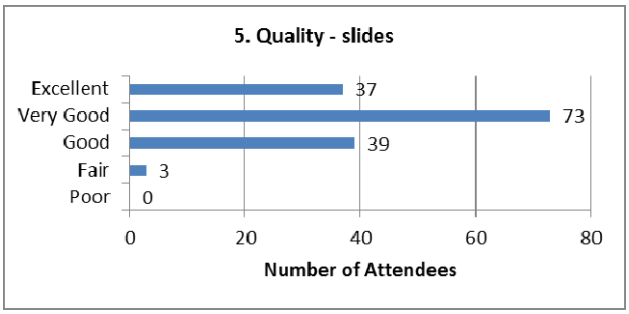
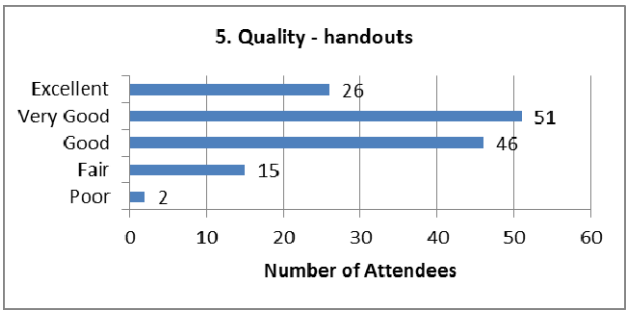
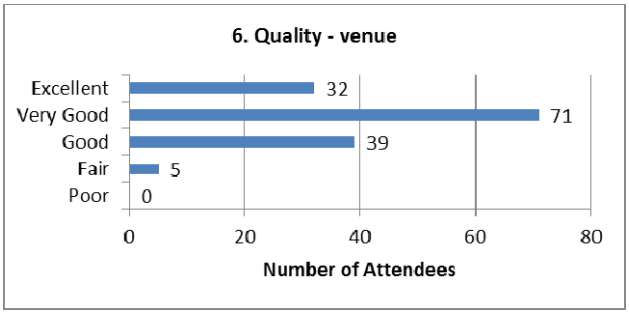
74
22
3
0
0
20
40
60
80
Number of Attendees


4. Effectiveness - other
Excellent
Very Good
Good
Fair
Poor
16
11
2
2
0
0
5
10
15
20
Number of Attendees







Additional Comments from Attendee Surveys

The following comments were provided by attendees in response to Item 8 on the form "Additional Comments".

1. Very good information provided. Thanks for the CD containing presentation slides. Great lunch/snacks. Thanks!
2. Needed to print power point materials.
3. Good seminar. A little cold in the room. (11/13/12, Pagoda Hotel)
4. Need to print out ppt so we can follow and take notes as per topic of the discussion (or give ahead of time). Very hard to follow and take notes without appropriate outline handout. Overall good course.
5. Thanks for the lunch! (& parking). These seminars are a great service to the community.
6. Add case studies of completed projects how they did to conform to IECC.
7. Include printed handouts.
8. Thank you for the great information and likewise great lunch!
9. More information in CD will be appreciated

10. Mr. Wiig made a couple of gender related comments that were not appreciated by female attendees.
11. 1) Keep all commercial with commercial section in PM session. 2) Need to keep to time allotted (start/end on time) 3) Question should be taken later after presentation of material unless time permits.
12. Noise from jack hammering spoiled PM lecture.
13. Buffet lunch please.
14. Thank you!
15. Excellent seminar. Very informative, methodical and enlightening presentation. Excellent presentation of the possibilities to resolve issues that are covered by the energy conservation code.
16. More detail on cost benefit analysis to new technology and code application.
17. Hands-free microphone for presenter (Maui)
18. What is in use on Maui now? Company that had system installed and working.
19. Venue seating was a little strange.
20. Chairs squeaked and creaked otherwise venue was very good.
21. Photos of HVAC and electrical equipment similar to wall photos.
22. Could email handouts to attendees to view on portable devices (tablet, phone).
23. Take a break every hour; the chairs were hard on the back.
24. Thank you. Great class.
25. Thank you for workshop.
26. Mahalo.
27. Thank you very much for the open registration.
28. Pass hard copy of slide, so participant won't need to spend time to copy/write.
29. Great job!
30. Good job - interesting!
31. Excellent presentation thank you. Very honest statement… without change you wouldn't have a job!!! Unfortunately this will always drive construction costs up and the burden will be passed on to the next generation. Sad.
32. Screen too small.

Recommendations for Future Training

The attendee survey form included three choices for suggestions for additional training and also included space for additional suggestions. Responses for the three choices were as follows:

- Residential energy efficiency, 41of 152 = 27%
- Commercial energy efficiency, 42 of 152 = 28%
- Energy code compliance software, 45 of 152 = 30%

Additional suggestions from attendees:

1. Energy modeling software; life cycle cost analysis/calculation
2. Project presentations
3. More discussion of options and cost of different options.
4. Retrofits to existing residences
5. Different types of AC systems (more in-depth look)
6. Cost efficient residential and commercial design strategy, e.g. common in Hawaii
7. Actual case studies and lessons learned
8. Other compliance alternatives
9. Energy modeling software tools
10. ASHRAE std 62.1 outdoor air
11. More visuals to show compliance.]

Appendix 1 – Detailed Attendee Survey Results

1. My role	Date	Bldg Official	Other Public	Architect	Engineer	Contractor	Supplier	Other	Total
	13-Nov	0	4	8	7	5	2	7	33
	14-Nov	0	8	10	6	1	0	6	31
	15-Nov	4	1	5	3	2	0	0	15
	16-Nov	8	3	8	9	1	0	6	35
	19-Nov	6	6	2	5	1	0	2	22
	20-Nov	2	0	6	2	0	0	0	10
	Total	20	22	39	32	10	2	21	146

2. Overall impression of the training	Date	Poor	Fair	Good	Very Good	Excellent	Average
	13-Nov	0	0	5	21	7	4.06
	14-Nov	0	1	9	17	4	3.77
	15-Nov	0	0	2	10	4	4.13
	16-Nov	0	2	10	17	7	3.81
	19-Nov	0	0	3	13	6	4.14
	20-Nov	0	0	3	6	2	3.91
	Total	0	3	32	84	30	3.95

3. Usefulness - AM residential	Date	Not at all useful	Slightly useful	Useful	Very useful	Average
	13-Nov	0	2	19	13	3.32
	14-Nov	0	5	12	11	3.21
	15-Nov	0	0	12	6	3.33
	16-Nov	0	1	20	11	3.31
	19-Nov	0	1	11	9	3.38
	20-Nov	0	0	5	6	3.55
	Total	0	9	79	56	3.33

3. Usefulness - AM commercial	Date	Not at all useful	Slightly useful	Useful	Very useful	Average
	13-Nov	0	1	18	15	3.41
	14-Nov	0	4	14	11	3.24
	15-Nov	0	1	12	5	3.22
	16-Nov	0	1	19	12	3.34
	19-Nov	0	0	10	10	3.50
	20-Nov	0	0	7	4	3.36
	Total	0	7	80	57	3.35

3. Usefulness - AM incentives	Date	Not at all useful	Slightly useful	Useful	Very useful	Average
	13-Nov	0	0	2	0	3.00
	14-Nov	0	0	1	0	3.00
	15-Nov	0	0	0	0	
	16-Nov	0	0	4	4	3.50
	19-Nov	0	0	0	0	
	20-Nov	0	0	0	1	4.00
	Total	0	0	7	5	3.42

3. Usefulness - PM residential	Date	Not at all useful	Slightly useful	Useful	Very useful	Average
	13-Nov	0	3	19	10	3.22
	14-Nov	0	4	14	8	3.15
	15-Nov	0	0	11	6	3.35
	16-Nov	1	3	13	7	3.08
	19-Nov	0	1	8	8	3.41
	20-Nov	0	0	5	4	3.44
	Total	1	11	70	43	3.24

3. Usefulness - PM commercial	Date	Not at all useful	Slightly useful	Useful	Very useful	Average
	13-Nov	0	2	17	10	3.28
	14-Nov	0	3	14	9	3.23
	15-Nov	0	1	12	4	3.18
	16-Nov	1	0	13	6	3.20
	19-Nov	0	0	5	8	3.62
	20-Nov	0	0	5	4	3.44
	Total	1	6	66	41	3.29

4. Effectiveness - Wiig	Date	Poor	Fair	Good	Very Good	Excellent	Average
	13-Nov	0	1	5	15	11	4.13
	14-Nov	0	3	7	13	8	3.84
	15-Nov	0	0	3	7	8	4.28
	16-Nov	0	2	11	14	6	3.73
	19-Nov	0	0	2	11	7	4.25
	20-Nov	0	0	3	3	5	4.18
	Total	0	6	31	63	45	4.01

4. Effectiveness - Kolderup	Date	Poor	Fair	Good	Very Good	Excellent	Average

13-Nov	0	0	4	15	14	4.30
14-Nov	0	2	7	15	7	3.87
15-Nov	0	0	2	7	9	4.39
16-Nov	0	1	7	20	8	3.97
19-Nov	0	0	1	12	8	4.33
20-Nov	0	0	1	5	5	4.36
Total	0	3	22	74	51	4.15

4. Effectiveness - other

Date	Poor	Fair	Good	Very Good	Excellent	Average
13-Nov	0	0	0	0	4	5.00
14-Nov	0	1	1	4	2	3.88
15-Nov	0	0	1	0	0	3.00
16-Nov	0	0	0	5	6	4.55
19-Nov	0	1	0	2	3	4.17
20-Nov	0	0	0	0	1	5.00
Total	0	2	2	11	16	4.32

5. Quality - slides

Date	Poor	Fair	Good	Very Good	Excellent	Average
13-Nov	0	0	11	11	12	4.03
14-Nov	0	1	9	18	3	3.74
15-Nov	0	0	4	9	5	4.06
16-Nov	0	2	10	19	5	3.75
19-Nov	0	0	3	11	8	4.23
20-Nov	0	0	2	5	4	4.18
Total	0	3	39	73	37	3.95

5. Quality - handouts

Date	Poor	Fair	Good	Very Good	Excellent	Average
13-Nov	1	5	12	10	5	3.39
14-Nov	1	6	7	11	2	3.26
15-Nov	0	0	7	6	5	3.89
16-Nov	0	3	12	14	3	3.53
19-Nov	0	0	5	7	7	4.11
20-Nov	0	1	3	3	4	3.91
Total	2	15	46	51	26	3.60

6. Quality - venue

Date	Poor	Fair	Good	Very Good	Excellent	Average
13-Nov	0	2	14	14	4	3.59
14-Nov	0	2	12	13	4	3.61

15-Nov	0	0	2	12	3	4.06
16-Nov	0	1	7	21	5	3.88
19-Nov	0	0	3	8	9	4.30
20-Nov	0	0	1	3	7	4.55
Total	0	5	39	71	32	3.88

	Count
7. Training suggestions - residential efficiency	41
7. Training suggestions - commercial efficiency	42
7. Training suggestions - code compliance software	45

Appendix 2 – Training Agenda

AGENDA
ENERGY CODE TECHNICAL SEMINAR
2009 International Energy Conservation Code (IECC)
Design Strategies to Achieve Compliance

Co-Sponsored by Hawaii State Energy Office and Hawaii Energy

These one-day seminars are directed to private sector professionals, building professionals, designers, architects, engineers, and public sector officials.

Participants may attend the morning or afternoon sessions, or both.

WHEN / WHERE: Participants may attend the morning or afternoon sessions, or both.
Full day: 7:30 a.m. - 4:00 p.m. (lunch included)
Morning only: 7:30 a.m. - 1:00 p.m. (lunch included)
Afternoon only: 1:00 p.m. - 4:00 p.m.

The training will be held at the following locations on the following dates:

Oahu	Tuesday, Nov. 13, 2012	Pagoda Hotel Ballroom
Oahu	Wednesday, Nov. 14, 2012	Pagoda Hotel Ballroom
Kauai	Thursday, Nov. 15, 2012	Mo`ikeha Building (4444 Rice Street)
Maui	Friday, Nov. 16, 2012	Ka Lama 103, Lecture Hall, UH Maui College
Hilo	Monday, Nov. 19, 2012	Hilo Hawaiian Hotel
Kona	Tuesday, Nov. 20, 2012	NELHA GATEWAY, Natural Energy Laboratory of Hawaii

Morning Agenda –2009 IECC

Time	Topic	Presenter
7:30 – 8:00a	Sign-in and Continental Breakfast	
8:00 – 8:15	**Welcome and introductions**, State and County Officials	
8:15-9:15	**Residential requirements** Envelope, HVAC, Lighting, Water Heating	Kolderup & Wiig
	Residential plan review checklist	Kolderup
9:15-9:30	BREAK	
9:30-10:30	**Commercial requirements** Envelope; HVAC; Water heating, including pools and heat recovery; Lighting; Commissioning	Kolderup & Wiig
	Commercial plan review checklist	Kolderup
	Commercial total building performance option	Kolderup
10:30-11:00	**Stretch Codes; preview of 2012 IECC, IgCC, ASHRAE 189**	Kolderup
11:00 – 11:45	**Energy Efficiency Incentives**	**Hawaii Energy/KIUC**
LUNCH	**Provided by sponsors**	

Afternoon Agenda – Design Strategies for Code Compliance

Time	Topic	Presenter
12:45 – 1:00 p	Sign-in	
1:00 – 1:15	Welcome and introductions	County Officials
1:15 – 2:30	**Design strategies for code compliance for an air-conditioned residence (2009 IECC and HAR 3-181)**	Kolderup
2:30-2:45	BREAK	
2:45 – 3:45	**Design strategies for code compliance for a commercial building (2009 IECC and HAR 3-181)**	Kolderup
3:45 – 4:00	Wrap up	

Presenters

Erik Kolderup, PE, has been an energy code specialist for over 20 years, and was instrumental in creating Hawaii's energy codes in the 1990s and in 2001

Howard Wiig, MA, with the State Energy Office, has been an energy code specialist for over 20 years, and has been in all phases of energy code development

County Presenters

Honolulu **Tim Hiu, PE**, Building Division Manager for 12 years, manages seven building codes

Kauai **Douglas Haigh, PE,** Building Division Manager for 17 years, manages seven building codes

Maui **Ralph Nagamine, PE,** Building Division Manager for 18 years, manages seven building codes

Hawaii **Jai Ho Cheng, PE,** Deputy Building Division Chief for 2 years; Plan Review Engineer for 14 years, manages seven building codes

Energy Efficiency Incentives

Hawaii Energy – Conservation and efficiency program for Hawaii, Honolulu and Maui counties

Honolulu **Michael Chang,** Deputy Program Manager

Maui **Walter Enomoto,** Program Specialist

Hawaii **Caroline Carl,** Program Specialist

Kauai Island Utility Cooperative – Claurino Bueno, Energy Wise Services Director

Co-sponsored by the Hawaii State Energy Office(Department of Business, Economic Development, and Tourism); Hawaii Energy; County of Kauai; and, supported by the U.S. Department of Energy State Energy Program under ARRA-SEP Award Number DE-EE0000216.

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Contract No. 59499; Task Order Number 2.F

APPENDIX 2.10

Energy Code FAQ

Appendix 3 – FAQs

GENERAL QUESTIONS

		Code Reference
Q.	When will IECC 2009 be formally adopted?	
A.	Amendments were approved by the State Building Code Council in February 2012. The Governor's signature is expected this year. Counties are encouraged to start adoption proceedings, with the expectation that IECC 2009 will be in effect in each county at some point during 2012.	
Q.	Are the Hawaii amendments included in the ResCheck and ComCheck compliance software?	
A.	Not currently (as of November 2012), but may be available in the future.	*405 & 506*

ENVELOPE QUESTIONS

		Code Reference
Q.	For re-roofing of buildings that do not have roof sheathing, does the code's insulation requirement still apply?	
A.	The IECC requires that a roof be brought into compliance with insulation requirements if the sheathing or insulation is exposed during a re-roofing project. The assumption is that there is an opportunity for a cost-effective upgrade at that point, either by filling an exposed cavity with insulation, adding foam board insulation on top of the sheathing, or by some other means such as a combination of a radiant barrier and cool roof. The question is whether this requirement applies to roofs without sheathing, such as tile or shingle roofs with battens. In some of those cases a cost-effective upgrade may be feasible, while in other cases the expense to upgrade the roof may be unreasonable. Therefore, projects without roof sheathing should be judged by the building department on a case-by-case basis.	*101.4.3*
Q.	If I am repairing a small portion of my roof and exposing the roof sheathing of that portion, do I need to upgrade the insulation?	
A.	The code does not specify a minimum area threshold for triggering the requirement to upgrade roof insulation. However, it may not be practical to, for example, add foam board insulation on top of the sheathing on only a small portion of an existing roof. Therefore, a reasonable interpretation of the requirement is that it applies when the whole roof is being re-roofed.	*101.4.3*
Q.	If a skylight is installed - will the entire roof need to be brought to code?	
A.	Only the skylight itself must meet the performance requirements in the code. The remainder of the roof does not need to be upgraded.	*101.4.3*
Q.	Why do the envelope requirements apply to unconditioned space?	
A.	The Hawaii amendments extend the scope of the envelope requirements to	*HI amendment*

	include habitable unconditioned space. The amendments also add several envelope compliance options that are targeted at reducing solar heat gain. The motivation for these changes is to improve occupant comfort and to reduce the chance that occupants will install air conditioners. The comfort benefits will vary and will typically be greater on leeward and sunnier portions of the islands.	*to 101.5.2*
Q.	Is the definition of non-habitable space in the Hawaii amendments consistent with the International Residential Code (IRC)?	
A.	Not necessarily. The intent of the Hawaii amendment is to apply the envelope requirements to all portions of residential and commercial buildings that are normally used by people. Non-habitable exempt spaces in the context of the energy code are buildings or portions of buildings such as mechanical rooms or garages that have very intermittent human occupancy.	*HI amendment to 101.5.2*
Q.	Is the manufacturer's label for window solar heat gain coefficient (SHGC) required to be kept on the product?	
A.	Not beyond inspection.	*303.1.3*
Q.	Is credit given for the shading impact of a photovoltaic system on the roof?	
A.	No. The focus is on efficiency first. However, there are some exemptions in the code for systems with solar water heating.	*402.1*
Q.	In the table of R-value requirements for roof and walls, is the R-value for the insulation or the whole assembly?	
A.	The R-value listed in the table is for the insulation alone, not counting other portions of the assembly such as gypsum board.	*402.1.2 & 502.1*
Q.	If I install my roof insulation under the roof deck rather than on the floor of the attic, do I need to also include attic ventilation openings, which might penetrate the insulation?	
A.	The energy code does not require attic ventilation in combination with insulation. However other building code requirements may apply. Check with your building department.	*HI amendment 402.1.6*
Q.	Can you lay decking with a radiant barrier and roofing directly on top?	
A.	A radiant barrier requires at least a 3/4" air gap on the shiny side. The radiant barrier can be placed on the floor of the attic or under the roof, but preferred application is with shiny side down and facing an air gap.	*HI amendment 402.1.6.6*
Q.	Can a radiant barrier be used for compliance if installed above the roof deck?	
A.	Section 402.1.6.8 allows a radiant barrier to be used for compliance credit in a <u>residential</u> roof when installed on top of the roof deck if the shiny side is facing up and there is an air gap of at least ¾ inches above the radiant barrier. This approach is allowed only for open-beam ceilings and when the roof slope is at least 14 degrees. The minimum-slope requirement is to help ensure that the radiant barrier surface does not collect dust. This option is part of the Roof Heat Gain Factor compliance path, in which a radiant barrier can be used to show compliance when combined with a reflective roof surface and/or insulation.	*HI amendment 402.1.6.8*

Q.	What is the difference between a radiant barrier and a cool roof?	
A.	A cool roof is the exterior roofing surface, with high reflectance to reduce the absorption of solar radiation and high emittance to promote radiation of heat to the sky. A cool roof helps prevent the roof surface from heating up in the sun. A radiant barrier is a layer within the roof construction with a low emittance, typically a shiny metallic foil. The radiant barrier reduces the radiant heat transfer within the roof/attic construction.	*HI amendment 402.1.6 & 502.2.1*
Q.	Are there any concerns with baking the roof with a radiant barrier?	
A.	A radiant barrier might cause the roof surface temperature increase somewhat, but the increase should not be enough to cause a problem for roofing materials. And the radiant barrier compliance option for residential roofs also requires ventilation, which helps mitigate roof heating.	*HI amendment 402.1.6.6*
Q.	Is roof insulation still required for unconditioned open metal buildings?	
A.	Yes, however there is an exemption available in the amendments for qualifying cool (white) roofs on commercial buildings.	*HI amendment 502.2.1*
Q.	How are a location's conditions accounted for, such as adjacent buildings, trees or geographical features?	
A.	The code does not provide credit for shading from adjacent objects. Of course, such shading can be beneficial and should be considered in the design of the building as long as the objects are expected to exist for the life of the building.	*502.3.2*

LIGHTING AND ELECTRICAL QUESTIONS

		Code Reference
Q.	Does the code specify the type of base required for residential high-efficacy lighting?	
A.	The code does not prohibit standard screw-base high efficacy lighting. It is recommended, however, that high-efficacy fixtures be installed that do not allow occupants to replace the high-efficacy lamps with incandescent lamps. An appropriate example is a fixture that requires pin-based compact fluorescent lamps rather than standard screw-based compact fluorescent lamps.	*404.1 & 505.1*
Q.	Do tenant spaces in buildings larger than 5,000 ft^2, such as a retail tenant in a shopping mall, need automatic lighting shutoff control per Section 505.2.2.2?	
A.	The automatic lighting shutoff control requirement of Section 505.2.2.2 applies to whole buildings larger than 5,000 ft^2, and the requirements extend to tenant spaces within those buildings. The tenant spaces must also be provided with occupant override controls per Section 505.2.2.2.1.	*505.2.2.2*
Q.	Do zones with various adjacent day-lit fixtures have to have individual controls?	
A.	Daylight zones can be combined into one large zone to meet the daylight switching requirement. For example, in a large space with multiple skylights, all fixtures within adjacent daylight zones can be switched on the same circuit.	*505.2.2.3*

Q.	How is display lighting for museums and galleries covered by the code?	
A.	Display lighting for exhibits in museums and galleries is exempt from the interior lighting power requirement.	*505.5.1*
Q.	How do the submetering requirements of Section 505.7 apply to grouped sub-tenants that add up to 1,000 sf?	
A.	The submetering requirement is intended to apply where a tenant occupies at least 1,000 sf of adjacent space within a building. If a tenant occupies multiple non-adjacent spaces that are each smaller than 1,000 sf, such as several small shops in different portions of a mall, then those individual spaces do not require submetering.	*HI amendment 505.7*
Q.	Does the code include the use of LED lamps?	
A.	Many LED (light emitting diode) lamps will qualify as "high efficacy" lamps and contribute to meeting the residential requirement that 50% of permanently installed lamps be high efficacy. To qualify, the efficacy of the LED lamps must be at least 40 lumens per watt for lamps smaller than 15 watts or at least 50 lumens per watt for lamps between 15 and 40 watts.	*202 & 401.2*

SYSTEMS QUESTIONS

		Code Reference
Q.	If an air conditioner is added to a previously unconditioned space, how does the code apply?	
A.	Any addition of cooling to a previously unconditioned space triggers full code compliance for the newly conditioned portion of the building. There is no minimum capacity threshold to trigger code applicability.	*101.4.5*
Q.	Will duct leakage testing be required on buildings of all types?	
A.	Duct leakage testing is required for only residential buildings with new duct systems.	*403.2.2*
Q.	Why is commissioning required?	
A.	Commissioning as defined in the Hawaii amendment Section 503.2.9 is a process to ensure that the HVAC system is installed and operated per the design intent. Commissioning has been shown to improve efficiency and comfort performance.	*HI amendment to 503.2.9*
Q.	Does commissioning need to be performed by a third party?	
A.	No, commissioning as defined in the Hawaii amendment Section 503.2.9 may be performed by any party. However, the design professional is responsible for providing a written certification of system completion prior to the certificate of occupancy being issued. That means that the design profession is certifying that commissioning has been performed according to the requirements of Section 503.2.9.	*HI amendment to 503.2.9*

APPENDIX 2.11

Checklist, Commercial Designer

IECC 2009 with Hawaii Amendments

COMMERCIAL DESIGN CHECKLIST

Project: _____

Code Section	Description	Documentation Requirement	NA	Complete
	GENERAL REQUIREMENTS			
103.1	**Construction documents**	Signed statement on plans	☐	☐
	ENVELOPE REQUIREMENTS			
502.1	**Roof – insulation entirely above deck** **Roof – metal building** **Roof – attic or other** ☐ Table 502.2(1) insulation R-value ☐ Table 502.1.2 U-factor ☐ 502.2.1 Cool roof exception	Insulation location and R-value indicated on plans. Cool roof specifications if applicable.	☐	☐
502.1	**Wall – mass** **Wall – metal building** **Wall – metal framed** **Wall – wood framed and other** ☐ Table 502.2(1) insulation R-value ☐ Table 502.1.2 U-factor	Insulation location and R-value indicated on plans.	☐	☐
502.3.1	**Windows – maximum area** ☐ 40% of gross wall area		☐	☐
502.3.2	**Windows – solar heat gain** ☐ SHGC ≤ 0.25 if projection factor < 0.25 ☐ SHGC ≤ 0.33 if projection factor 0.25-0.50 ☐ SHGC ≤ 0.40 if projection factor ≥ 0.50 ☐ Area-weighted average	SHGC indicated on plans. Overhang dimensions on plans, if applicable.	☐	☐
502.3.1	**Skylights – maximum area** ☐ 3% of gross roof area		☐	☐
502.3.2	**Skylights – solar heat gain** ☐ SHGC ≤ 0.35 ☐ Area-weighted average	SHGC indicated on plans.	☐	☐
502.3.2	**Skylights – U-factor** ☐ U-factor ≤ 0.75	U-factor indicated on plans.	☐	☐
502.4	**Air leakage** ☐ 502.4.1 Window and door assemblies ☐ 502.4.2 Curtain wall, storefront glazing and commercial entrance doors ☐ 502.4.3 Sealing of the building envelope ☐ 502.4.4 Outdoor air intakes and exhaust openings ☐ 502.4.6 Loading dock weatherseals ☐ 502.4.8 Recessed lighting	Sealing requirements indicated on plans, if applicable.	☐	☐

Code Section	Description	Documentation Requirement	NA	Complete
	MECHANICAL SYSTEM REQUIREMENTS			
503.2.1	**Calculation of heating and cooling loads**		☐	☐
503.2.2	**Equipment and system sizing**		☐	☐
503.2.3	**HVAC equipment performance requirements** ☐ Tables 503.2.3(1)-(8)	Equipment capacity and efficiency indicated on plans.	☐	☐
503.2.4	**HVAC system controls** ☐ 503.2.4.1 Thermostatic control ☐ 503.2.4.3 Off-hour control ☐ 503.2.4.4 Shutoff damper controls	Indicated on plans, if applicable.	☐	☐
503.2.5	**Ventilation** ☐ Outdoor air ventilation per IMC ☐ 503.2.5.1 Demand controlled ventilation	Outdoor air ventilation rate indicated on plans. Demand controlled ventilation indicated on plans, if applicable.	☐	☐
503.2.6	**Energy recovery ventilation systems** ☐ Required for some systems ☐ Exceptions	Energy recovery system indicated on plans if applicable.	☐	☐
503.2.7	**Duct and plenum insulation and sealing** ☐ Exception for ducts in conditioned space ☐ Exception for T difference ≤ 15F	Insulation R-value on plans, if applicable.	☐	☐
503.2.8	**Piping insulation** ☐ Exception for piping within equipment ☐ Exception for fluid T 55F to 105F	Insulation R-value on plans, if applicable.	☐	☐
503.2.9	**HVAC system completion** ☐ System commissioning ☐ Commissioning plan ☐ Systems adjusting and balancing	Drawing notes include commissioning and completion requirements. Statement of completion required prior to certificate of occupancy.	☐	☐
503.2.10	**Air system design and control** ☐ Allowable fan horsepower ☐ Motor nameplate horsepower	Fan airflow and motor horsepower indicated on plans.	☐	☐

Code Section	Description	Documentation Requirement	NA	Complete
	COMPLEX HVAC SYSTEMS REQUIREMENTS		☐	☐
503.4.2	**VAV fan control** ☐ VSD for fan motors ≥ 10 hp	Fan motor horsepower on plans. VSD control indicated on plans, if applicable.	☐	☐
503.4.3	**Hydronic system controls** ☐ 503.4.3.4 Part load controls ☐ 503.4.3.5 Pump isolation	Sequence of operations describes flow control method and pump isolation control, if applicable.	☐	☐
503.4.4	**Heat rejection equipment fan speed control** ☐ Cooling tower fans ≥ 7.5 hp	Cooling tower fan motor horsepower on plans. Fan control method indicated on plans, if applicable	☐	☐
503.4.5	**Systems serving multiple zones** ☐ Variable air flow ☐ Supply air temperature reset control ☐ Exceptions	Maximum and minimum flow for all variable-air-volume terminal units indicated on plans.	☐	☐
503.4.6	**Heat recovery for service water heating** ☐ Where cooling >6,000,000 Btu/hr & water heating >1,000,000 Btu/hr ☐ Exceptions		☐	☐
503.4.7	**Hot gas bypass limitation** ☐ Exception for capacity ≤90,000 Btu/hr	Hot-gas bypass limitation indicated on plans, if applicable	☐	☐
	SERVICE WATER HEATING REQUIREMENTS			
504.2	**Service water-heating equipment efficiency** ☐ Table 504.2	Equipment efficiency on plans.	☐	☐
504.3	**Temperature controls** ☐ Dwelling units ☐ Public lavatories ☐ Other occupancies	Indicate temperature setpoint capability on plans.	☐	☐
504.4	**Heat traps** ☐ Heat trap required, or ☐ Integral heat trap	Indicate heat trap requirement on plans.	☐	☐
504.5	**Pipe insulation** ☐ Circulating systems ☐ Non-circulating systems	Indicate insulation location and R-value on plans.	☐	☐
504.6	**Heat water system controls** ☐ Auto or manual control for circulators and heat trace	Indicate control capability on plans.	☐	☐
504.7.1	**Pool heaters** ☐ Readily accessible switch ☐ No continuous pilot light	Indicated on plans, if applicable.	☐	☐
504.7.2	**Pool time switch** ☐ Exceptions	Indicated on plans, if applicable.	☐	☐
504.7.3	**Pool cover** ☐ Required for all heated pools ☐ Exception for solar and waste heat	Indicated on plans, if applicable.	☐	☐

Code Section	Description	Documentation Requirement	NA	Complete
	LIGHTING REQUIREMENTS			
505.1	**Dwelling unit lighting** ☐ Lighting equipment ≥50% high efficacy	Lighting fixture locations included on plans. Lighting fixture schedule indicating lamp and ballast type on plans.	☐	☐
505.2.2.1	**Interior lighting controls** ☐ Manual control for each space ☐ Exceptions	Controls for each space indicated on plans.	☐	☐
505.2.2.1	**Light reduction controls** ☐ Reduce by ≥50% ☐ Exceptions	Controls for each space indicated on plans.	☐	☐
505.2.2.2	**Automatic shutoff** ☐ Time of day or motion sensor ☐ Exceptions	Controls indicated on plans.	☐	☐
505.2.2.3	**Daylight zone control** ☐ Adjacent to vertical fenestration ☐ Under skylights ☐ Exceptions	Lighting circuiting and control indicated on plans.	☐	☐
505.2.3	**Sleeping unit controls** ☐ Control of t-stat, lights, outlets ☐ Keycard, sensor or electronic control ☐ Cooling interlock for balcony or patio doors	Controls indicated on plans.	☐	☐
505.2.4	**Exterior lighting controls** ☐ Dawn-to-dusk lighting ☐ Other lighting	Controls indicated on plans.	☐	☐
505.3	**Tandem wiring** ☐ Applies to fixtures with both magnetic ballasts and odd number of lamps	Indicated on plans, if applicable.	☐	☐
505.4	**Exit signs** ☐ ≤ 5 watts per face	Indicated in fixture schedule.	☐	☐
505.5	**Interior lighting power requirements** ☐ 505.5.1 Connected lighting power ☐ 505.5.2 Allowed lighting power	All fixtures located and identified on plans. Fixture schedule includes input power for each fixture.	☐	☐
505.6.1	**Exterior building grounds lighting** ☐ Efficacy ≥ 60 lumens/watt for fixtures >100 watts	Fixture schedule includes input power and lamp lumen output	☐	☐
505.6.2	**Exterior building lighting power** ☐ Allowance per Table 505.6.2(2) ☐ Exceptions	All fixtures located and identified on plans. Fixture schedule includes input power for each fixture.	☐	☐

Sponsor: State of Hawaii, Department of Business, Economic Development and Tourism
Acknowledgment: This material is based upon work supported by the Department of Energy under Award Number DE-EE0000216
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APPENDIX 2.12

Checklist, Residential Designer

IECC 2009 with Hawaii Amendments

RESIDENTIAL DESIGN CHECKLIST

Project: _____

Code Section	Description	Documentation Requirement	NA	Complete
103.1	**Construction documents**	Signed statement on plans	☐	☐
402.1	**Wood-frame ceiling insulation** ☐ Table 402.1.1 insulation R-value ☐ Table 402.1.3 U-factor ☐ 402.1.4 alternatives ☐ 402.1.4 Total UA alternative	Insulation location and R-value indicated on plans. Radiant barrier location, if applicable. Cool roof specifications if applicable.	☐	☐
402.1	**Steel-frame roof insulation** ☐ Table 402.1.1 insulation R-value ☐ Table 402.1.3 U-factor ☐ 402.2.5 exception ☐ 402.1.4 Total UA alternative		☐	☐
402.1	**Wood-frame wall insulation** ☐ Table 402.1.1 insulation R-value ☐ Table 402.1.3 U-factor ☐ Table 402.1.1 exceptions ☐ 402.1.4 Total UA alternative		☐	☐
402.1	**Steel-frame wall insulation** ☐ Table 402.1.1 insulation R-value ☐ Table 402.1.3 U-factor ☐ 402.2.5 exceptions ☐ 402.1.4 Total UA alternative		☐	☐
402.1	**Mass wall insulation** ☐ Table 402.1.1 insulation R-value ☐ Table 402.1.3 U-factor ☐ Table 402.1.1 exceptions ☐ 402.1.4 Total UA alternative		☐	☐
402.3	**Windows** Table 402.1.1 SHGC ≤ 0.30 ☐ 15 ft^2 area exemption ☐ Area-weighted average ☐ North-facing window exemption ☐ Shaded window exemption	SHGC indicated on plans	☐	☐
402.3	**Skylights** Table 402.1.1 SHGC ≤ 0.30 ☐ 15 ft^2 area exemption ☐ Area-weighted average Table 402.1.3 U-factor ≤ 0.75 ☐ 15 ft^2 area exemption ☐ Overall envelope compliance	SHGC and U-factor indicated on plans.	☐	☐
402.4	**Air leakage** ☐ Envelope sealing ☐ Unconditioned dwelling exemption	Sealing requirements indicated on plans, if applicable.	☐	☐

Code Section	Description	Documentation Requirement	NA	Complete
402.4.2	**Air sealing and insulation** ☐ Whole-house pressure test ☐ Field verification ☐ Unconditioned dwelling exemption	Verification method indicated on plans, if applicable.	☐	☐
402.4.4	**Fenestration air leakage** ☐ Listed and labeled products ☐ Site-built window exemption ☐ Jalousie windows ☐ Unconditioned dwelling exemption		☐	☐
403.1	**Thermostat controls**	Indicated on plans, if applicable.	☐	☐
403.2.1	**Duct insulation** ☐ Exception for ducts in conditioned space	Insulation R-value on plans, if applicable.	☐	☐
403.2.2	**Duct leakage testing** ☐ Exception for ducts in conditioned space	Testing requirement indicated on plans, if applicable.	☐	☐
403.3	**Mechanical system piping insulation**	Insulation R-value on plans, if applicable.	☐	☐
403.4	**Circulating hot water systems**	Insulation R-value on plans, if applicable.	☐	☐
403.6	**Equipment sizing**		☐	☐
403.7	**Systems serving multiple dwelling units** ☐ Meet commercial requirements		☐	☐
403.9	**Pool controls**	Controls indicated on plans, if applicable.	☐	☐
403.9.3	**Pool cover** ☐ Required for heated pool ☐ Exception for ≥60% solar/waste heat	Indicated on plans, if applicable.	☐	☐
404.1	**Lighting equipment ≥50% high efficacy**	Lighting fixture locations included on plans. Lighting fixture schedule indicating lamp and ballast type on plans.	☐	☐

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Acknowledgment: This material is based upon work supported by the Department of Energy under Award Number DE-EE0000216
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APPENDIX 2.13

Energy Code Stringency Analysis

REPORT

Hawaii Building Energy Code
Stringency Assessment and Savings Forecast

Prepared for
Department of Business, Economic Development, and Tourism
State of Hawaii

December 17, 2012

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Acknowledgment: This material is based upon work supported by the Department of Energy under Award Number DE-EE0000216

Sponsor: State of Hawaii, Department of Business, Economic Development and Tourism

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Contract No. 59499; Task Order Number 2.F

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Executive Summary

This analysis finds that the Hawaii Code (2009 International Energy Conservation Code with amendments) provides equal or greater energy savings when compared to the 2009 IECC for residential buildings and ASHRAE Standard 90.1-2007 for nonresidential buildings. The Hawaii amendments are included for reference in Appendix 3 of this report.

Residential buildings. The energy consumption of an air-conditioned home complying with minimum requirements of the Hawaii Code is likely to be 2% to 3% higher than the same home complying with the minimum 2009 IECC requirements. The Hawaii Code also includes homes without air conditioning in the scope of the envelope requirements, providing improved comfort as well as likely energy savings in cases when homeowners install room air conditioners. The magnitude of those savings is difficult to quantify, but it seems reasonable to assume that it will more than offset the 2% to 3% penalty in air-conditioned homes. Therefore, the net impact of the amendments is that the Hawaii Code provides equal or greater energy savings for residential buildings compared to the 2009 IECC.

Nonresidential buildings. One of the Hawaii Code amendments reduces stringency for nonresidential building while four other amendments provide increased savings. Therefore, the question is whether lost savings due to reduced stringency is offset by the additional savings due to the other amendments. The modeling and research carried out as part of this analysis show that:

- The Hawaii Code cool roof insulation exception for nonresidential buildings increases energy consumption by roughly 5% for buildings following that compliance path.
- The commissioning requirement should provide average savings of at least 5%.
- The occupancy-based guest room controls should provide at least 5% savings in hotels.
- Submetering requirements should provide average savings of at least 5% in tenant occupied buildings.
- The inclusion of unconditioned buildings within the scope of the envelope requirements will likely provide improved comfort and some energy savings in cases where room air conditioners or spot coolers are used.

The net impact of the amendments is that the Hawaii Code provides equal or greater energy savings for nonresidential buildings compared to the 2009 IECC and ASHRAE 90.1-2007.

Energy savings forecast. The Hawaii Code is expected to provide electricity savings of 642 MWh/yr in 2013, increasing to 3,397 MWh/yr in 2023, 5,779 MWh/yr in 2030 and 6,800 MWh/yr in 2033. Those estimates are savings for the Hawaii Code vs. the 2009 IECC and ASHRAE Standard 90.1-2007. Those estimates are net savings, in which an increase in residential energy consumption is offset by savings in commercial construction. Please see the section titled Energy Savings Forecast on page 19 for details.

Introduction

This report assesses the stringency of the building energy code (Hawaii Code) approved by the Hawaii State Building Code Council in February 2012. The approved code applies to both residential and nonresidential buildings and consists of the 2009 International Energy Conservation Code (2009 IECC) with specific Hawaii amendments. The following codes are the benchmark for this assessment:

- Residential buildings: 2009 IECC without amendments
- Nonresidential buildings: ASHRAE Standard 90.1-2007 (note that the Hawaii Code allows 90.1.-2007 as a compliance alternative for nonresidential buildings)

The purpose of this assessment is to determine whether the Hawaii Code meets or exceeds these benchmark codes or achieves equivalent or greater energy savings.

A review of a preliminary version of this stringency assessment was provided by Kosol Kiatreungwattana of the National Renewable Energy Laboratory in September 2012.

Summary of Hawaii Amendments

A set of amendments to the 2009 IECC were approved by the State Building Code Council in February 2012. Those amendments are included as an attachment to this report. This section provides a brief summary.

- The scope of the envelope requirements is extended to apply also to unconditioned, habitable spaces (HI amendment to 101.5.2)
- Hawaii amendments provide alternatives for residential envelope compliance:
    - Wall insulation tradeoffs allow reduction in insulation for walls that are light color or shaded by overhangs. The reduction is also allowed if 90% of permanent lighting is high efficacy (HI amendment to Table 402.1.1)
    - Four options for ceiling heat-gain reduction are included: insulation, radiant barrier plus ventilation, radiant barrier plus cool roof, or a roof heat gain factor calculation (new section 402.1.6)
    - Steel-frame walls do not require R-5 continuous insulation if they qualify for one of four exceptions: light color, overhang shading, high-efficacy lighting, or high efficiency air conditioner (HI amendment to 402.2.5)
    - North-facing and well-shaded windows are exempt from the SHGC requirement (HI amendment to 402.3.3)
    - Air leakage exemption for unconditioned dwellings, which exempts them from sealing requirements but applies alternative requirements for minimum natural ventilation vent area and ceiling fan stub-ins (HI amendment to 402.4.1.1)
    - Air leakage allowance for jalousie windows, sets a higher tested air leakage threshold for jalousies (HI amendment to 402.4.4)

- No roof insulation is required in a commercial building roof that has a qualifying cool roof membrane, at elevations below 2,400 ft. (HI amendment to 502.2.1)
- An area weighted average is allowed for commercial window SHGC compliance (HI amendment to 502.3.3)
- Mechanical systems commissioning and completion requirements. The designer is required to provide a written statement of system completion (HI amendment to 503.2.9)
- Hotel thermostat and lighting controls. Automatic controls are required that detect whether the room is occupied and adjust the thermostat and lighting accordingly. Interlock switches are also required on lanai doors to shut off AC when the door is open (HI amendment to 505.2.3)
- Tenant electrical submetering is required for tenants occupying 1,000 ft^2 or more (HI amendment to 505.7)

Residential Stringency Assessment

The baseline for comparison for residential buildings is the 2009 IECC. The Hawaii Code is equal to the 2009 IECC except for a number of amendments. Therefore, this residential code assessment addresses each of those Hawaii amendments and their likely energy impact.

Each of the residential amendments is presented in Table 1 alongside the corresponding 2009 IECC requirement. In each case a determination is indicated regarding whether the 2009 IECC or the Hawaii Code is more stringent. This assessment shows that in some cases the Hawaii Code is more stringent and in others the 2009 IECC is more stringent. In some cases an EnergyPlus simulation model was used to evaluate the impact of the Hawaii amendment.

The energy consumption of an air-conditioned home complying with minimum requirements of the Hawaii Code is likely to be 2% to 3% higher than the same home complying with the minimum 2009 IECC requirements. The Hawaii Code also includes homes without air conditioning in the scope of the envelope requirements, providing improved comfort as well as likely energy savings in cases when homeowners install room air conditioners. The magnitude of those savings is difficult to quantify, but it seems reasonable to assume that it will more than offset the 2% to 3% penalty in air-conditioned homes. Therefore, the net impact of the amendments is that the Hawaii Code provides equal or greater energy savings compared to the 2009 IECC.

Table 1. Residential Assessment Summary

2009 IECC	Hawaii Amendment	Discussion
101.5.2. Exempts unconditioned buildings from envelope compliance. Specifically, exempts buildings for which peak design rate of energy usage for space conditioning is less than 3.4 Btuhr-ft^2.	Includes habitable unconditioned spaces in scope of envelope requirements. The intent of the amendment is that all residences meet the envelope requirements, which will help improve comfort of unconditioned dwellings.	**Hawaii Code is more stringent**. It is expected that this amendment will save energy by reducing the number of homes that add air conditioning after construction and will improve the efficiency of homes that do add air conditioning after construction.

2009 IECC	Hawaii Amendment	Discussion
Table 402.1.1. Mass wall insulation requirement is R-3 exterior or R-4 interior	Allows reduction of R-5 interior insulation or R-4 exterior insulation for walls that meet one of three criteria. 1. Exterior surface light reflectance ≥ 0.64 2. 90% high efficacy lighting 3. Overhang shading with projection factor ≥0.3 on non-north walls This amendment effectively allows uninsulated mass walls if the project meets one of the three criteria. The intent of this amendment is to provide a potentially lower-cost path to equal energy savings.	**Varies depending on exception.** See Table 4 for analysis results, which show that option 1 is slightly more stringent and options 2 and 3 are slightly less stringent. Solar heat gain is the primary source of cooling load for residences in Hawaii. Therefore, reflective walls and overhangs provide alternate paths for cooling load reduction. The high efficacy lighting exception increases the existing 50% limit in the 2009 IECC to 90%.
Table 402.1.1. Ceiling insulation requirement is R-30	New section 402.1.6 provides four ceiling insulation alternatives for dwellings located below 2,400 ft elevation. The intent of these amendments is to provide potentially lower-cost paths to equal performance. In most Hawaii residences the reduction of solar heat gain through the roof is the primary concern. 1. Roof insulation. R-30 at attic ceiling or R-19 under roof 2. Radiant barrier + attic ventilation 3. Radiant barrier + cool roof 4. Roof heat gain factor ≤ 0.05 (combines U-factor, surface absorptance, and radiant barrier)	**2009 IECC is more stringent** See Table 2 for analysis results. For dwellings located above 2,400 ft elevation there is no difference in stringency. For dwellings below 2,400 ft elevation there are paths that allow less than R-30 insulation when other heat-gain reduction measures are used. However, in some cases R-19 is accepted without additional heat gain measures. Therefore, this amendment is likely to be slightly less stringent on aggregate.

2009 IECC	Hawaii Amendment	Discussion
402.2.5. Steel frame walls require R-13 cavity insulation + R-5 continuous insulation	Buildings at elevation lower than 2,400 ft are exempt from the R-5 continuous insulation requirement if they meet one of the following criteria: 1. Exterior surface light reflectance ≥ 0.64 2. 90% high efficacy lighting 3. Overhang shading with projection factor ≥0.3 on non-north walls 4. Central air conditioner with SEER ≥ 14. The intent of this amendment is to provide a potentially lower-cost path to equal energy savings, considering that solar heat gain and air conditioning energy is the primary concern in Hawaii.	**Hawaii Code is equal or more stringent, depending on exception.** See Table 3 for analysis results. In Hawaii's climate solar heat gain is the primary source of cooling load. Reflective walls and overhangs provide alternate paths for cooling load reduction. The high efficacy lighting exception increases the existing 50% limit in the 2009 IECC to 90%. The minimum SEER by Federal regulation is SEER 13.
402.3.3 Up to 15 ft^2 of glazing area is exempted from the U-factor and SHGC requirements	In addition, north-facing windows and windows shaded with overhangs providing a projection factor of ≥1.0 are exempt from the SHGC requirements. This amendment is based on the fact that solar heat gain is the primary concern for residential windows in Hawaii, and well-shaded windows can be exempted from the SHGC requirement with little energy penalty	**IECC is more stringent for north-facing windows.** **Hawaii code is equal or more stringent for non-north-facing windows.** See Table 5 for analysis results. The energy impact is likely to be small because solar heat gain will be very low through the exempted windows.
402.4.1.1 building envelope sealing required to limit infiltration	Unconditioned dwellings are exempted from the sealing requirements. In addition, unconditioned dwelling must meet minimum requirements for natural ventilation vent area and must include stub-ins for ceiling fans.	**Hawaii Code is more stringent.** Unconditioned dwelling envelope is not covered by the 2009 IECC, while the Hawaii amendment includes requirements to improve comfort and potentially offset the future addition of air conditioning.

2009 IECC	Hawaii Amendment	Discussion
402.4.4 Windows, skylights and sliding glass doors must meet air leakage limits of 0.3 cfm/ft^2 to minimize infiltration	A higher limit of 1.2 cfm/ft^2 is added for jalousie windows. Jalousies are a common choice in Hawaii where they provide the benefit of high net vent area for natural ventilation.	**IECC is more stringent.** There is likely to be some natural ventilation benefit during mild weather to allowing the use of jalousie windows; however, there is also likely to be some increased infiltration and increased air conditioning energy during hot weather conditions.

Residential Energy Impact

In summary, the electricity consumption of an air-conditioned house complying with the Hawaii Code is equal to or slightly higher than the consumption for a 2009 IECC house, depending on which Hawaii Code compliance path is followed. The range in performance is from 0% to 6% above baseline electricity consumption. Equal performance results from a choice of baseline roof (R-30) and window (SHGC-0.30) compliance options. The worst-case path includes roof design option #2 (ventilation + radiant barrier) combined with clear glass on the north side. There are many possible compliance path combinations, and the likely average case results in electricity consumption of 2% to 3% above the 2009 IECC baseline. The average impact calculated for forecast purposes is estimated to be an increase of 2.3%, as described on page 9.

A simulation model was used to evaluate the energy impact of several Hawaii Code amendments. Results for those alternatives are presented in this section. Please see Appendix 1 for more details on the EnergyPlus simulation model and assumptions. This prototype home simulation model was selected because it was developed by Pacific Northwest National Laboratory for evaluating energy code savings.

The electricity consumption results for the baseline residential model are illustrated in Figure 1. Total annual electricity consumption is 19,876 kWh per year. The largest end use is air conditioning (cooling + fan) at 41%. This model represents a 2,400 ft^2 two-story house with 24 hour per day air conditioning and with electric resistance water heating. As a result the consumption is higher than the average existing Hawaii dwelling due to both the size and the continuous air conditioning. The average Hawaii residential electricity customer consumes about 7,000 kWh/yr of electricity[1]. However, that average includes both single-family and multi-family dwellings, and many of those existing homes have little or no air conditioning. Many existing homes also have solar water heating. It is expected that the energy consumption predicted by this prototype model is reasonably accurate for a large air-conditioned home even though it is higher than the average existing dwelling unit.

[1] 2011 Hawaii Data Book, Table 17.09, DBEDT

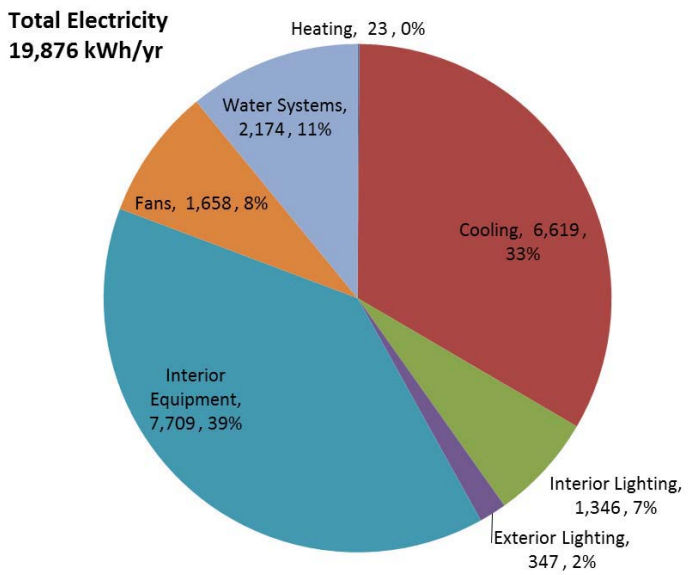

Figure 1. Residential Baseline Model Electricity Consumption (kWh/yr) (EnergyPlus model results; see also Appendix 1 for assumptions)

Roof Insulation

The impact of Hawaii Code amendments for residential roof insulation is illustrated in Table 2. The first option for R-30 insulation is essentially equal to the IECC 2009 baseline. Options 2, 3 and 4 are less stringent than the baseline requirement, resulting in an increase in electricity consumption of 4.3%, 1.8% and 3.1% respectively.

Table 2. Results for Residential Roof Alternatives

Roof Alternatives	kWh/yr	Difference
Option 1: baseline R-30	19,876	--
Option 2: ventilation + radiant barrier	20,730	4.3%
Option 3: radiant barrier + cool roof	20,236	1.8%
Option 4: RHGF = 0.05 (cool roof + R-3)	20,491	3.1%

Metal Frame Walls

The impact of Hawaii Code amendments for residential metal-frame walls is illustrated in Table 3. Electricity consumption compared to the baseline is nearly equal or lower in all cases. The two cases that reduce solar heat gain, reflective walls and overhangs, both perform slightly better than the baseline. The alternatives for high efficacy lighting and higher efficiency air conditioner provide nearly equal performance to the baseline.

Table 3. Results for Residential Metal-Frame Wall Alternatives

Metal Wall Alternatives	kWh/yr	Difference
Baseline: R-13 + foam board sheathing (U-0.082)	19,790	--
Alt 1: R-13 + 64% reflectance	19,495	-1.5%
Alt 2: R-13 + 90% high efficacy lighting	19,806	0.1%
Alt 3: R-13 + overhangs with PF=0.3	19,441	-1.8%
Alt 4: R-13 + SEER 14 air conditioner	19,828	0.2%

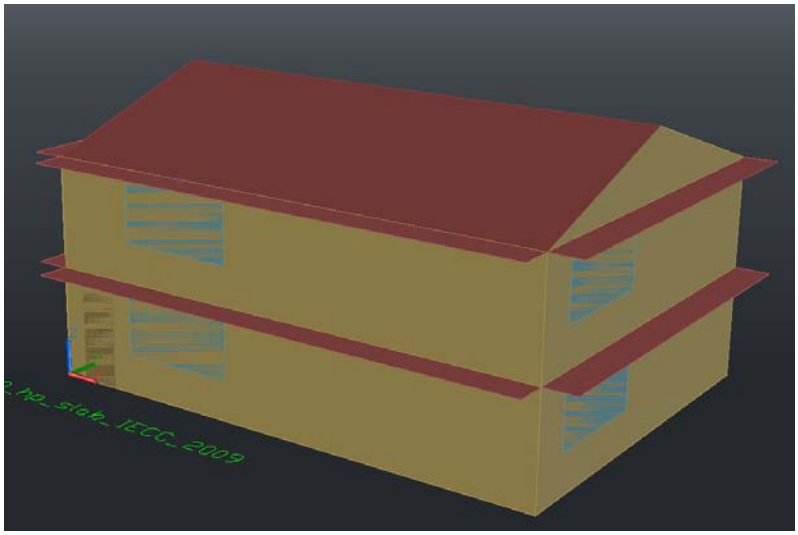

Figure 2. Residential Model Showing Wall Overhang Shading

Mass Walls

The impact of Hawaii Code amendments for residential mass walls is shown in Table 4. The first alternative, high reflectance walls, performs better than the baseline. The other two alternatives, high efficacy lighting and overhang shading, do not completely offset the energy penalty due to eliminating mass wall insulation.

Table 4. Results for Residential Mass Wall Alternatives

Mass Wall Alternatives	kWh/yr	Difference
Baseline: Mass wall with insulation (U-0.197)	20,836	--
Alt 1: no insulation + 64% reflectance	20,402	-2.1%
Alt 2: no insulation + 90% high efficacy lighting	21,917	5.2%
Alt 3: no insulation + overhangs with PF=0.3	21,165	1.6%

Residential Window Shading

The impact for residential window shading exceptions in the Hawaii Code amendments is shown in Table 5. Allowing clear glass on north-facing windows results in an increase in electricity consumption compared

to the baseline. The exception allowing clear glass with overhang shading on non-north orientations provides slightly better performance than the baseline. The combination of both exceptions results in a slight increase in electricity consumption compared to the baseline.

Table 5. Results for Residential Window Shading Exceptions

Window Shading Exceptions	kWh/yr	Difference
Baseline: SHGC 0.30 for all windows	19,876	--
Alt 1: clear glass on north windows	20,157	1.4%
Alt 2: clear glass + overhangs (PF=1.0) on non-north	19,802	-0.4%
Alt 1 + Alt 2	20,086	1.1%

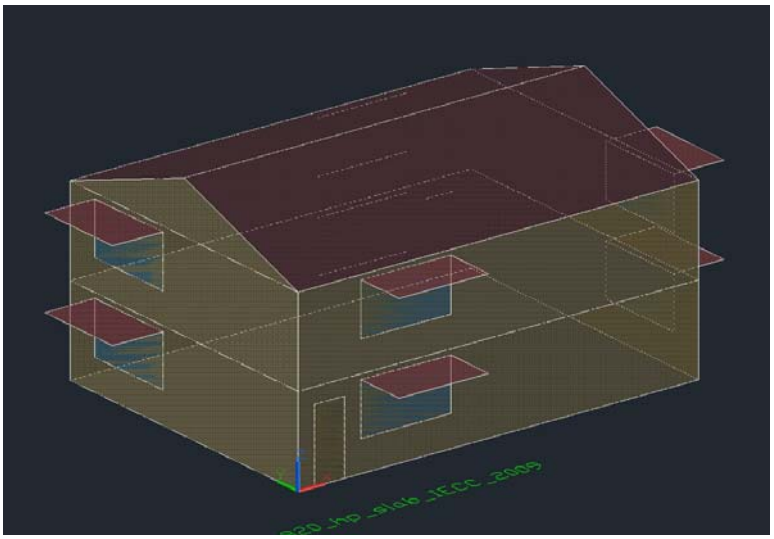

Figure 3. Residential Model Showing Window Overhang Shading

Overall Energy Impact for Residential Prototype

As noted above, the impact will vary depending on the selected compliance paths. As a rough estimate of the likely combined impact of the Hawaii Code amendments the simulation results described above are combined for a net increase of 451 kWh/yr for the prototype single-family house, equal to about 2.3%. These calculations are summarized in Table 6 and are based on the following assumptions.

- Each of the four roof options listed in Table 2 is followed equally. In other words, each option accounts for 25% of new construction. The net impact is an increase of 457 kWh/yr per home.
- Each of the four steel frame wall alternatives in Table 3 is also followed equally, resulting in a net savings of 147 kWh/yr per home or 0.7%. Assuming that 75% of new homes have steel frames, the overall net savings drops to 110 kWh/yr.
- The fraction of new residences with mass walls is assumed to be very small; therefore that impact is not included in this estimate.
- For windows, each of the four options listed in Table 5 is followed equally, and the net impact is an increase of 104 kWh/yr.

Table 6 also includes second set of simulation results using a reduced air-conditioning schedule. The original PNNL prototype model assumed 24-hour per day cooling, which is not the norm in Hawaii where natural ventilation provides cooling for much of the year and where high electricity rates provide incentive for conservation. The following air-conditioning schedule was implemented in the EnergyPlus model to represent more typical operation. The results are listed in the right-hand column in Table 6.

- Jan 1 – Feb 28: No air-conditioning
- Mar 1 – Mar 15: 4pm- 7pm (3 hours/day)
- Mar 16 – May 31: 4pm – 8pm (4 hours/day)
- Jun 1 – Oct 31: 2pm – 8pm (6 hours/day)
- Nov 1 – Nov 15: 4pm – 7pm (3 hours/day)
- Nov 15 – Dec 31: No air-conditioning

Table 6. Estimate of Energy Impact for Prototype 2,400 ft^2 Single-Family House

Roof Alternatives	**kWh/yr** (Original PNNL model assumption, 24/7 air conditioning)	**kWh/yr** (Reduced air conditioning schedule)
Option 1: baseline R-30	19,876	15,391
Option 2: ventilation + radiant barrier	20,730	16,021
Option 3: radiant barrier + cool roof	20,236	15,708
Option 4: RHGF = 0.05 (cool roof + R-3)	20,491	15,835
Average	20,333	15,739
Baseline: R-30	19,876	15,391
Difference (kWh/yr)	**457**	**348**
Metal Wall Alternatives	**kWh/yr**	
Alt 1: R-13 + 64% reflectance	19,495	15,155
Alt 2: R-13 + 90% high efficacy lighting	19,806	15,244
Alt 3: R-13 + overhangs with PF=0.3	19,441	15,113
Alt 4: R-13 + SEER 14 air conditioner	19,828	15,465
Average	19,643	15,244
Baseline: R-13 + foam board sheathing	19,790	15,296
Difference (kWh/yr)	(147)	(52)
75% of difference (assuming 75% of new homes use steel framing)	**(110)**	**(39)**
Window Shading Exceptions	**kWh/yr**	
SHGC 0.30 for all windows	19,876	15,391
Alt 1: clear glass on north windows	20,157	15,572
Alt 2: clear glass + overhangs (PF=1.0) on non-north	19,802	15,356
Alt 1 + Alt 2	20,086	15,535
Average	19,980	15,463
Baseline: SHGC 0.30 for all windows	19,876	15,391
Difference (kWh/yr)	**104**	**72**
Total Net Impact		
Roof Alternatives	457	348
Metal Wall Alternatives	(110)	(39)
Window Shading Exceptions	104	72
Net increase in electricity (kWh/yr)	**451**	**381**
Net increase in electricity (%)	2.3%	2.5%

Nonresidential Stringency Assessment

ASHRAE 90.1-2007 is the benchmark code for nonresidential buildings. This analysis shows that the Hawaii Code is likely to provide equal or greater energy savings compared to 90.1-2007. This nonresidential assessment is presented in two parts.

1. First is a comparison of the 2009 IECC to 90.1-2007, showing that the 2009 IECC provides equal or greater energy savings.
2. Second is a comparison of the Hawaii Code to the 2009 IECC, showing that the Hawaii Code is likely to provide equal or greater savings.

The Hawaii Code also permits the use of 90.1-2007 as a compliance option for nonresidential buildings. Therefore, buildings following that option will, of course, meet the stringency of 90.1-2007.

Nonresidential Assessment - 2009 IECC vs. ASHRAE 90.1-2007

A 2009 assessment by Pacific Northwest National Laboratory[2] identified differences between the 2009 IECC and 90.1-2007. The purpose of that assessment was to aid states in determining whether the 2009 IECC meets or exceeds 90.1-2007. That assessment identified a list of key differences to be considered, and those differences are summarized in Table 7 along with a discussion of the likely impact for buildings in Hawaii.

In some cases the 2009 IECC is more stringent and in other cases 90.1-2007 is more stringent. In general, the envelope requirements of the 2009 IECC are equivalent or more stringent. In cases where the HVAC requirements are different, they are typically more stringent in 90.1-2007. However, most of the HVAC differences apply for only specific building or system types and do not apply generally. The water heating requirements of the 2009 IECC are equal or more stringent. Lighting requirements are essentially equal.

In aggregate the relative stringency will vary from one building to the next, but in most cases the difference will be very small. The summary in Table 7 indicates that the 2009 IECC is likely to provide equal or greater savings when compared to ASHRAE 90.1-2007.

Table 7. Key Differences –2009 IECC vs. ASHRAE 90.1-2007

2009 IECC	90.1-2007	Discussion
No separate category for semi-heated buildings.	Includes separate envelope requirements for semi-heated buildings.	**No difference.** Semi-heated buildings are very rare or non-existent in Hawaii's climate
Glazing sloped at more than 15 degrees from vertical is considered a skylight	Glazing sloped at more than 30 degrees from vertical is considered a skylight	**Varying case-by-case impact**

[2] Conover, David, et al. *Comparison of Standard 90.1-2007 and the 2009 IECC with Respect to Commercial Buildings*, December 2009, Pacific Northwest National Laboratory.

2009 IECC	90.1-2007	Discussion
Walls considered "above grade" if more than 15% of area is above grade.	Above-grade wall requirement applies to above-grade portion and below-grade requirement to below-grade portion.	**2009 IECC more stringent.** Impact is likely small, but some below grade portions of walls may require more insulation under the IECC
40% window-wall-ratio limit calculated based on above-grade wall area.	40% window-wall-ratio calculation includes below-grade wall area	**2009 IECC more stringent.** Buildings with below grade walls would be allowed more window area under 90.1-2007.
Opaque envelope, metal-building insulation requirement is R-16	Metal building insulation requirement is R-13	**2009 IECC more stringent.** The insulation requirement for metal building walls is slightly more stringent in 2009 IECC. Other opaque envelope insulation requirements are identical.
SHGC requirement varies depending on overhang projection factor: 0.25 for PF < 0.25 0.33 for 0.25 ≤ PF < 0.50 0.40 for PF ≥ 0.50	SHGC requirement is 0.25, with multipliers available for overhang shading (Table 5.5.4.4.1).	**2009 IECC more stringent.** Without overhangs the two codes are equal. With overhangs, the 2009 IECC requirement will be more stringent in most cases, especially when PF < 0.25 and PF > 0.50.
Skylight area limited to 3% of roof area	Skylight area limited to 5% of roof area	**2009 IECC more stringent**
Skylight U-factor 0.75	U-1.98 with curb or U-1.36 with curb	**2009 IECC more stringent**
Skylight SGHC 0.35	SHGC 0.36 for up to 2% roof area SHGC 0.19 for 2.1% – 5%	**Varies.** IECC 2009 more stringent if area less than 2% or greater than 3%. 90.1 more stringent if area is between 2% and 3%.
No credit for roof reflectance	Allows reduced roof insulation with qualifying cool roof (Table 5.5.3.1)	**2009 IECC more stringent**
HVAC sizing limited to load calculations	No specific sizing requirement	**2009 IECC more stringent**

2009 IECC	90.1-2007	Discussion
No requirement	HVAC system optimum start control required for systems > 10,000 cfm	**90.1-2007 more stringent**
No requirement	Dehumidification (6.5.2.3) limits the use of reheat and simultaneous heating and cooling for dehumidification, with a number of exceptions.	**90.1-2007 more stringent**
Service water heating equipment efficiency (Table 504.2)	Service water heating equipment efficiency (Table 7.8)	**2009 IECC equal or more stringent**
Interior lighting power allowances (Table 505.5.2)	Two interior lighting power allowance methods. The building area method (Table 9.5.1) is equivalent to IECC. The space-by-space method (Table 9.6.1) is an alternate path that can be less stringent.	**Little difference.**

Nonresidential Assessment - Hawaii Code vs. 2009 IECC

As the second step in this assessment, the Hawaii Code is compared to the 2009 IECC. Table 8 describes the Hawaii Code amendments alongside a description of the corresponding section of the 2009 IECC. In each case a determination of relative stringency is described. In the following section, more discussion of energy impact is included.

One of the amendments reduces stringency compared to the 2009 IECC while four other amendments provide increased savings. Therefore, the question is whether lost savings due to reduced stringency is offset by the additional savings due to the other amendments. In brief,

- The cool roof insulation exception increases energy consumption by roughly 5% for buildings following that compliance path.
- The commissioning requirement should provide average savings of at least 5%.
- The occupancy-based guest room controls should provide at least 5% savings in hotels.
- Submetering requirements should provide average savings of at least 5% in tenant occupied buildings.
- The inclusion of unconditioned buildings within the scope of the envelope requirements will likely provide saving in future avoided air conditioning energy.

<u>The net impact of the amendments is that the Hawaii Code provides equal or greater energy savings for nonresidential buildings compared to the 2009 IECC and ASHRAE 90.1-2007.</u>

Table 8. Nonresidential Assessment – Hawaii Code vs. 2009 IECC

2009 IECC	Hawaii Amendment	Discussion
101.5.2. Exempts unconditioned buildings from envelope compliance. Specifically, exempts buildings for which peak design rate of energy usage for space conditioning is less than 3.4 Btuhr-ft^2.	Includes habitable unconditioned spaces in scope of envelope requirements. The intent of the amendment is that all habitable buildings meet the envelope requirements, which will help improve comfort of unconditioned dwellings.	**Hawaii Code is more stringent**. It is expected that this amendment will save energy by reducing the number of buildings that add air conditioning after occupancy and will improve the efficiency of buildings that do add air conditioning after construction.
502.2.1 Roof insulation requirement for climate zone 1 is: • R-15 for insulation above roof • R-19+R-5 thermal block for metal building • R-30 for attic and other	For buildings at elevation below 2,400 ft, no insulation is required if the roof has initial reflectance of ≥ 0.70 and extended reflectance ≥ 0.55. The intent is to provide a potentially lower cost alternative to insulation. In Hawaii solar heat gain reduction is the primary role of roof insulation, and a cool roof membrane will significantly reduce heat gain.	**IECC is more stringent.** An EnergyPlus simulation analysis shows that electricity consumption increases by 5% for a medium-sized office building that follows the cool roof exception. See Table 9 for simulation results. The impact will vary between building types and will vary based on building dimensions.
502.3.3 Maximum fenestration SHGC limits	Allows an area-weighted average SHGC to be used for compliance	**No impact.** Not net increase in solar heat gain.
503.2.9 HVAC System Completion requirements include air balancing, hydronic system balancing and O&M manuals	Requirements added for system commissioning and commissioning plan, which require that the design professional provide written certification of system completion prior to occupancy. In addition, more detail is added to the balancing requirements.	**Hawaii Code is more stringent.** The commissioning requirement has potential for significant energy savings. See page 17 for discussion. One study reports 13% average savings. Savings of at least 5% are considered likely. The additional balancing requirements have potential for minor additional savings.

2009 IECC	Hawaii Amendment	Discussion
505.2.3 Sleeping unit controls. Requires a master switch in hotel guest rooms controlling permanently wired luminaires and switched receptacles.	Hotel thermostat and lighting controls. Automatic controls are required that detect whether the room is occupied and adjust the thermostat and lighting accordingly. Interlock switches are also required on lanai doors to shut off AC when the door is open	**Hawaii Code is more stringent.** Significant savings are expected due to automatic control of both lighting and thermostat. In addition, significant savings should be provided by HVAC interlock switches on balcony doors. Hotels represent a significant fraction of construction in Hawaii, so this amendment should have a large impact. Savings of at least 5% seem reasonable for hotel buildings. See page 17 for further discussion of likely savings for occupancy based controls.
505.7 requires separate electrical metering for individual dwelling units	Expands the submetering requirement to all nonresidential buildings and requires electrical submetering for all tenants occupying at least 1,000 ft^2.	**Hawaii Code is more stringent.** While not guaranteeing energy savings, submetering provides energy consumption information to tenants and increases the incentive to conserve. Savings of at least 5% seem likely for tenant-occupied buildings that fall under the scope of this requirement. See page 18 for further discussion of likely savings for submetering.

Nonresidential Energy Impact

Cool Roof Exception

EnergyPlus simulation results show that electricity use increases by about 5% when the Hawaii Code's nonresidential cool roof exception is followed. Results are summarized in Table 9. That exception allows an uninsulated roof if a qualifying cool roof membrane is installed. The magnitude of the impact will vary between building types and will vary based on building dimensions. These results are for a three-story office building model that was developed by Pacific Northwest National Laboratory for use in energy code studies. The impact will like be greater in one and two story buildings and lower in taller buildings. More information about the prototype building model is included in Appendix 2.

Two sets of simulation results are presented in Table 9. The base roof meets minimum 2009 IECC requirements for a U-factor of 0.062 and has a roof surface solar reflectance of 30%. The Hawaii Code roof has no insulation and a U-factor of 0.52. The cool roof reflectance is assumed to be 55%, accounting for aged performance. If the reflectance were assumed to be 70%, which is the minimum requirement for new roof reflectance, then the energy penalty would be only 2% rather than 5%.

It is important to note that not all nonresidential buildings will follow this compliance exception. Therefore, the statewide average impact will be lower.

Table 9. Nonresidential Simulation Results, Electricity Consumption (kWh/yr)

	BASE ROOF U-factor = 0.062 Reflectance = 30%	Hawaii Code Exception COOL ROOF, NO INSULATION U-factor = 0.52 Reflectance = 55%	DIFFERENCE (%)
Heating	4,754	11,435	140.5%
Cooling	270,645	299,399	10.6%
Interior Lighting	153,611	153,611	0.0%
Exterior Lighting	62,925	62,925	0.0%
Interior Equipment	226,829	226,829	0.0%
Fans	32,988	36,240	9.9%
Total	**751,751**	**790,439**	**5.1%**

Commissioning

The energy savings achieved through commissioning will vary among buildings. A 2009 study by Lawrence Berkeley National Lab estimated an average of 13% source energy savings for new construction.[3] It is reasonable to expect energy savings of at least a 5% percent due to the Hawaii Code's requirement for commissioning.

Hotel Sleeping Unit Controls

A 2010 study commissioned by Pacific Gas & Electric found an average of 25% guest-room energy savings for occupancy-based controls based on field monitoring. A simulation study estimated 15% HVAC savings for on/off control and 5% HVAC savings for temperature setback control. [4]

A 2011 report prepared for the California Energy Commission to support energy code development estimates guest-room occupancy controls produced HVAC savings of 12-25% and guest room lighting savings of 16%.[5]

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[3] Mills, Evan, "Building Commissioning, A Golden Opportunity for Reducing Energy Costs and Greenhouse Gas Emissions", LBNL, July 21. 2009.
[4] PG&E, Emerging Technologies Program, "Application Assessment Report #0825, Occupancy-Based Guestroom Controls Study", April 10, 2010.
[5] California Utilities Statewide Codes and Standards Team, "Guest Room Occupancy Controls", October 2011.

Based on these studies, the savings due to the Hawaii Code requirements for sleeping unit controls could reasonably be expected to be at least 5% for hotel buildings. That savings estimate is based on assumptions that guest room HVAC accounts for about 25% of total hotel energy use and guest room lighting accounts for about 10%. The remainder of the hotel energy consumption is assumed to be due to hot water, plugs loads, cooking, and lighting and HVAC for support-areas and would not be affected by this code requirement.

Submetering

Submetering does not guarantee any energy savings, but provides greater incentive to tenants to consume less energy. A report by the National Science and Technology Council describes studies of submetering's impact on residential buildings showing savings of 0 to 20%. No studies were identified on the impact in nonresidential buildings, however case studies were presented claiming savings of 30% and 18% due to tenant submetering.[6]

The impact of the submetering requirement in the Hawaii Code will vary among buildings. It seems reasonable to expect an average of about 5% energy savings for the tenant-occupied buildings that fall under the scope of this requirement.

Overall Energy Impact for Nonresidential Buildings

The estimate for the combined impact of the four measures discussed above is an energy savings of 7.5% for hotels and 3.5% for other nonresidential buildings compared to ASHRAE Standard 90.1-2007, equal to roughly 1.21 kWh/ft^2 per year for hotels and 0.49 kWh/ft^2 for other nonresidential buildings. The savings estimate is summarized in Table 10. That estimate is based on the following assumptions.

- Average electricity consumption for new buildings is 16.1 kWh/ft^2 per year for hotels and 14.0 kWh/ft^2 per year for other nonresidential buildings. (See table notes for sources)
- One-half of new nonresidential buildings use the cool roof exemption, resulting in an average increase of 2.5%, equal to 0.40 kwh/ft^2 in hotels and 0.35 kWh/ft^2 in other nonresidential buildings
- Mechanical system commissioning provides an average of 5% savings, equal to 0.81 kWh/ft^2 in hotels and 0.70 kWh/ft^2 in other nonresidential buildings.
- Hotel sleeping unit controls save 5% in hotels, equal to 0.81 kWh/ft^2.
- Submetering saves 5% and applies to 20% of nonresidential buildings, equal to 0.14 kWh/ft^2. Potential savings in hotels are not included because submetering would likely affect only a small part of their total energy consumption.

[6] "Submetering of Building Energy and Water Use", National Science and Technology Council, October 2011.

Table 10. Nonresidential Electricity Impact Estimate (kWh/ft^2-yr)

	Hotel	Other	Notes
Baseline electricity consumption	**16.1**	**14.0**	Sources: Hotel, Evan Mills, LBL, referencing T. Van Liew, HECO, 2003 "Other", office simulation model, described on page 26.
Cool roof exemption	0.40	0.35	2.5% increase
Commissioning	(0.81)	(0.70)	5% savings
Sleep unit occupancy controls	(0.81)	0.00	5% savings in hotels
Submetering	0.00	(0.14)	5% savings in 20% of "other" buildings
Net impact (kWh/ft^2/yr)	**(1.21)**	**(0.49)**	
Net impact (%)	**-7.5%**	**-3.5%**	

Energy Savings Forecast

This section of the report includes construction forecasts for both residential and nonresidential projects followed by forecasts of energy impact in the years 2013, 2023 and 2033. The energy impact estimate compares the Hawaii Code to the 2009 IECC for residential buildings and to ASHRAE Standard 90.1-2007 for nonresidential buildings.

Residential Construction Forecast

The forecast for residential new construction is based on past construction activity. Statewide construction for the ten years of 2002 through 2011 is listed in Table 11 and plotted in Figure 4 and Figure 5. These data show a ten-year average of 3,827 single-family units per year and 1,339 apartments per year. The data also show a significant decline in construction since 2005.

Table 11. Residential Construction History, Number of Dwelling Units (Source: Dodge data provided by Mary Blewitt, DBEDT)

Year	Single-family	Apartments
2002	4,191	1,186
2003	5,131	687
2004	4,967	2,581
2005	6,413	2,490
2006	5,191	1,126
2007	4,370	1,342
2008	2,653	987
2009	2,145	381
2010	1,702	1,513
2011	1,504	1,100
5-yr average	2,475	1,065
10-yr average	3,827	1,339

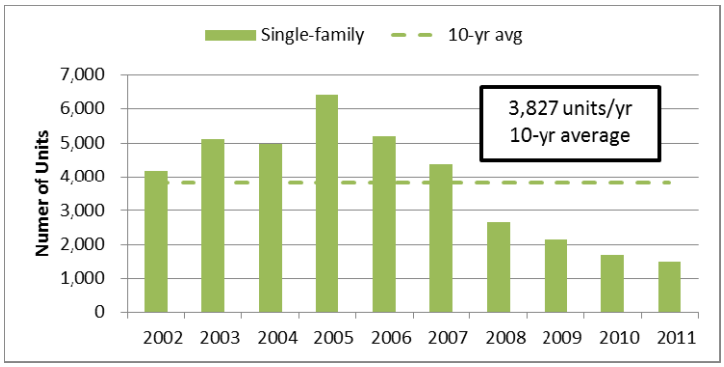

Figure 4. Residential Construction History, Single-Family (Source: Dodge data provided by Mary Blewitt, DBEDT)

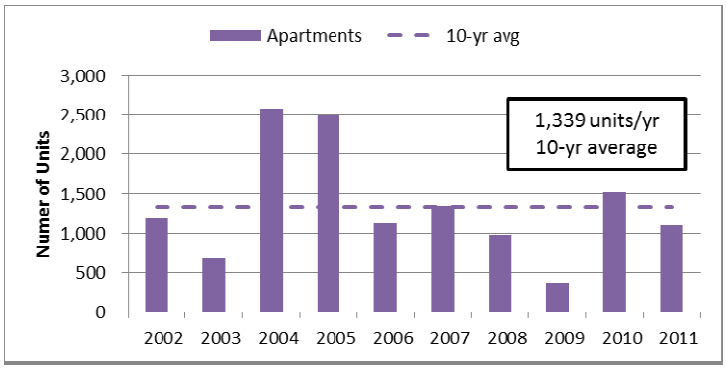

Figure 5. Residential Construction History, Apartments (Source: Dodge data provided by Mary Blewitt, DBEDT)

The residential construction forecast used in this analysis is illustrated in Figure 6 and Figure 7. The construction activity for 2013 is assumed to be equal to the 5-year average, which is 2,475 single-family units per year and 1,065 apartment units per year. Then activity is assumed to increase until 2018 when it would reach the 10-year average. Figure 6 shows the assumption for number of units constructed in each year. Figure 7 shows the cumulative number of new units constructed over 20 years. The cumulative total for single-family units reaches 38,038 in the year 2023, 64,825 in 2030 and 76,305 in the year 2033. The cumulative total for apartment units reaches 13,908 in 2023, 23,283 in 2030 and 27,301 in 2033.

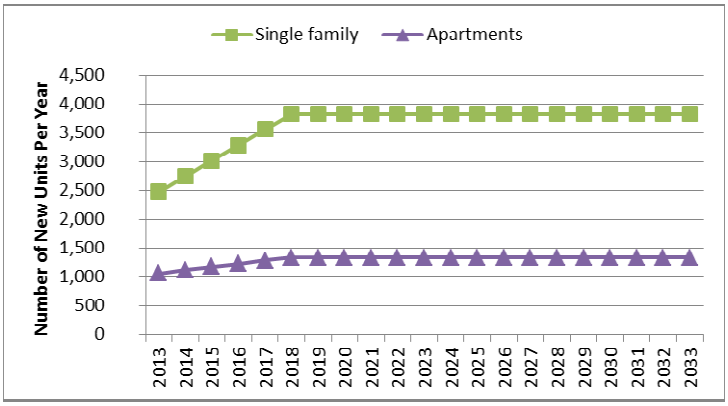

Figure 6. Residential Construction Forecast, Units per Year

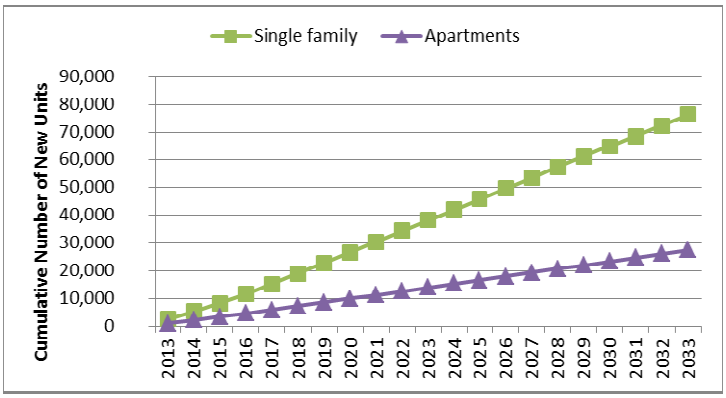

Figure 7. Residential Construction Forecast, Cumulative Number of Units

Nonresidential Construction Forecast

Nonresidential construction is estimated to include 430,000 ft^2/yr of hotels and 1.49 million ft^2/yr of other nonresidential buildings. This is a rough estimate based on Dodge data for permit value and the assumption that average permit value is $200 per square foot of floor area. The resulting historical estimate of floor area is shown in Figure 8 for hotels and Figure 9 for other nonresidential buildings. The cumulative construction forecasts for 2023, 2030 and 2033 are summarized in Table 12.

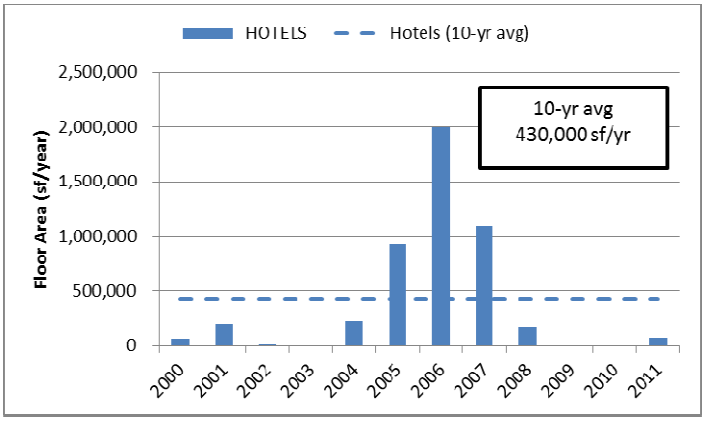

Figure 8. Hotel Construction History
(Source: Dodge data provided by Mary Blewitt, DBEDT)

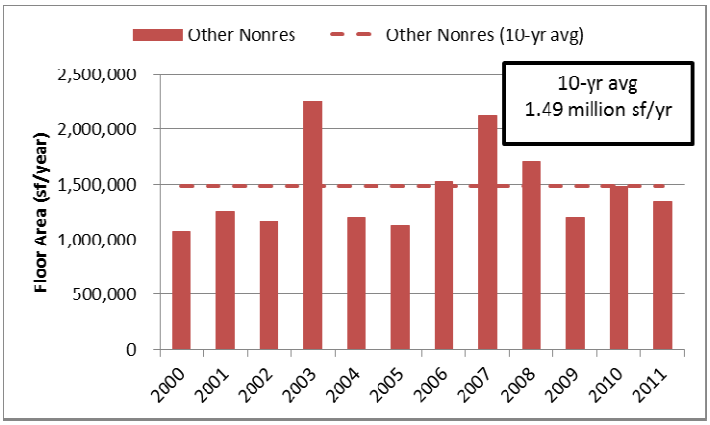

Figure 9. Other Nonresidential Construction History (Source: Dodge data provided by Mary Blewitt, DBEDT)

Table 12. Nonresidential Construction Forecast, Square Feet of Floor Area

	2013	2023	2030	2033
Hotels	430,000	4,300,000	7,310,000	8,600,000
Other nonresidential	1,490,000	14,900,000	25,330,000	29,800,000
Total	1,920,000	19,200,000	32,640,000	38,400,000

Residential Energy Impact Forecast

The estimated impact of the Hawaii Code on residential energy is an increase of 609 MWh/yr in 2013 (year 1) compared to the 2009 IECC. The cumulative total increases to 9,107 MWh/yr in 2023 (year 10), 15,477 MWh/yr in 2030 and 18,208 MWh/yr in 2033 (year 20). Calculations are summarized in Table 13. These estimates are based on the residential construction forecast described on page 19 and the residential energy calculation described on page 9. The forecast for energy impact was determined as follows:

- The increase of 381 kWh/yr in electricity for air conditioning described in Table 6 is appropriate for a 2,400 ft^2 single-family home with seasonally-varying air conditioning operation.
- The typical single-family home size[7] is assumed to be 1,700 ft^2 rather than 2,400 ft^2. The impact is assumed to reduce proportionately from 381 to 270 kWh/yr.
- As a rough assumption, 75% of new homes statewide have air conditioning, reducing the average impact to 202 kWh/yr.
- For apartments, the impact is assumed to be 50% of the value calculated for single-family homes, equal to 101 kWh/yr per apartment.

[7] *Hawaii Housing Planning Study, 2011 Inventory Report*, SMS Research & Marketing Services, November 2011. This report notes that the median single-family home size is 1,700 ft^2 on Oahu and 1,400 to 1,500 ft^2 on other islands. The Oahu value is used in this analysis based on the assumption that average new homes would be larger than average existing homes.

Table 13. Residential Energy Forecast
(Positive value indicates increase in electricity consumption)

		2013	2023	2030	2033
Single-family	# units	2,475	38,038	64,825	76,305
	kWh/yr-unit	202	202	202	202
	MWh/yr	501	7,699	13,121	15,445
Apartment	# units	1,065	13,908	23,283	27,301
	kWh/yr-unit	101	101	101	101
	MWh/yr	108	1,408	2,356	2,763
Total	# units	3,539	51,946	88,108	103,606
	MWh/yr	**609**	**9,107**	**15,477**	**18,208**

Nonresidential Energy Impact Forecast

The estimated savings for the nonresidential buildings under the Hawaii Code is 1,250 MWh/yr in 2013 compared to ASHRAE Standard 90.1-2007. The cumulative total increases to 12,504 MWh/yr in 2023, 21,257 MWh/yr in 2030 and 25,008 MWh/yr in 2033. These savings estimates are summarized in Table 14. This estimate combines the construction forecast described on page 21 with the savings estimate described on page 18.

Table 14. Nonresidential Energy Forecast
(Negative value indicates decrease in electricity consumption)

		2013	2023	2030	2033
Hotel	ft^2	430,000	4,300,000	7,310,000	8,600,000
	kWh/ ft^2	(1.21)	(1.21)	(1.21)	(1.21)
	MWh/yr	(520)	(5,203)	(8,845)	(10,406)
Other	ft^2	1,490,000	14,900,000	25,330,000	29,800,000
	kWh/ ft^2	(0.49)	(0.49)	(0.49)	(0.49)
	MWh/yr	(730)	(7,301)	(12,412)	(14,602)
Total	ft^2	1,920,000	19,200,000	32,640,000	38,400,000
	MWh/yr	**(1,250)**	**(12,504)**	**(21,257)**	**(25,008)**

Net Energy Impact Forecast

The net overall impact of the Hawaii Code is estimated to be savings of 642 MWh/yr in 2013, 3,397 MWh/yr in the year 2023, 5,779 MWh/yr in 2030 and 6,800 MWh/yr in the year 2033. These estimates are summarized in Table 15 which shows that the expected increase in residential energy consumption is offset by the estimated savings in nonresidential energy consumption.

Table 15. Combined Residential and Nonresidential Energy Forecast

	2013	2023	2030	2033
Residential (see also Table 13)	609	9,107	15,477	18,208
Nonresidential (see also Table 14)	(1,250)	(12,504)	(21,257)	(25,008)
Total	**(642)**	**(3,397)**	**(5,779)**	**(6,800)**

Appendix 1 - Residential Prototype Simulation Model

Residential Model Starting Point

The starting point for the residential prototype simulation model is a single-family model developed by Pacific Northwest National Laboratory (PNNL) for evaluating energy code savings. The selected EnergyPlus input file includes the following characteristics:

- Single family, two-story, 2,400 ft^2 floor area.
- Slab-on-grade floor
- Air conditioning and heat pump heating, with 24 hour-per-day conditioning and 75°F cooling setpoint
- 2009 IECC minimum equipment efficiency, including SEER 13 air conditioner
- Electric water heating (no solar water heating)
- Honolulu Airport weather data
- IECC 2009 compliance

The file was downloaded from www.energycodes.gov/development/residential/iecc_models.

More details of model characteristics are documented in PNNL's report *Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes*, April 2012, available at http://www.energycodes.gov/development/residential/methodology/.

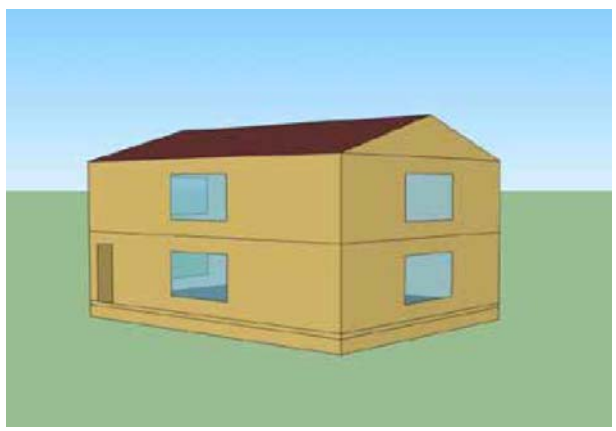

Figure 10. Residential Prototype Model
(Source: *Methodology for Evaluating Cost-Effectiveness of Residential Energy Code Changes*, PNNL, April 2012)

Residential Model Modifications and Assumptions

The following updates were made to the prototype model obtained from PNNL:

- The file was updated to run on EnergyPlus v7.1, the latest version at the time of this study.
- Attic vent area was increased in the baseline model. Output from the original baseline model showed an average attic ventilation rate of 1.4 air changes per hour (ach) based on an EnergyPlus effective leakage area (ELA) input of 57.4 in^2. Based on a survey of literature on measured attic ventilation rates

it appears that an average ventilation rate of about 2.7 ach is typical[8]. Therefore, the baseline attic ELA was increased to 114.7 in^2, which results in an average attic ventilation rate of 2.7 ach, ranging from about 1 ach to 5 ach depending on wind speed and temperature.

Two additional baseline models were developed in order to evaluate the wall insulation tradeoffs in the Hawaii Code: 1) metal-framed wall baseline and 2) mass wall baseline. The baseline metal wall construction has U-factor of 0.082(2009 IECC requirement) and solar absorptance of 70%. The baseline mass wall consists of concrete masonry units with insulation and drywall on the interior and with U-factor of 0.197 (2009 IECC requirement). The mass wall solar absorptance is 70%.

Roof construction options were modeled in EnergyPlus as follows:

- Radiant barrier. A material layer was added under the roof (at the top of the attic) with minimal "thermal resistance" but with "thermal absorptance" of 0.05 rather than 0.90 used for other materials.
- Cool roof. The "solar absorptance" of the roof membrane was changed from a baseline of 70% to 45%, which represents an aged reflectance of 55%.
- Extra ventilation. The "Effective Leakage Area" input was doubled from 114.7 in^2 to 229.4 in^2, to represent the doubling of minimum vent area required for this option. The result in EnergyPlus is to roughly double the attic ventilation air change rate.

Two of the wall insulation exceptions apply for residences where high efficacy lighting is used for a minimum of 90% of permanently installed lighting fixtures. The baseline requirement is 50%. To represent this change from 50% to 90% the lighting power density is decreased from 0.138 W/ft^2 of hardwired lighting in the baseline model to 0.083 W/ft^2, which is a reduction of 40%. This reduction is based on an assumption that the average efficacy of the high efficacy lighting is 45 lumens/watt and the efficacy of standard lighting is 15 lumens/watt. The average efficacy in the baseline case is 22.5 lumens/watt, and the average efficacy in the improved case is 37.5 lumens/watt, which results in a 40% drop in lighting power.

Another wall insulation exception applies where the visible light reflectance of the exterior wall surface is at least 64%. This requirement is expressed in visible reflectance rather than solar reflectance because the solar reflectance performance data is not commonly available for wall paint. In the EnergyPlus model it is assumed that the two values are equal.

[8] Parker, Danny, "A Stratified Air Model for Simulation of Attic Thermal Performance", Florida Solar Energy Center, http://www.fsec.ucf.edu/en/publications/html/FSEC-PF-226-91/

Appendix 2 - Nonresidential Prototype Simulation Model

An EnergyPlus simulation model was used in this analysis to evaluate the impact of the cool roof insulation exception for nonresidential roofs. A prototype medium-sized office building model developed by Pacific Northwest National Laboratory was used as the baseline. That model has the following characteristics.

- Three stories
- 53,600 ft^2 floor area
- 33% window-wall ratio
- Packaged VAV air conditioning system
- 90.1-2007 compliant envelope, lighting and HVAC for ASHRAE climate zone 1 (which includes Hawaii)

More details of the prototype model are included in the report, "Achieving the 30% Goal: Energy and Cost Savings Analysis of ASHRAE Standard 90.1-2010". That report, along with the EnergyPlus model, is available at http://www.energycodes.gov/development/commercial/90.1_models.

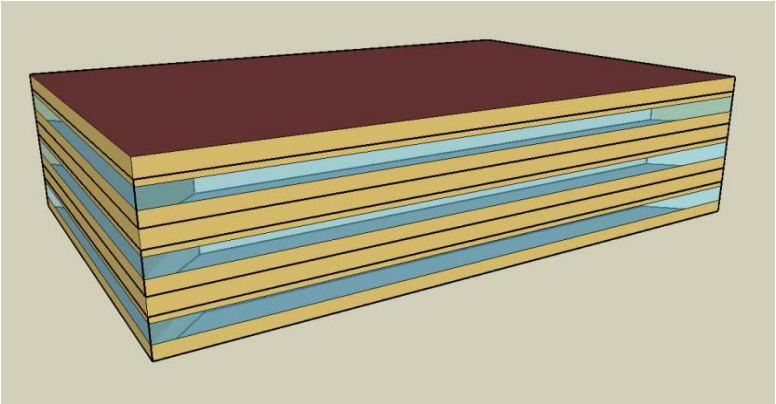

Figure 11. Nonresidential Prototype Model (Source: www.energycodes.gov)

For this analysis the prototype model was updated with climate and location data for Honolulu and was converted to run on EnergyPlus version 7.1. Changes to the roof insulation and the roof surface "solar absorptance" were made to evaluate the energy impact of replacing the baseline roof with an uninsulated cool roof. Results are presented earlier on page 17 and in Table 9.

Appendix 3 – Hawaii Code Amendments

Amendments adopted by the Hawaii State Building Code Council in February 2012 are attached for reference.

DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES

Adoption of Chapter 3-181
Hawaii Administrative Rules

SUMMARY

1. Chapter 181 of Title 3, Hawaii Administrative Rules, entitled "State Energy Conservation Code" adopting and amending the "*International Energy Conservation Code, 2006 Edition*", is repealed.

2. Chapter 181 of Title 3, Hawaii Administrative Rules, entitled "State Energy Conservation Code", amending the "*International Energy Conservation Code, 2009 Edition*" to include amendments applicable to the state, is adopted.

HAWAII ADMINISTRATIVE RULES

TITLE 3

DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES

SUBTITLE 14

STATE BUILDING CODE COUNCIL

CHAPTER 181

STATE ENERGY CONSERVATION CODE

Subchapter 1 Rules of General Applicability

§3-181-1	Purpose
§3-181-2	Scope
§3-181-3	Definitions
§3-181-4	Adoption of the *International Energy Conservation Code*
§3-181-5	Permit authorization

Subchapter 2 Amendments to the 2009 *ICC International Energy Conservation Code*

§3-181-6	Title
§3-181-7	Low energy buildings
§3-181-8	General
§3-181-9	Inspections
§3-181-10	Certificate
§3-181-11	Insulation and fenestration requirements by component
§3-181-12	Wall insulation alternative
§3-181-13	Ceiling insulation alternatives
§3-181-14	Equivalent *U*-factors
§3-181-15	Steel-frame ceilings, walls and floors
§3-181-16	*U*-factor
§3-181-17	Glazed fenestration exemption
§3-181-18	Unconditioned building exemption
§3-181-19	Fenestration air leakage
§3-181-20	Residential pools
§3-181-21	Roof assembly
§3-181-22	Area-weighted average - commercial
§3-181-23	Wall insulation reduction
§3-181-24	Mechanical systems commissioning and completion requirements

181-1

§3-181-25	Sleeping unit controls
§3-181-26	Electrical energy consumption (Mandatory)
§3-181-27	Referenced standards

181-2

§3-181-1

SUBCHAPTER 1

RULES OF GENERAL APPLICABILITY

§3-181-1 Purpose. The purpose of this chapter is to adopt the state energy conservation code as required by section 107-25, Hawaii Revised Statutes (HRS). [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-2 Scope. This chapter sets forth minimum requirements for the design and construction of buildings for the effective use of energy and is intended to provide flexibility to allow the use of innovative approaches and techniques to achieve the effective use of energy. [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-3 Definitions. In this chapter, unless the context otherwise requires:

"ICC" means the International Code Council.

"IECC Section" means a section of a chapter of the *International Energy Conservation Code*.

"IECC" means the ICC, *International Energy Conservation Code*, [~~2006~~] 2009 edition, as copyrighted by the International Code Council. [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-4 Adoption of the *International Energy Conservation Code*. The "*International Energy Conservation Code, [~~2006~~] 2009 Edition*" as copyrighted and published in [~~2006~~] 2009 by International Code Council, Incorporated, 500 New Jersey Avenue, 6th Floor, Washington, DC 20001, is adopted by reference and made a part of this chapter. This incorporation by reference includes all parts of the *International Energy Conservation Code* subject to the amendments hereinafter set forth. The appendices of the ICC, IECC are not adopted except as provided in this chapter. [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

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§3-181-5 Permit authorization. Each county may, by ordinance, require that a permit be obtained from the building official for any area regulated by this chapter. [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

SUBCHAPTER 2

AMENDMENTS TO THE 2009 ICC *INTERNATIONAL ENERGY CONSERVATION CODE*

§3-181-6 Title. IECC section 101.1 is amended to read as follows:

"101.1 Title. This code shall be known as the [~~International~~] Energy Conservation Code of the State of Hawaii, and shall be cited as such. It is referred to herein as "this code"." [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-7 Low energy buildings. IECC section 101.5.2 is amended to read as follows:

"101.5.2 Low energy buildings. The following buildings, or portions thereof, separated from the remainder of the building by building thermal envelope assemblies complying with this code shall be exempt from the building thermal envelope provisions of this code:

1. Conditioned spaces with a peak design rate of energy usage less than 3.4 Btu/h•ft^2 (10.7 W/m^2) or 1.0 watt/ft^2 (10.7 W/m^2) of floor area for space conditioning purposes.
2. Unconditioned spaces that are non-habitable spaces." [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-8 General. IECC section 103.1 is amended to read as follows:

"103.1 General. When the requirements in this code apply to a building as specified in Section 101.4, plans, specifications or other construction documents submitted for a building, electrical or plumbing permit required by the jurisdiction shall comply with this code and shall be prepared, designed, approved and observed by a design professional. The responsible design professional shall

§3-181-9

provide on the plans a signed statement certifying that the project is in compliance with this code.

Exception: Any building, electrical or plumbing work that is not required to be prepared, designed, approved or observed by a licensed professional architect or engineer pursuant to chapter 464 Hawaii Revised Statutes." [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-9 Inspections. IECC section 104 is deleted in its entirety. [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-10 Certificate. IECC section 401.3 is amended to read as follows:

"**401.3 Certificate.** When required by the code official, a permanent certificate shall be posted on or in the electrical distribution panel. The certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. The certificate shall be completed by the builder or registered design professional. The certificate shall list the predominant R-values of insulation installed in or on ceiling/roof, walls, foundation (slab, basement wall, crawlspace wall and/or floor) and ducts outside conditioned spaces; *U*-factors for fenestration and the solar heat gain coefficient (SHGC) of fenestration. Where there is more than one value for each component, the certificate shall list the value covering the largest area. The certificate shall list the types and efficiencies of heating, cooling and service water heating equipment. Where a gas-fired unvented room heater, electric furnace, or baseboard electric heater is installed in the residence, the certificate shall list "gas-fired unvented room heater," "electric furnace" or "baseboard electric heater," as appropriate. An efficiency shall not be listed for gas-fired unvented room heaters, electric furnaces or electric baseboard heaters." [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-11 Insulation and fenestration requirements by component. IECC Table 402.1.1 is amended to read as follows:

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§3-181-11

"Table 402.1.1
Insulation and Fenestration Requirements by Component[a]

Climate Zone	Fenestration *U*-Factor	Skylight[b] *U*-Factor	Glazed Fenestration SHGC[b,e]	Ceiling *R*-Value	Wood Frame Wall *R*-Value[i]	Mass Wall *R*-Value[i,i]	Floor *R*-Value	Basement Wall *R*-Value[c]	Slab[d] *R*-Value & Depth	Crawl Space[c] Wall *R*-Value
1	1.20	0.75	0.30	See Section ~~[402.1.1.1]~~ 402.1.6	13	3/4	NR	NR	NR	NR
2	0.75	0.75	0.30	30	13	4/6	13	0	0	0
3	0.65	0.65	0.30	30	13	5/8	19	0	0	5 / 13
4 except Marine	0.40	0.60	NR	38	13	5/10	19	10 / 13	10, 2 ft	10 / 13
5 and Marine 4	0.35	0.60	NR	38	20 or 13+5[h]	13/17	30[g]	10 / 13	10, 2 ft	10 / 13
6	0.35	0.60	NR	49	20 or 13+5[h]	15/19	30[g]	10 / 13	10, 4 ft	10 / 13
7 and 8	0.35	0.60	NR	49	21	19/21	30[g]	10 / 13	10, 4 ft	10 / 13

For SI: 1 foot = 304.8 mm.
NR = No requirement.

a. *R*-values are minimums. *U*-factors and SHGC are maximums. *R*-19 batts compressed into a nominal 2 × 6 framing cavity such that the *R*-value is reduced by *R*-1 or more shall be marked with the compressed batt *R*-value in addition to the full thickness *R*-value.
b. The fenestration *U*-factor column excludes skylights. The SHGC column applies to all glazed fenestration.
c. "15/19" means *R*-15 continuous insulated sheathing on the interior or exterior of the home or *R*-19 cavity insulation at the interior of the basement wall. "15/19" shall be permitted to be met with *R*-13 cavity insulation on the interior of the basement wall plus *R*-5 continuous insulated sheathing on the interior or exterior of the home. "10/13" means *R*-10 continuous insulated sheathing on the interior or exterior of the home or *R*-13 cavity insulation at the interior of the basement wall.
d. *R*-5 shall be added to the required slab edge *R*-values for heated slabs. Insulation depth shall be the depth of the footing or 2 feet, whichever is less in Zones 1 through 3 for heated slabs.
e. There are no SHGC requirements in the Marine zone.
f. Basement wall insulation is not required in warm-humid locations as defined by Figure 301.1 and Table 301.1.
g. Or insulation sufficient to fill the framing cavity, *R*-19 minimum.
h. "13+5" means *R*-13 cavity insulation plus *R*-5 insulated sheathing. If structural sheathing covers 25 percent or less of the exterior, insulating sheathing is not required where structural sheathing is used. If structural sheathing covers more than 25 percent of exterior, structural sheathing shall be supplemented with insulated sheathing of at least R-2."
i. The second *R*-value applies when more than half the insulation is on the interior of the mass wall.

181-6

§3-181-12

j. For impact rated fenestration complying with Section R301.2.1.2 of the Residential Code of the State of Hawaii or Section 1608.1.2 of the Building Code of the State of Hawaii, the maximum *U*-factor shall be 0.75 in Zone 2 and 0.65 in Zone 3.

k. A reduction of *R*-5 for interior walls or *R*-4 for exterior walls shall be permitted in buildings that meet one of the following criteria:

1. Exterior walls are finished with a paint or surface with an average light reflectance value ≥ 0.64 (garages, trim and other non-wall components are exempt).
2. High efficacy lamps in a minimum of 90 percent of permanently installed lighting fixtures.
3. The building has a wall projection factor, in accordance with Equation 4-1, of not less than 0.30 for all walls that face more than 22.5 degrees from true north."

[Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-12 Wall insulation alternative. Section 402.1.5 is added to the IECC to read as follows:

"**402.1.5 Wall insulation alternative.** Insulation requirements for walls in buildings are permitted to be reduced in accordance with Footnote k of Table 402.1.1, where the following conditions are met:

1. The building is located in climate zone 1, and
2. The wall projection factor is not less than 0.30 for all walls that face more than 22.5 degrees from true north.

The wall projection factor shall be determined in accordance with Equation 4-1.

(Equation 4-1)

$$WPF = A/B$$

where:

WPF = Wall projection factor (decimal)

A = Distance measured horizontally from the furthest continuous extremity of any overhang, eave, or permanently attached shading device to the vertical surface of the wall

B = Distance measured vertically from the bottom of the wall to the underside of the overhang, eave, or permanently attached shading device. The distance B does not need to extend below the bottom of the floor assembly of the lowest occupied floor level

[Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

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§3-181-13 Ceiling insulation alternatives. Sections [~~402.1.1.1~~] 402.1.6 to [~~402.1.1.8.1~~] 402.1.6.8.1 are added to the IECC to read as follows:

[~~402.1.1.1~~] 402.1.6 Ceiling insulation alternatives. [~~Insulation requirements for ceilings of buildings constructed in climate zone 1 shall meet one of the design options in Table 402.1.1.1.~~] Insulation requirements for ceilings of buildings are permitted to be modified in accordance with Sections 402.1.6.1 through 402.1.6.8.1 for buildings:

1. Located in climate zone 1, and
2. Located at elevations below 2,400-foot (731.5 m).

402.1.6.1 Design options. Ceiling insulation requirements shall meet at least one of the design options in Table 402.1.6.1. Construction documents required in accordance with Section 402.1.6.3 shall be provided for any design option utilized.

Table [~~402.1.1.1~~] 402.1.6.1
Ceiling Insulation for Buildings in Climate Zone 1

Design Option	Design and Construction Components				
	Roof Insulation (Section [~~402.1.1.4~~] 402.1.6.4)	Attic Ventilation (Section [~~402.1.1.5~~] 402.1.6.5)	Radiant Barrier (Section [~~402.1.1.6~~] 402.1.6.6)	Cool Roof (Section [~~402.1.1.7~~] 402.1.6.7)	Roof Heat Gain Factor below 0.05 (Section [~~402.1.1.8~~] 402.1.6.8)
1	R				
[~~2~~] 2		R	R		
[~~3~~] 3			R	R	
[~~4~~] 4					R

R = Required

[~~a. Design Option is not allowed at building sites above a 2,400 foot (731.5 m) elevation.~~]

[~~402.1.1.2~~] 402.1.6.2 Definitions. For the purpose of this section, the following terms shall be defined as follows:

GROSS AREA OF OPAQUE ROOF SURFACES. Gross area of opaque roof surfaces means the total surface of the roof assembly exposed to outside air or unconditioned spaces. The opaque roof assembly shall exclude skylight surfaces, service openings, and overhangs.

NET FREE VENT AREA. Net free vent area means the total area through which air can pass in a screen, grille face or register.

§3-181-13

ROOF AREA. Roof area means attic floor area; or, if there is no attic, "roof area" means the horizontal projection of roof area measured from the outside surface of the exterior walls.

[~~402.1.1.3~~] **402.1.6.3 Construction documents.** Plans shall be submitted which indicate insulation type, thickness, and location; ventilation opening types, sizes and locations; radiant barrier location; and roof surface type as appropriate, depending on the option selected from Table [~~402.1.1.1.~~] 402.1.6.1.

[~~402.1.1.4~~] **402.1.6.4 Roof insulation.** Roof insulation shall be provided as follows:

1. In buildings with an attic space provide either:
   1.1. R-30 insulation installed above the ceiling level, or
   1.2. R-19 insulation installed at the roof level between the roof framing members.
2. In buildings without an attic space provide either:
   2.1. R-19 insulation installed at the roof level between the roof framing members, or
   2.2. R-15 entirely above the roof deck.

[~~402.1.1.5~~] **402.1.6.5 Attic Ventilation.** Ventilation shall be provided by at least one of the following:

1. A baffled ridge vent installed in accordance with the manufacturer's instructions in addition to lower inlet openings to provide a total of no less than one square foot of net free vent area for each 300 square feet of roof area. No less than 30 per cent of the total vent area shall be in either the ridge vent or the lower half of the ventilated space.
2. A solar-powered exhaust fan that provides at least one cubic foot per minute of airflow for each square foot of roof area.
3. Upper and lower vents with total net free vent area of at least one square foot for each 150 square feet of roof area. At least 30 percent of the total vent area shall be in the upper half of the ventilated space and at least 30 percent of the total vent area shall be in the lower half of the ventilated space.

[~~402.1.1.6~~] **402.1.6.6 Radiant barrier.** A radiant barrier shall have an emissivity of no greater than 0.05 as tested in accordance with ASTM E-408. The radiant barrier shall be installed with the shiny side facing down and with a minimum air gap thickness of ¾ inch below. The radiant barrier may be securely attached to the roof framing or may be laminated to the bottom of the roof sheathing.

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Exception: The radiant barrier is not required within 24 inches (610 mm) of the face of the exterior wall when Table 402.1.6.1 Option 2 or 3 is selected and the unprotected portion of the roof is insulated to a value of R-19 with continuous insulation to the exterior wall.

[~~402.1.1.7~~] **402.1.6.7 Cool roof.** A cool roof rated in compliance with the Cool Roof Rating Council, Product Rating Program Manual, shall have an infrared emittance of no [~~more~~] less than 0.75 when tested in accordance with ASTM E-408 and [~~a high solar reflectance~~] an initial reflectance of no less than 0.70 and an extended reflectance of no less than 0.55. [~~The manufacturer's test results shall be acceptable for compliance.~~]

[~~402.1.1.8~~] **402.1.6.8 Roof Heat Gain Factor.** The Roof Heat Gain Factor (RHGF) shall not exceed 0.05 when calculated as described in Equation [~~402.1.1-1.~~] 4-2.

Equation [~~402.1.1-1~~] 4-2

$RHGF = U_r \times \alpha \times RB$

Where:

$RHGF$ = Roof Heat Gain Factor [Btu/ft^2•h•°F]

U_r = overall thermal transmittance value for the gross area of opaque roof surfaces [Btu/ft^2•h•F]

α = roof surface absorptivity. Between 0.3 and 1.0 [~~unitless~~]

RB = Radiant Barrier credit. Equals 0.33 if a radiant barrier is installed and 1.00 otherwise [~~unitless~~]. Radiant barrier installation must comply with Section [~~402.1.1.7.1~~] 402.1.6.8.1 to qualify for Radiant Barrier credit.

[~~402.1.1.8.1~~] **402.1.6.8.1 Radiant barrier credit.** To qualify for the radiant barrier credit (RB) described in Section [~~402.1.1.8,~~] 402.1.6.8, the installation of the radiant barrier must meet the following criteria:

1. The emissivity of the radiant barrier must be 0.10 or less. The manufacturer must provide test data or documentation of the emissivity as tested in accordance with ASTM E-408.
2. The radiant barrier must be securely installed in a permanent manner using one of the following installation methods:
   - 2.1. The radiant barrier shall be draped with the shiny side facing down over the top cord of the truss before the roof deck is installed. A minimum air gap of ¾ inch must be provided between the radiant barrier and the roof deck

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above at the center of the span. A minimum ¾ inch air gap must also be provided between the radiant barrier and the ceiling or insulation below.

2.2. The radiant barrier shall be stretched with the shiny side facing down between the top cords of the truss and stapled or otherwise secured at each side. A minimum air space of ¾ inch above and below is required.

2.3. For attic installations only, the radiant barrier shall be stapled or otherwise secured to the bottom surface of the top cord of the truss and draped below with the shiny side facing down. A minimum air space of ¾ inch above and below is required.

2.4. For open beam ceiling construction only, the radiant barrier shall be laid on top of the roof deck with the shiny side facing up and a minimum ¾ inch air gap between the radiant barrier and the roofing material above. The roof slope must be greater than or equal to 14° from horizontal.

3. At least one square foot of free area for ventilation shall be provided per 150 square feet of attic floor area, or in the case of vaulted or open-beam ceilings, per 150 square feet of ceiling area. In vaulted or open beam ceilings, the air space shall be vented with vent area approximately evenly distributed between the top and the bottom. In vaulted ceilings, vents shall be provided for each air space between rafters."

[Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

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§3-181-14 Equivalent *U*-factors. IECC Table 402.1.3 is amended to read as follows:

"Table 402.1.3
Equivalent *U*-Factors [a]

Climate Zone	Fenestration *U*-Factor	Skylight *U*-Factor	Ceiling *U*-Factor	Frame Wall *U*-Factor	Mass Wall *U*-Factor[b]	Floor U-Factor	Basement Wall U-Factor	Crawl Space Wall *U*-Factor[c]
1	1.2	0.75	0.035	0.082	0.197	NR	NR	NR
2	0.65	0.75	0.035	0.082	0.165	0.064	0.360	0.477
3	0.50	0.65	0.035	0.082	0.141	0.047	0.091[c]	0.136
4 except Marine	0.35	0.60	0.030	0.082	0.141	0.047	0.059	0.065
5 and Marine 4	0.35	0.60	0.030	0.057	0.082	0.033	0.059	0.065
6	0.35	0.60	0.026	0.057	0.060	0.033	0.050	0.065
7 and 8	0.35	0.60	0.026	0.057	0.057	0.028	0.050	0.065

NR = No requirement.

a. Nonfenestration *U*-factors shall be obtained from measurement, calculation or an approved source.

b. When more than half the insulation is on the interior, the mass wall *U*-factors shall be a maximum of 0.17 in Zone 1, 0.14 in Zone 2, 0.12 in Zone 3, 0.10 in Zone 4 except Marine, and the same as the frame wall *U*-factor in Marine Zone 4 and Zones 5 through 8.

c. Basement wall *U*-factor of 0.360 in warm-humid locations as defined by Figure 301.1 and Table 301.1." [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-15 Steel-frame ceilings, walls and floors. IECC section 402.2.5 is amended to read as follows:

"**402.2.5 Steel-frame ceilings, walls, and floors.** Steel-frame ceilings, walls and floors shall meet the insulation requirements of Table 402.2.5 or shall meet the *U*-factor requirements in Table 402.1.3. The calculation of the *U*-factor for a steel-frame envelope assembly shall use a series-parallel path calculation method.

Exception: Buildings located at elevations below 2,400 feet (731.5 m) do not need to comply with the continuous R-value requirement where one of the following apply:

1. In Climate Zones 1 and 2, the continuous insulation requirements in Table 402.2.5 shall be permitted to be reduced to *R*-3 for steel frame wall assemblies with studs spaced at 24 inches

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(610 mm) on center.

2. In Climate Zones 1 and 2, the continuous insulation requirements in Table 402.2.5 shall be permitted to be reduced to R-0 for steel frame wall assemblies of buildings that meet one of the following criteria:
   - 2.1. Exterior walls are finished with a paint or surface with an average light reflectance value ≥0.64 (garages, trim and other non-wall components are exempt),
   - 2.2. High efficacy lamps in a minimum of 90 percent of permanently installed lighting fixtures, or
   - 2.3. A wall projection factor, in accordance with Equation 4-1, of not less than 0.30 of all walls that face more than 22.5 degrees from true north.
   - 2.4. The building is equipped with central air conditioning with a minimum efficiency rating of 14 SEER.
3. The building has a steep slope roof with an initial reflectance of 0.25 or higher."

[Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-16 *U*-factor. IECC section 402.3.1 is amended to read as follows:

"**402.3.1 *U*-factor.** An area-weighted average of fenestration products shall be permitted to satisfy the *U*-factor and SHGC requirements." [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-17 Glazed fenestration exemption. IECC section 402.3.3 is amended to read as follows:

"**402.3.3 Glazed fenestration exemption.** Up to 15 square feet (1.4 m^2) of glazed fenestration per dwelling unit shall be permitted to be exempt from *U*-factor and SHGC requirements in Section 402.1.1. This exemption shall not apply to the *U*-factor alternative approach in Section 402.1.3 and the Total UA alternative in Section 402.1.4. North-facing windows and windows with a projection factor of 1.0 or more shall be permitted to be exempt from SHGC requirements in Section 402.1.1." [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

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§3-181-18 Unconditioned building exemption. Section 402.4.1.1 is added to the IECC to read as follows:

"402.4.1.1 Unconditioned building exemption. Unconditioned residential buildings are exempt from compliance with Section 402.4. The free-vent fenestration area of unconditioned buildings shall be no less than 14 per cent of the floor area. All interior doors shall be capable of being secured in the open position and ceiling fan stub-ins shall be provided to living areas and bedrooms." [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-19 Fenestration air leakage. IECC section 402.4.4 is amended to read as follows:

"402.4.4 Fenestration air leakage. Windows, skylights and sliding glass doors shall have an air infiltration rate of no more than 0.3 cfm per square foot (1.5 L/s/m^2), and swinging doors no more than 0.5 cfm per square foot (2.6 L/s/m^2), when tested according to NFRC 400 or AAMA/WDMA/CSA 101/I.S.2/A440 by an accredited, independent laboratory and listed and labeled by the manufacturer.

Exceptions:

1. Site-built windows, skylights and doors.
2. Jalousie windows shall not exceed 1.2 cfm per square foot (6.1 L/s/m^2)." [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-20 Residential pools. IECC section 403.9 is amended to read as follows:

"403.9 Residential pools. Residential pools shall be provided with energy-conserving measures in accordance with Sections 403.9.1 through 403.9.3.

403.9.1 Pool heaters. All pool heaters shall be equipped with a readily accessible on-off switch to allow shutting off the heater without adjusting the thermostat setting. [~~Pool heaters fired by natural gas~~] Gas-fired pool heaters shall not have continuously burning pilot lights.

403.9.2 Time switches. Time switches that can automatically turn off and on heaters and pumps according to a preset schedule shall be installed on swimming pool heaters and pumps.

Exceptions:

1. Where public health standards require 24-hour pump operation.

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2. Where pumps are required to operate solar- and waste-heat-recovery pool heating systems.

403.9.3 Pool covers. Heated pools shall be equipped with a vapor retardant pool cover on or at the water surface. Pools heated to more than 90°F (32°C) shall have a pool cover with a minimum insulation value of R-12.

Exception: Pools deriving over 60 percent of the energy for heating from site-recovered energy or solar energy source." [Eff] (Auth: HRS §107-29)(Imp: HRS §§107-24, 107-25)

§3-181-21 Roof assembly. IECC section 502.2.1 is amended to read as follows:

"**502.2.1 Roof assembly.** The minimum thermal resistance (*R*-value) of the insulating material installed either between the roof framing or continuously on the roof assembly shall be as specified in Table 502.2(1), based on construction materials used in the roof assembly.

Exception: Buildings located at elevations below 2,400 feet (731.5 m) do not need to comply where one of the following apply:

1. Continuously insulated roof assemblies where the thickness of insulation varies 1 inch (25 mm) or less and where the area-weighted *U*-factor is equivalent to the same assembly with the *R*-value specified in Table 502.2(1).
2. Roofs in compliance with the Cool Roof Rating Council, Product Rating Program Manual, meeting initial reflectance values of 0.70 and extended reflectance values of 0.55.

Insulation installed on a suspended ceiling with removable ceiling tiles shall not be considered part of the minimum thermal resistance of the roof insulation." [Eff] (Auth: HRS §107-29)(Imp: HRS §§107-24, 107-25)

§3-181-22 Area-weighted average - commercial. Section 502.3.3 is added to the IECC to read as follows:

"**502.3.3 Area-weighted average - commercial.** In commercial buildings, an area-weighted average of fenestration products shall be permitted to satisfy SHGC requirements." [Eff] (Auth: HRS §107-29)(Imp: HRS §§107-24, 107-25)

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§3-181-23 Wall insulation reduction. Section 502.2.3.1 is added to the IECC to read as follows:

"**502.2.3.1 Wall insulation reduction.** A reduction of R-5 for interior walls or R-4 for exterior walls shall be permitted in buildings that meet the following criteria:

1. The building is located at an elevation below 2,400-foot (731.5 m) above sea level,
2. The building is located in climate zone 1, and
3. The building has a wall projection factor, in accordance with Equation 4-1, of not less than 0.30 for all walls that face more than 22.5 degrees from true north." [Eff] (Auth: HRS §107-29)(Imp: HRS §§107-24, 107-25)

§3-181-24 Mechanical systems commissioning and completion requirements. IECC sections 503.2.9 to 503.2.9.3 are retitled and amended to read as follows:

"**503.2.9 Mechanical systems commissioning and completion requirements.** Prior to the issuance of a certificate of occupancy, the design professional shall provide a written statement of system completion in accordance with Sections 503.2.9.1 through 503.2.9.3.

503.2.9.1 System commissioning. Commissioning is a process that verifies and documents that the selected building systems have been designed, installed, and function according to the owner's project requirements and construction documents. Drawing notes shall require commissioning and completion requirements in accordance with this section. Drawing notes may refer to specifications for further requirements. Copies of all documentation shall be given to the owner.

503.2.9.2 Commissioning plan. A commissioning plan shall include as a minimum the following items:

1. A detailed explanation of the original owner's project requirements,
2. A narrative describing the activities that will be accomplished during each phase of commissioning, including guidance on who accomplishes the activities and how they are completed,
3. Equipment and systems to be tested, including the extent of tests,
4. Functions to be tested (for example calibration, economizer control, etc.),
5. Conditions under which the test shall be performed

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(for example winter and summer design conditions, full outside air, etc.), and

6. Measurable criteria for acceptable performance.

503.2.9.3 Systems adjusting and balancing. All HVAC systems shall be balanced in accordance with generally accepted engineering standards. Air and water flow rates shall be measured and adjusted to deliver final flow rates within 10 per cent of design rates. Test and balance activities shall include as a minimum the following items:

1. Air systems balancing: Each supply air outlet and zone terminal device shall be equipped with means for air balancing in accordance with the requirements of Chapter 6 of the International Mechanical Code. Discharge dampers are prohibited on constant volume fans and variable volume fans with motors 10 hp (18.6 kW) and larger. Air systems shall be balanced in a manner to first minimize throttling losses then, for fans with system power of greater than 1 hp, fan speed shall be adjusted to meet design flow conditions.
   Exception: Fan with fan motors of 1 hp or less.
2. Hydronic systems balancing: Individual hydronic heating and cooling coils shall be equipped with means for balancing and pressure test connections. Hydronic systems shall be proportionately balanced in a manner to first minimize throttling losses, then the pump impeller shall be trimmed or pump speed shall be adjusted to meet design flow conditions. Each hydronic system shall have either the ability to measure pressure across the pump, or test ports at each side of each pump.
   Exceptions:
   1. Pumps with pump motors of 5 hp or less.
   2. When throttling results in no greater than 5% of the nameplate horsepower draw above that required if the impeller were trimmed." [Eff]

(Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-25 Sleeping unit controls. IECC section 505.2.3 is amended to read as follows:

"505.2.3 Sleeping unit controls. [~~Sleeping units in hotels, motels, boarding houses or similar buildings shall have at least one master switch at the main entry door that controls all permanently wired luminaires and switched receptacles, except those in the bathroom(s). Suites shall~~

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~~have a control meeting these requirements at the entry to each room or at the primary entry to the suite.~~] Sleeping units in Group R-1 occupancies shall be equipped with a method of adjusting thermostat set points and turning off all permanently installed light fixtures and all outlets powering portable light fixtures and entertainment devices when the unit is unoccupied.

Exception: Bathroom night lights, not exceeding three watts.

Each sleeping unit in Group R-1 occupancies shall be equipped with one or more of the following devices or systems:

1. A master switch at the main entry door activated by a room card that must be inserted upon entry,
2. A sensor capable of detecting when the room is occupied, or
3. An electronic control system capable of detecting when the room is occupied.

Operable doors leading from a conditioned space to a balcony or patio in sleeping units of Group R-1 occupancies shall be provided with interlock controls to disable heating and cooling of the space while the door is open." [Eff] (Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

§3-181-26 Electrical energy consumption. (Mandatory). IECC section 505.7 is amended to read as follows:

"505.7 Electrical energy consumption. (Mandatory). [~~In buildings having individual dwelling units, provisions shall be made to determine the electrical energy consumed by each tenant by separately metering individual dwelling units.~~] In new buildings with tenants, metering shall be collected for the entire building and individually for each tenant occupying 1,000 square feet (93 m^2) or more. Tenants shall have access to all data collected for their space. A tenant is defined as "one who rents or leases from a landlord." [Eff] (Auth: HRS §107-29)(Imp: HRS §§107-24, 107-25)

§3-181-27 Referenced standards. The following standard is added to IECC chapter 6 - Referenced Standards to read as follows:

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"ASTM E 408-2008, Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection Meter Techniques..... [~~402.1.1.6, 402.1.1.7, 402.1.1.8.1~~] 402.1.6.6, 402.1.6.7, 402.1.6.8.1" [Eff]
(Auth: HRS §107-29) (Imp: HRS §§107-24, 107-25)

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DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES

Chapter 3-181, Hawaii Administrative Rules, on the Summary Page dated _____, was adopted on _____, following a public hearing held on _____, after public notice was given in the Honolulu Star-Advertiser on _____.

The adoption of chapter 3-181 shall take effect ten days after filing with the Office of the Lieutenant Governor.

_____
BRUCE COPPA
State Comptroller and
Chairperson, State Building Code Council

APPROVED:

_____
NEIL ABERCROMBIE
GOVERNOR
STATE OF HAWAII

Dated: _____

APPROVED AS TO FORM:

_____
Deputy Attorney General

_____
Filed

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APPENDIX 2.14

Mailing List

(Attached as separate excel file)

APPENDIX 2.15

DAGS Building Statewide ESPC Final

DEPARTMENT OF ACCOUNTING AND GENERAL SERVICES BUILDINGS - STATEWIDE ENERGY SERVICE PERFORMANCE CONTRACT (ESPC) PROPOSAL REVIEW

D.A.G.S. Job No. 56-10-0652

FINAL SUBMITTAL

January 2012

INSYNERGY ENGINEERING INC

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

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ATTACHMENT M1 - Mechanical Field Survey

1 - Field Survey Comparison

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1.0 FIELD SURVEY COMPARISON

InSynergy Engineering (ISE) conducted limited field surveys at DAGS facilities to confirm the findings and recommended scope of work developed by the three proposers: Ameresco, Johnson Control, and Noresco. Field surveys were conducted from July 11-18, 2011 on the islands of Oahu, Hawaii, Kauai, and Maui. A majority of the mechanical and electrical systems were evaluated and compared with the proposer's evaluations. Based on the proposals, it appears that Ameresco has a completed a more comprehensive review of the facilities and has covered a larger set of energy conservation measures. Johnson Controls, however, has a more detailed list of the existing mechanical systems and equipment.

Based on our field survey, we agree equally among the three proposers with their recommended mechanical system upgrades and overall condition assessment of the equipment. However, Ameresco and Johnson Controls are more ambitious about upgrades to the mechanical systems. If we take into consideration the time frame of a 20 year contract, these recommended upgrades would be necessary although the condition of the equipment may currently be satisfactory. Both Ameresco and Noresco appear to have similar programs for lighting retrofits and in general we agree with the recommended scopes of work for these electrical ECM's. Both of these proposals include more extensive electrical upgrades than Johnson Controls. Ameresco and Johnson Controls have a larger scope for HVAC replacement and in general we agree with the recommended scopes of work. The findings of our surveys are summarized in attachment M1 for the DAGS facilities.

2.0 PROPOSAL COMPARISON

ISE reviewed and summarized the proposals that were developed by three proposers. Ameresco organized their proposal by ECM's while Noresco organized the ECM's by island. Johnson Controls organized their proposal by facility and listed the ECM's for each building separately. The findings of our proposal comparison are summarized in attachment P1 for DAGS facilities on Oahu, Hawaii, Kauai, Maui, and Molokai. Results of our proposal comparison detailed in this attachment are summarized as follows:

2.1 Baseline Utility Usage And Cost

The comparison of the baseline energy usage and total utility costs of the three prospers are as follows: The Johnson Controls has higher assumed electricity rates for Oahu while Noresco and Ameresco were similar. Noresco and Johnson Controls have similar rates for Maui and Hawaii while rates for Molokai and Kauai varied among the three candidates. All three proposers have similar reported baseline electricity usage for all islands except for Oahu. Johnson Controls reports a one year baseline electricity usage for Oahu of 4,248,172 kWh annually while Amereso reports a high of 10,868,688 kWh annually. Baseline electricity cost data show Ameresco and Noresco to have a similar total annual cost. Johnson Controls did not make a distinction between baseline electricity and water expense and reported only a combined utility expense. Baseline water usage is similar among the three candidates for Maui, Molokai, and Kauai. Noresco and Amereso report the same usage for Oahu while Johnson Controls reports a lower number. The reported water figures for the island of Hawaii varied significantly for the three proposers.

			Noresco	**Ameresco**	**Johnson Controls**
Baseline Energy Use	Electricity (kwh/year)	Oahu	8,289,638	10,868,688	4,248,172
	Electricity (kwh/year)	Maui	974,693	975,719	975,719
	Electricity (kwh/year)	Molokai	364,260	364,260	364,260
	Electricity (kwh/year)	Hawaii	1,276,938	1,125,011	1,128,221
	Electricity (kwh/year)	Kauai	983,222	1,047,745	984,232
	Electricity (kwh/year)	**Total**	**11,888,751**	**14,316,900**	**7,700,604**
	Water (kgal/year)	Oahu	15,244	15,244	9,608
	Water (kgal/year)	Maui	4,511	5,104	4,511
	Water (kgal/year)	Molokai	881	898	881
	Water (kgal/year)	Hawaii	858	n/a	5,071
	Water (kgal/year)	Kauai	673	673	673
	Water (kgal/year)	**Total**	**22,167**	**21,919**	**20,744**
	Utility ($) = elec + water	**Total**	**3,782,616**	**3,901,815**	**2,336,111**

2.2 Energy Conservation Measures Cost

			Noresco	Ameresco	Johnson Controls
ECM Cost ($)	Lighting	All Islands	1,734,791	1,445,486	588,489
	Energy Management	All Islands	2,758,625	4,275,514	3,567,516
	HVAC (air side)	All Islands	539,838	1,236,002	5,174,684
	HVAC (water side)	All Islands	1,714,934	3,297,418	2,738,431
	Data Center Reconfiguration	All Islands	2,113,778	3,095,925	0
	Water	All Islands	0	178,519	75,700
	Envelope	All Islands	2,905	3,757,477	0
	Renewable Energy	All Islands	0	6,634,067	11,250,618
	Information Technology	All Islands	72,253	91,309	0
	Other	All Islands	342,509	822,406	234,964
	IGA	All Islands	0	0	99,170
	Total ECM Cost	**Total**	**9,279,633**	**24,834,123**	**23,729,572**
	Rebates/Tax Credit	Total	172,617	212,903	0
	Net Construction Cost	**Total**	**9,107,016**	**24,621,220**	**23,729,572**

The comparison breakdown of the major ECM costs for each of the three proposers is as follows:

Ameresco proposes to spend the most on energy cost measures at $24,621,220 with Johnson Controls following closely at $23,729,572. Noresco proposes to spend less than half of what the other two proposed at $9,107,016. Johnson Controls proposes to spend more on renewable energy at $11,250,618 than all of Noresco's proposed ECM's. Johnson Controls also proposes significant spending in HVAC replacement but much less on lighting. However, they are not proposing any improvements in the data center reconfiguration, information technology, and the envelope categories. Ameresco also shows a significant portion of their ECM costs going to renewable energy at $6,634,067. This amounts to a little more than half of what Johnson Control proposes. They are also proposing higher spending on energy management, data center reconfiguration, and envelope modifications than the others. Noresco's ECM's are spread evenly among most of the categories. However, they are not proposing any spending in the water and renewable energy categories. Photovoltaics will be owned by Noresco under its PPA plan. It should be noted that the proposed ECM costs for Ameresco and Johnson Controls include construction and soft costs while Noresco's total only

represents construction costs. If soft cost factors like design fees, commissioning, and interest are included, Noresco's total ECM cost would increase to $11,091,758.

2.3 Energy Conservation Measures Savings

The comparison breakdown of the major ECM savings for each of the three proposers is summarized as follows:

ECM Savings ($/year)			Noresco	Ameresco	Johnson Controls
	Lighting	All Islands	205,418	164,333	216,896
	Energy Management	All Islands	256,838	177,104	188,629
	HVAC (air side)	All Islands	68,261	65,403	426,486
	HVAC (water side)	All Islands	77,023	103,020	280,767
	Data Center Reconfiguration	All Islands	249,722	363,162	0
	Water	All Islands	0	8,596	6,113
	Envelope	All Islands	949	2,374	0
	Renewable Energy	All Islands	198,879	462,143	654,808
	Information Technology	All Islands	36,261	62,132	0
	Other	All Islands	151,884	99,575	63,114
	Total ECM Savings	**Total**	**1,245,235**	**1,507,842**	**1,836,813**

The data shows Johnson Controls with the greater annual ECM savings at $1,836,813 with Ameresco second at $1,507,842, and Noresco third with $1,245,235. It should be noted that Johnson Controls also reported a significantly lower baseline energy usage than the others, a fact that may help boost its overall savings. Most of Johnson Controls savings show to be coming from renewable energy and HVAC improvement, those very ECM's they propose to invest in. They also show the highest savings in the lighting category although they proposed to spend significantly less than the other proposers. Ameresco's ECM annual savings data show most of the savings coming from renewable energy and data center re-configuration, those very ECM's they propose to invest in. However, their investment in HVAC improvement does not show any significant savings return. Unlike the other proposers, there is no dominant ECM annual savings category for Noresco. The annual savings are balanced among lighting, energy management, HVAC, data center reconfiguration, and renewable energy categories. The data shows Noresco's savings in the energy management to be greater than the other proposers.

2.4 Cash Flow Comparison

The Cash Flow Comparison presented below summarizes the overall financial costs and 20 year cash flows for the three proposers:

		Noresco*	Ameresco**		Johnson Controls***
			Base Project	Alternate Project	
Total Project Costs	Total Construction Costs	9,279,633	21,784,320	19,620,458	19,651,060
	Subtotal Soft Costs	1,812,125	3,049,804	2,746,864	4,078,510
	Total Project Costs	**11,091,758**	**24,834,124**	**22,367,322**	**23,729,570**
Annual Fees	First Year Annual Fees	689,732	49,734	47,615	318,912
Cash Flow Summary	Financed Project Cost	11,091,758	27,356,914	23,320,441	24,948,182
	Total Utility Cost Savings	32,300,219	45,058,176	40,270,094	59,521,946
	Guaranteed Cost Savings	**32,300,219**	**44,917,800**	**40,111,349**	**59,521,946**
	Total Annual Fees	13,913,610	1,164,492	1,114,878	9,496,587
	Total Financing Payments	13,580,596	43,753,307	38,996,471	36,056,932
	Power Purchase Payments	3,891,106			
	Total Net Savings	**914,907**	**140,377**	**158,745**	**13,968,427**
	* Noresco PV: 600 KW, PPA				
	** Ameresco 908 KW (base), PV:1,629 KW, PPA project financed (alternate), includes additional $4.2M in capital projects				
	*** Johnson Controls PV: 660 KW buildings + 600 KW parking canopy, project financed				

The analysis assumes a 20 year finance term at 5% interest and 4% utility escalation rate for all proposers. This section is broken down into three sections comprised of projects costs, annual fees, and summary. Ameresco has included a second option for financing additional renewable energy, primarily PV, as an alternate third party financed PPA project. Noresco's proposal also involves a PPA and the payments involved under this agreement are reflected in the total net savings. The total project costs include the cost for construction and soft costs. Ameresco and Johnson Controls report similar values and are double what Noresco proposes. The proposed annual fee section list various subcategories of charges such as measurement and verification (M&V) and maintenance agreements. Noresco proposes significantly higher annual fees at $689,732 due to maintenance agreements and functions. Johnson Control's first year annual fees of $318,912 consist mainly of monitoring and verification while Ameresco doesn't report

any maintenance data. Subsequently, they have the lowest annual fee at $47,615. The breakdown of the Preliminary Cash Flow Analysis is as follows:

Johnson Controls has structured their proposal such that their net savings after the 20 year period is $13,968,427. This amount is the remainder after all of the guaranteed savings has been used to finance the construction costs and annual fees. Noresco reports a net savings of $914,907 with Ameresco reporting $140,377 for its base project at the end of the 20 year period. Direct comparison of the cash flow projections indicates that the Johnson Controls proposal will provide more capital back to the state over the life of the contract at the expense of higher initial investment. The investment proposed under Ameresco's plan is similar to Johnson Controls but with a significantly lower savings. Noresco's plan proposes a significantly lower investment than the others with a guaranteed cost savings that is comparable to Ameresco's proposal.

Attachment M1

Mechanical Field Survey

1 - FIELD SURVEY COMPARISON

		Operating Condition			
		Noresco	Ameresco	Johnson Controls	Insynergy
Oahu	**Equipment**				
CSD Baseyard	Air Cooled Condensing Unit, 7.5 tons	no	no	yes	
	Chilled Water Pump, 83 gpm	no	yes	yes	
	Air Cooled Chiller, 35 ton	no	yes	yes	
	Air Cooled Condensing Unit, 3 ton	no	no	yes	
	Fan Coil Unit, 3 ton	no	no	yes-service	
	3 Window AC units	no	yes	yes	
Hale Auhau	55 Fan Coils	no	no	yes-service	
	2 Air Cooled Condensing Units	no	no	no	
Kakuhihewa	2 Screw Chillers, 200 ton	no	yes	yes	
	Reciprocal Chiller, 48 ton	no	yes	yes	
	Cooling Tower, 400 ton	yes	no	no	
	2 Air Cooled Condensing Units, 3 ton	no	no	no	
	43 Fan Coil Units	no	no	no	
	8 Air Handling Units, 24,000 cfm	no	no	yes-service	
Kalanimoku					
Kamehameha V	Air Packaged Unit, 25 ton	no	no	no	no
	Air Hadling Unit, 4000 cfm	no	no	no	no
	ACU-2, 5 ton	no	no	yes	no
	ACU-4, 0.7 ton	no	yes	yes	yes
	ACU-3, 2 ton	no	yes	yes	yes
Kaneohe Civic Center	2 Air Cooled Condensing Units, 2 ton	no	no	no	
	2 Fan Coil Units, 2 tons	no	no	no	
OR&L	Packaged Air Cooled Chiller, 50 ton	no	yes	yes	
	4 Air Handling Units, 4500 cfm	no	no	no	
	VAV terminal units	no	no	yes	
	Chilled Water Pump, 124 gpm	no	no	yes-service	
Wahiawa Civic Center	4 Window AC	no	yes	yes	
	4 Window AC	no	yes	no	
	5 Fan Coil Units	no	no	no	
	2 Air Cooled Condensing Units, 3 ton	no	no	no	
Waipahu Civic Center	15 Air Handling Units	no	no	no	
	3 Water Cooled Chiller units, 70 ton	no	yes-only 2	yes	
	2 Cooling Towers, 70 ton	no	yes-only 1	yes	
	2 Chilled Water pumps, 175 gpm	no	yes	yes-service	
	2 Condeser Water pumps, 210 gpm	no	yes	yes-service	
Hawaii					
Hilo State Office Building	2 Water Cooled Chillers, 140 ton	no	yes	no	no
	2 Cooling Towers, 7.5 HP, 140 ton	no	no	no	no
	4 Air Handling Units, 8000-14,000 cfm	no	no	no	no
Honokaa State Office Buildings 1	Window AC, 0.75 ton	no	no	no	no
Honokaa State Office Buildings 2					
Keakealani State Office Building	Packaged Air Cooled Chiller, 50 ton	yes	yes	yes	yes
	Chilled Water Pump, 5 HP	yes	yes	yes	yes
	2 AHU, 3 ton	no	no	no	no
	Window AC, 1 ton	no	yes	no	no
Kona Civic Center	Window AC	no	yes	no	no
Kulana Naauao	ACU-1, 14 ton	no	yes	yes	yes
	ACU-2, 4 ton	no	yes	no	no
	ACU-3, 1.5 ton	no	yes	no	no
	ACU-4, 1.5 ton	no	no	no	no
Naalehu State Office Building	7 Window AC units	no	yes	yes-service	yes
North Kohala Civic Center Building	2 Window AC, 0.75 ton	no	no	no	no
Waimea State Office Building	3 Window AC, 0.75 ton	no	no	no	no
Kauai					
Kaui DAGS Admin Building	PAC-1	no	no	yes	no
	Window AC, 1 ton	no	no	yes	no
	12 Condenser Unit, 2 tons	no	no	no	no
Kaui DAGS Maintenance	Window AC unit	no	yes	no	no
Lihue Health Center	2 Packaged Units, 14 tons	no	no	yes	no
	1 Packaged Unit 2, 16 tons	no	no	no	no
Lihue Health Center Annex	Packed Unit, 16 tons	no	no	no	no
Lihue State Office Building*	2 Air Cooled Chiller, 60 tons	no*	yes	yes	?
*noresco plans hvac construction, missing page	Air Cooled Chiller (conf rm) 3 ton	yes-eliminate	no	no	?
	2 Chilled Water Pumps, 20 HP	yes	no	yes	?
Plant Industry Building	Condensing Unit, 16 ton	no	no	yes	no
	Air Handling Unit, 16 ton	no	no	yes	no
Vector Control Building	Condensing Unit, 7.5 ton	no	no	no	no
	Air Handling Unit, 7.5ton	no	no	no	no
Maui					
DAGS Baseyard & Office	2 Packaged Units	no	no	no	no
	2 Condenser Units, 7.5 tons	no	no	no	no
	2 Air Handling Units, 3500 cfm	no	no	no	no
	7 Room AC units, 4-6k btuh	no	yes	yes-service	yes
Dept. of Agriculture Baseyard	Condensing Unit, 25 ton	no	yes	yes	yes
	Air Handling Unit, 25 ton	no	yes	yes	yes
	3 Window AC	no	yes	yes	yes
Dept. of Health Vector Control Building	4 Window AC	no	yes	no	no
Lahaina Comprehensive Health	Condensing Unit, 4.5 ton	no	no	no	no
	Air Handling Unit, 1800 cfm	no	no	no	no
	Window AC, 1 ton	no	yes	no	no
Wailuku Health Center*	Packaged Unit, 4 ton split	no	no	yes	yes
*under DAGS renovation	Air Handling Unit, 4 ton	no	no	yes	yes
	Window AC, 2 ton	no	yes	yes	yes
Wailuku State Office 1	2 Water Cooled Chiller, 75 tons	yes	yes	yes	yes
	2 Cooling Towers, 75 tons	yes	yes	yes	yes
	2 CHP, 160 gpm	yes	yes	yes	yes
	2 CHWP, 200 gpm	yes	yes	yes	yes
	15 Air Handling Units	no	no	no	no
Wailuku State Office 2	5 Condensing Units, R-22	no	no	yes	yes
	5 Air Handling Units	no	no	yes	yes
	3 Exhaust Fans	no	yes	yes-service	yes
Molokai					
Kaunakakai Civic Center	Condensing Unit, 45 ton	no	yes	yes	n/a
	Air Handling Unit	no	yes	yes	n/a
	17 VAV terminal units	no	no	yes	n/a

Attachment P1

Proposal Comparison Analysis

1 - BASELINE AND PROJECTED UTILITY SAVINGS COMPARISON

			Noresco	Ameresco	Johnson Controls
Assumed Utility Costs					
	Electricity ($/kwh)	Oahu	0.247	0.25	0.362
	Electricity ($/kwh)	Maui	0.3889	0.304	0.3832
	Electricity ($/kwh)	Molokai	0.3889	0.304	0.3241
	Electricity ($/kwh)	Hawaii	0.3577	0.386	0.3551
	Electricity ($/kwh)	Kauai	.4216/.3874	0.372	0.2689
	Electricity	Escalation	4%		
	Water/Sewer ($/kgal)	Oahu	3.13/9.96	3.13/9.96	
	Water/Sewer ($/kgal)	Maui	4.25/5.40	/5.40	
	Water/Sewer ($/kgal)	Molokai	4.75/5.40		
	Water/Sewer ($/kgal)	Hawaii	3.60/5.00	/4.05	
	Water/Sewer ($/kgal)	Kauai	0/4.25	3.20/4.51	
Baseline Energy Use	Electricity (kw; kwh/year)	Oahu	14,736; 8,289,638	29,044; 10,868,688	n/a ; 4,248,172
	Electricity (kw; kwh/year)	Maui	4,936; 974,693	5,005; 975,719	n/a ; 975,719
	Electricity (kw; kwh/year)	Molokai	1,929; 364,260	1,929; 364,260	n/a ; 364,260
	Electricity (kw; kwh/year)	Hawaii	n/a; 1,276,938	n/a; 1,125,011	n/a; 1,128,221
	Electricity (kw; kwh/year)	Kauai	4,688; 983,222	4,686; 1,047,745	n/a ; 984,232
	Electricity (kw; kwh/year)	**Total**	**26,289; 11,888,751**	**41,122; 14,316,900**	**n/a; 7,700,604**
	Water (kgal/year)	Oahu	15,244	15,244	9,608
	Water (kgal/year)	Maui	4,511	5,104	4,511
	Water (kgal/year)	Molokai	881	898	881
	Water (kgal/year)	Hawaii	858	n/a	5,071
	Water (kgal/year)	Kauai	673	673	673
	Water (kgal/year)	**Total**	**22,167**	**21,919**	**20,744**
Baseline Energy Cost	Electricity ($/year)	Oahu	2,138,997	2,503,755	n/a
	Electricity ($/year)	Maui	338,602	299,869	n/a
	Electricity ($/year)	Molokai	129,243	128,187	n/a
	Electricity ($/year)	Hawaii	462,747	362,680	n/a
	Electricity ($/year)	Kauai	436,324	357,852	n/a
	Electricity ($)	**Total**	**3,505,914**	**3,675,596**	**n/a**
	Water/ Sewer ($/year)	Oahu	214,222	158,269	n/a
	Water/ Sewer ($/year)	Maui	43,297	44,907	n/a
	Water/ Sewer ($/year)	Molokai	8,942	9,085	n/a
	Water/ Sewer ($/year)	Hawaii	7,379	n/a	n/a
	Water/ Sewer ($/year)	Kauai	2,862	13,958	n/a
	Water/ Sewer ($)	Total	276,702	226,219	n/a
	Utility ($) = elec + water	**Total**	**3,782,616**	**3,901,815**	**2,336,111**
ECM Energy Savings	Electricity (kwh/year)	Oahu	n/a	n/a	2,143,839
	Electricity (kwh/year)	Maui	n/a	n/a	524,222
	Electricity (kwh/year)	Molokai	n/a	n/a	188,678
	Electricity (kwh/year)	Hawaii	n/a	n/a	776,279
	Electricity (kwh/year)	Kauai	n/a	n/a	404,055
	Electricity (kwh/year)	**Total**	**n/a**	**n/a**	**4,037,073**
	Water/Sewer (kgal/year)	Oahu	n/a	n/a	0
	Water/Sewer (kgal/year)	Maui	n/a	n/a	45
	Water/Sewer (kgal/year)	Molokai	n/a	n/a	33
	Water/Sewer (kgal/year)	Hawaii	n/a	n/a	33
	Water/Sewer (kgal/year)	Kauai	n/a	n/a	1
	Water/Sewer (kgal/year)	**Total**	**n/a**	**n/a**	**112**
ECM Cost	$ - net construction cost	Oahu	4,363,568	9,165,481	14,361,420
	$ - net construction cost	Maui	1,136,816	3,958,084	2,500,414
	$ - net construction cost	Molokai	711,913	2,501,575	910,152
	$ - net construction cost	Hawaii	1,691,883	4,245,301	3,362,125
	$ - net construction cost	Kauai	1,034,253	4,750,782	2,134,333
	$ - net construction cost	**Total**	**8,938,433**	**24,621,223**	**23,268,444**
ECM Savings	Electricity ($/year)	Oahu	502,773	666,491	1,099,138
	Electricity ($/year)	Maui	69,277	213,085	200,378
	Electricity ($/year)	Molokai	64,098	84,785	61,157
	Electricity ($/year)	Hawaii	269,749	280,009	290,078
	Electricity ($/year)	Kauai	207,262	238,423	179,949
	Electricity ($/year)	**Total**	**1,192,462**	**1,482,793**	**1,830,700**
	Water ($/year)	Oahu	43,211	3,431	0
	Water ($/year)	Maui	9,598	2,041	172
	Water ($/year)	Molokai	0	1,483	127
	Water ($/year)	Hawaii	0	3,969	5,511
	Water ($/year)	Kauai	0	0	303
	Water ($/year)	**Total**	**52,809**	**10,924**	**6,113**
	Utility($)=elec+water	**Total**	**1,245,271**	**1,493,717**	**1,836,813**

Notes:
1. Rates based on General Schedule
2. Ameresco Electricity Demand and Costs does not include several facilities

2 - ECM COMPARISON

			Noresco*	Ameresco**	Johnson Controls***
ECM Savings ($/year)					
	Lighting	All Islands	205,418	164,333	216,896
	Energy Management	All Islands	256,838	177,104	188,629
	HVAC (air side)	All Islands	68,261	65,403	426,486
	HVAC (water side)	All Islands	77,023	103,020	280,767
	Data Center Refiguration	All Islands	249,722	363,162	
	Water	All Islands	0	8,596	6,113
	Envelope	All Islands	949	2,374	0
	Renewable Energy	All Islands	198,879	462,143	654,808
	Information Technology	All Islands	36,261	62,132	
	Utility Systems	All Islands	72,617		
	Energy Conservation thru Behavior Change	All Islands	79,267		
	Maintenance	All Islands			
	Energy Efficient Transformers	All Islands		66,931	
	Exhaust Fans	All Islands		2,612	
	Refrigerators	All Islands		4,916	
	Ice Machines	All Islands		5,112	
	Heat Pump Water Heaters	All Islands		4,730	
	Premium Efficiency Motors	All Islands		8,402	
	Vending Machines	All Islands		6,872	
	Other	All Islands			63,114
	IGA	All Islands			0
	Total ECM Savings	**Total**	**1,245,235**	**1,507,842**	**1,836,813**
ECM Cost ($)	Lighting	All Islands	1,734,791	1,445,486	588,489
	Energy Management	All Islands	2,758,625	4,275,514	3,567,516
	HVAC (air side)	All Islands	539,838	1,236,002	5,174,684
	HVAC (water side)	All Islands	1,714,934	3,297,418	2,738,431
	Data Center Refiguration	All Islands	2,113,778	3,095,925	
	Water	All Islands	0	178,519	75,700
	Envelope	All Islands	2,905	3,757,477	0
	Renewable Energy	All Islands	0	6,634,067	11,250,618
	Information Technology	All Islands	72,253	91,309	
	Utility Systems	All Islands	173,925		
	Energy Conservation thru Behavior Change	All Islands	168,584		
	Maintenance	All Islands			1,579
	Energy Efficient Transformers	All Islands		532,817	
	Exhaust Fans	All Islands		52,022	
	Refrigerators	All Islands		35,902	
	Ice Machines	All Islands		28,899	
	Heat Pump Water Heaters	All Islands		52,126	
	Premium Efficiency Motors	All Islands		114,266	
	Vending Machines	All Islands		6,374	
	Other	All Islands			233,385
	IGA	All Islands			99,170
	Total ECM Cost	**Total**	**9,279,633**	**24,834,123**	**23,729,572**
	Rebates/Tax Credit	Total	172,617	212,903	0
	Net Construction Cost	**Total**	**9,107,016**	**24,621,220**	**23,729,572**

* Noresco PV: 600 KW, PPA
** Ameresco PV: 908 KW (base project) ; 1629 KW PPA project financed (alternate project) with additional $4.2 M in capital projects
*** JC PV: 660 KW buildings + 600 KW parking canopy, project financed

3 - CASH FLOW COMPARISON

			Noresco*	Ameresco**		Johnson Controls***
				Base Project	Alternate Project	
			* Noresco PV: 600 KW, PPA	908 KW (base project)	** Ameresco PV:1,629 KW PPA project financed (alternate project), includes additional $4.2M in capital projects	*** JC PV: 660 KW buildings + 600 KW parking canopy, project financed
Total Project Costs						
	Total Construction Costs	All Islands	9,279,633	21,784,320	19,620,458	19,651,060
	Investment Grade Audit	All Islands	207,822	130,706	130,706	99,170
	Design Fees	All Islands	103,210	1,089,216	981,023	1,375,574
	Construction Management	All Islands	723,950	1,307,059	1,177,227	1,179,064
	System Commissioning	All Islands	46,011	217,843	183,221	245,638
	Maintenance Functions/First Responder/Reporting	All Islands	346,211			
	Energy Conservatio thru Behavior Change	All Islands	115,028			
	Training	All Islands	23,892	87,137	78,482	
	Contingency	All Islands	185,402			1,179,064
	Interest	All Islands	60,599	217,843	196,205	
	Subtotal Soft Costs	All Islands	1,812,125	3,049,804	2,746,864	4,078,510
	Total Project Costs	**Total**	**11,091,758**	**24,834,124**	**22,367,322**	**23,729,570**
Proposed Annual Fees						
	Measurement and Verification	All Islands	49,711	33,156	31,037	183,681
	Energy Star	All Islands	38,160	7,368	7,368	
	Maintenance Agreements	All Islands	117,941			52,961
	Maintenance Functions/First Responder/Reporting	All Islands	352,767			
	Energy Conservation thru Behavior Change	All Islands	68,900			
	Verification Reports	All Islands	62,253			11,327
	Performance Monitoring					31,269
	On-going Training Services			9,210	9,210	39,674
	First Year Annual Fees	**All Islands**	**689,732**	**49,734**	**47,615**	**318,912**
Cash Flow Summary						
	Financed Project Cost	Total	11,091,758	27,356,914	23,320,441	24,948,182
	Finance Term		20	20	20	20
	Interest Rate		5	5	5	5
	Utility Escalation Rate		4	4	4	4
	Operational Cost Savings Escalation Rate		3	3	3	
	Escalation rate for annual fees		3	3	3	4
	Total Utility Cost Savings		**32,300,219**	**45,058,176**	**40,270,094**	**59,521,946**
	Total Guaranteed Cost Savings		**32,300,219**	**44,917,800**	**40,111,349**	**59,521,946**
	Total Annual Fees		**13,913,610**	**1,164,492**	**1,114,878**	**9,496,587**
	Total Financing Payments		**13,580,596**	**43,753,307**	**38,996,471**	**36,056,932**
	Total Power Purchase Payments		**3,891,106**	**0**	**0**	**0**
	Total Net Savings		**914,907**	**140,377**	**158,745**	**13,968,427**
	Double Check Net Savings		***914,907***	***140,377***	***158,745***	***13,968,427***

APPENDIX 2.16

Technical Review Comments for DAGS Phase 2 IGA

TECHNICAL REVIEW COMMENTS FOR DAGS PHASE 2 IGA

1. ECM 1 - Premium Efficiency Lighting:
    a. Please confirm that light poles for all parking areas will also be replaced with high efficiency LED lighting. Volume 2 appears to have pole lighting included but it doesn't seem to be included in the narrative in Volume 1.
    b. Please verify that the Lighting Ordinance of each island is complied with when exterior lighting is retrofitted or replaced.
2. ECM 2 – Lighting Controls: No comment.
3. ECM 3 – New Energy Management and Control System – No comment.
4. ECM 5 – PV Power Generation:
    a. Please confirm that all roofs with PV that are not being replaced are in good condition with a remaining life of at least 20 years.
    b. Please confirm that the HECO/MECO/HELCO/KIUC feeders have sufficient capacity and meet the utility company requirements for interconnection.
    c. The Volume 2, Schedule A (Pages 9,10) shows 22 buildings for PV Power Generation, while the Site drawings (Volume 2, ECM 5) show 10 buildings, and the Energy Savings Analysis (Volume 2) show 12 buildings in index but only 9 have analysis. Please coordinate all sections to show the correct amount of buildings.
    d. The energy savings analysis section shows all of the simulations using "Kahului Airport" data for all work on all islands. Please provide closer data to the specific job locations.
5. ECM 6 - Chiller Plant Upgrades:
    a. Please confirm if the chillers have been sized based on actual building loads and are not oversized.
    b. Please confirm if temporary air conditioning will be required for the Wailuku State Office building.
6. ECM 7 - Cooling Tower Upgrades: For the new cooling towers at the Wailuku State Office building, recommend providing 304 ss in lieu of galvanized towers.
7. ECM 8 – Repair Duct Leaks: No comment.
8. ECM 9 – Variable Volume Pumping: Recommend providing a bypass on each system to maintain the minimum required chiller flow to allow for off-hour cooling.
9. ECM 10 – Fan Variable Frequency Drives: Recommend providing each drive with a bypass starter.
10. ECM 11 – Replace HVAC Equipment:
    a. For Kamehameha V, Kaunakakai Phase 1 & 2, and Maui Dept of Agriculture Bldg A, recommend replacing air conditioning systems in their entirety and using R-407C or E or R-410A or other 0 ODP refrigerants.
    b. Ensure that all new equipment have coated condenser coils, and UV lights in the air handlers in accordance with DAGS guidelines.

   c. Please also confirm if air conditioning systems have been sized based on actual loads and are not oversized.
11. ECM 12 – Replace Window Air Conditioning Units: Confirm that replacement of window units with high efficiency variable refrigerant flow Dx units will not be cost effective.
12. ECM 14 – Energy Efficient Transformers: No comment.
13. ECM 16 – Replace Refrigerators: No comment.
14. ECM 17 – Ice Machine Measures: No comment.
15. ECM 18 – Water Conservation Plumbing Measures: Ensure that ADA fixture requirements are also addressed.
16. ECM 19 – Heat Pump Water Heaters: Confirm that replacement of water heaters with solar water heating in lieu of heat pumps will not be cost effective.
17. ECM 20 - Premium Efficiency Motors: Please confirm if motors have been replaced based on actual loads and are not oversized.
18. ECM 21 –Vending Machine Controllers: No comment.
19. ECM 22 – Computer Facility Upgrades: No comment.
20. ECM 23 – Replace Roofs: Please confirm if installation of additional roof insulation or a radiant barrier would be cost effective as part of the reroofing.
21. ECM 24 – Pipe Insulation: No comment.
22. ECM 25 – Weather Stripping: No comment.
23. ECM 26 – Computer Power Management: No comment.
24. ECM 27 – Replace Windows: Please use double pane low e low SC windows for the window replacements.
25. ECM 28 – Irrigation System Measures: No comment.
26. Additional Comments:
    a. Please confirm that the air conditioning loads in each facility were confirmed by monitoring and/or load analysis. Any building where the existing system is oversized should be retro-commissioned for proper air and chilled water flows, and the systems adjusted and rebalanced to match the actual loads.
    b. Please ensure that the appropriate energy rebates are applied for and approved by Hawaii Energy.

APPENDIX 2.17

DOT ESPC Report

DEPARTMENT OF TRANSPORTATION
ENERGY SERVICE PERFORMANCE CONTRACT
PROPOSAL REVIEW

December 2011

INSYNERGY ENGINEERING INC

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

ISE PROPOSAL EVALUATION REPORT

1.0 FIELD SURVEYS

InSynergy Engineering (ISE) conducted limited field surveys to confirm the findings and recommended scope of work developed by the two proposers: Ameresco and Johnson Controls. The findings of our surveys are summarized in attachments M1.1 and M1.2, and E1 for the DOT airport facilities, in attachments M2 and E2 for the DOT Harbors, and in attachments M3 and E3 for the DOT highways.

Results of our survey work detailed in these attachments are summarized as follows:

1.1 DOT AIRPORTS

Johnson Controls appears in general to have completed a more comprehensive review of the existing mechanical systems and equipment at the DOT Airports, except at the Honolulu International Airport where Ameresco appears to have completed a more detailed survey. In general, we agree with the recommended mechanical system upgrades that were recommended, and agree with the overall condition assessment of the equipment that was completed by both proposers, with the exception that we recommend providing a third chiller plant at the HIA Diamond Head wing following the current design for the central chilled water system modernization instead of replacing it with a micro-grid chiller plant. Johnson Controls' proposal includes more mechanical upgrades than Ameresco.

Both Johnson Controls an Ameresco appeared to have similar programs for lighting retrofits and transformer replacements, and in general we agree with the recommended scopes of work for these electrical ECM's. Ameresco's proposal includes more electrical upgrades than Johnson Controls.

Johnson Controls appears to have a larger scope included for photovoltaics than Ameresco. However, at several sites Johnson Controls includes installing additional PV's on buildings that appear to be out of the project boundaries, and on some roofs that appear to require reroofing within the 20 year projected life of the panels.

1.2 DOT HARBORS

Johnson Controls appears to have completed a more comprehensive review of the existing mechanical systems and equipment and includes more mechanical upgrades for DOT Harbors than Ameresco. In general, we agree with the recommended mechanical system upgrades that were recommended, and agree with the overall condition assessment of the equipment that was completed by both proposers.

Both Johnson Controls an Ameresco appeared to have similar programs for lighting retrofits and transformer replacements, and in general we agree with the recommended scopes of work for these electrical ECM's. Ameresco's proposal includes more electrical upgrades than Johnson Controls.

Johnson Controls also has a larger scope included for photovoltaics than Ameresco.

1.3 DOT HIGHWAYS

Johnson Controls appears to have completed a more comprehensive review of the existing mechanical systems and equipment and includes more mechanical upgrades for DOT Highways than Ameresco. In general, we agree with the recommended mechanical system upgrades that were recommended, and agree with the overall condition assessment of the equipment that was completed by both proposers.

Both Johnson Controls an Ameresco appeared to have similar programs for lighting retrofits and transformer replacements, and in general we agree with the recommended scopes of work for these electrical ECM's. Ameresco's proposal includes more electrical upgrades than Johnson Controls.

Johnson Controls also has a larger scope included for photovoltaics than Ameresco.

2.0 PROPOSAL COMPARISON

ISE reviewed and summarized the proposals and the 2 follow-up responses that were developed by the two proposers: Ameresco and Johnson Controls. The findings of our proposal comparison are summarized in attachment P1 for all DOT facilities and include DOT airport, DOT Harbors, and DOT highways.

Results of our proposal comparison detailed in this attachment are summarized as follows:

Sheet 1 - Summary for Baseline Energy Usage, ECM Cost and Savings confirms that both Ameresco and Johnson Controls utilized similar but not identical utility rates and assumed approximately the same total baseline electrical and water/sewer consumption and annual utility costs. The annual total utility cost baseline in Ameresco's proposal was $38.8 Million versus $35.5 Million in Johnson Control's analysis. A detailed breakdown of the baseline energy use by Division and each facility within the Division is included on Sheet 2 - Baseline Energy Comparison by Division.

The Sheet 1 - Summary also shows that Ameresco is proposing to implement $211.2 Million in ECM's versus $153.8 Million by Johnson Controls with the breakdown of the total ECM investment by category summarized as follows:

		Amerecso	Johnson Controls
Cost by ECM Category	$ - Lighting	19,190,904	9,851,836
	$ - Renewable Energy	37,354,439	83,363,776
	$ - HVAC	30,792,222	52,170,876
	$ - Water Conservation	1,892,064	1,720,849
	$ - Envelope	33,310,357	4,385,061
	$ - Various	11,798,741	2,214,546
	$ - Maintenance/Upgrades	888,376	55,357
	$ - Additional Capital Projects	76,000,000	0
	Total ($)	211,227,103	153,762,301

This indicates that Ameresco is implementing significantly more upgrades in lighting, building envelop upgrades (including re-roofing), various other miscellaneous improvements, and maintenance, while

Johnson Controls is investing more in renewable energy (PV), and HVAC upgrades. Ameresco has also included an additional $76 Million in additional capital projects which have not yet been defined. The ECM Costs are also detailed for each Division and each facility within the Division on Sheet 3. ECM Cost Comparison, and are described and detailed further on Sheet 5. ECM Breakdown Cost.

Please note that Sheet 1 - Summary also shows that Ameresco is proposing to implement more ECM's for the DOT-Harbors and DOT-Highways, while Johnson Controls is expending more ECM upgrades for DOT-Airports:

			Amerecso	Johnson Controls	
ECM Cost	$	Airports	102,073,229	126,876,528	
	$	Harbors	29,755,374	20,159,579	
	$	Highways	3,398,503	6,726,195	
	$ - Subtotal		135,227,106	153,762,302	
	$ - Additional capital projects		76,000,000	0	
	$	Total	211,227,106	153,762,302	*see note 2

The Sheet 1 - Summary also shows that Ameresco is estimating an annual utility cost savings due to the implementation of their recommended ECM's of $10.6 Million versus $23.3 Million for Johnson Controls. The breakdown of the total ECM savings by category is summarized as follows:

		Amerecso	Johnson Controls
Savings by ECM Category	$ - Lighting	4,303,619	3,288,169
	$ - Renewable Energy	2,080,939	8,233,060
	$ - HVAC	2,486,640	11,163,620
	$ - Water Conservation	1,309,804	132,749
	$ - Envelope	2,806	22,895
	$ - Various	463,040	450,658
	Total ($)	10,646,848	23,291,151

This summary indicates that Ameresco is estimating significantly higher savings in lighting and water conservation, while Johnson Controls is estimating higher savings realized in renewable energy (PV), and HVAC upgrades. The ECM Savings are also detailed for each Division and each facility within the Division on Sheet 4. ECM Savings Comparison, and are described and detailed further on Sheet 6 - ECM Breakdown Savings. There appears to be a discrepancy in Johnson Control's proposal in that the estimate ECM savings on Sheet 4 matches the Sheet 1 - Summary for Savings by ECM Category of $23,291,151, but the ECM Savings on Sheet 6 - ECM Breakdown Savings tallies only $17,984,820, with the disparity caused by an inconsistency in the HVAC savings ($11,163,620 on Sheet 1 vs. $5,953,507 on Sheet 6).

The Sheet 1 - Summary also shows that Johnson's estimates of the total utility savings realized by the implementation of the ECM's are higher than those estimated by Ameresco in all three of the DOT 's operational areas, including DOT-Airport, DOT-Harbors, and DOT-Highways:

			Amerecso	Johnson Controls
ECM Savings	**$/year**	**Airports**	**9,623,318**	**20,314,718**
	$/year	**Harbors**	**811,978**	**2,319,341**
	$/year	**Highways**	**210,951**	**657,093**
	$/year	**Total**	**10,646,247**	**23,291,152**

Sheet 7 - Preliminary Cash Flow Comparison summarizes the overall financial costs and 20 year cash flows for both proposers. Ameresco has structured their proposal so that their net savings after the 20 year period is only $502,089. All of the savings realized would be used to finance the initial ECM's plus the additional $76 Million in additional capital projects that have not yet been defined. This would provide the DOT a means to finance other deferred maintenance projects through the ESPC contract during this timeframe. Conversely, Johnson Controls has structured their proposal to maximize the return to the State to realize a net savings of $211,173,050 at the end of the 20 year period.

Direct comparison of the cash flow projections indicates that the Johnson Controls proposal will provide more capital back to the DOT over the 20 year life of the contract. However, the savings projections in Johnson Control's proposal are contingent on two issues that need to be verified:

1. Renewable energy savings for Johnson Controls are dependent on the amount of PV that the local utilities will allow to be connected to the grid. This amount of PV that can actually be installed should be confirmed, and the associated cost to install PV on roofs that do not appear to have a 20 year remaining life should be included as part of this ECM.
2. The energy savings for the HVAC ECMs should also be confirmed due to the large discrepancy between the $11,163,620 HVAC savings on Sheet 1 and the $5,953,507 HVAC savings that can be found on Sheet 6.

Both proposals have also included an option for financing additional renewable energy, primarily PV, as an alternate third party financed PPA project.

Attachment P1

Proposal Comparison Analysis

1 - SUMMARY - BASELINE ENERGY USAGE, ECM COST AND SAVINGS

			Ameresco	Johnson Controls	
Averaged Utility Rates					
	Electricity ($/kwh)	Oahu	0.23	0.25	
	Electricity ($/kwh)	Maui	0.31	0.32	
	Electricity ($/kwh)	Molokai	0.43	0.47	
	Electricity ($/kwh)	Hawaii	0.38	0.33	
	Electricity ($/kwh)	Kauai	0.39	0.35	
	Electricity ($/kwh)	Lanai	0.47	0.43	
	Water/Sewer ($/kgal)	Oahu	12.078	4.243	*see note 1
	Water/Sewer ($/kgal)	Maui	8.422	5.365	
	Water/Sewer ($/kgal)	Molokai	12.233	0	
	Water/Sewer ($/kgal)	Hawaii	4.832	4.660	
	Water/Sewer ($/kgal)	Kauai	4.257	11.650	
	Water/Sewer ($/kgal)	Lanai	1.714	0	
Current Baseline Energy Use	Electricity (kwh/year)	Airports	126,966,871	128,075,784	
	Electricity (kwh/year)	Harbors	5,158,000	4,852,494	
	Electricity (kwh/year)	Highways	644,989	693,636	
	Electricity (kwh/year)	**Total**	**132,769,860**	**133,621,914**	
	Water (kgal/year)	Airports	639,333	371,360	
	Water (kgal/year)	Harbors	128,756	148,142	
	Water (kgal/year)	Highways	7,720	14,473	
	Water (kgal/year)	**Total**	**775,809**	**533,975**	*see note 1
Current Baseline Energy Cost	Electricity ($/year)	Airports	29,769,387	not given	
	Electricity ($/year)	Harbors	1,399,279	not given	
	Electricity ($/year)	Highways	208,715	not given	
	Electricity ($)	**Total**	**31,377,381**	not given	
	Water ($/year)	Airports	2,335,609	not given	
	Water ($/year)	Harbors	463,234	not given	
	Water ($/year)	Highways	48,150	not given	
	Water ($)	**Total**	**2,846,993**	not given	
	Sewer ($/year)	Airports	3,931,607	not given	
	Sewer ($/year)	Harbors	630,681	not given	
	Sewer ($/year)	Highways	0	not given	
	Sewer ($/year)	**Total**	**4,562,288**	not given	
	Utility ($/yr) = elec + water/sewer	Airports	36,036,603	33,198,805	
	Utility ($/yr) = elec + water/sewer	Harbors	2,493,194	1,967,047	
	Utility ($/yr) = elec + water/sewer	Highways	256,865	319,590	
	Utility ($/yr) = elec + water/sewer	**Total**	**38,786,662**	**35,485,442**	
ECM Cost	$	Airports	102,073,229	**126,876,528**	
	$	Harbors	29,755,374	**20,159,579**	
	$	Highways	3,398,503	**6,726,195**	
	$ - Subtotal		135,227,106	**153,762,302**	
	$ - Additional capital projects		76,000,000	**0**	
	$	**Total**	**211,227,106**	**153,762,302**	***see note 2**
ECM Savings	Electricity (kwh/year)	Airports	not given	48,746,292	
	Electricity (kwh/year)	Harbors	not given	8,460,439	
	Electricity (kwh/year)	Highways	not given	1,789,817	
	Electricity (kwh/year)	**Total**	not given	**58,996,548**	
	Water/Sewer (kgal/year)	Airports	not given	15,515	
	Water/Sewer (kgal/year)	Harbors	not given	426	
	Water/Sewer (kgal/year)	Highways	not given	35	
	Water/Sewer (kgal/year)	**Total**	not given	**15,976**	
	$/year	Airports	9,623,318	**20,314,718**	
	$/year	Harbors	811,978	2,319,341	
	$/year	Highways	210,951	657,093	
	$/year	**Total**	**10,646,247**	**23,291,152**	***see note 3**
Cost by ECM Category	$ - Lighting		19,190,904	**9,851,836**	
	$ - Renewable Energy		37,354,439	**83,363,776**	
	$ - HVAC		30,792,222	**52,170,876**	
	$ - Water Conservation		1,892,064	**1,720,849**	
	$ - Envelope		33,310,357	**4,385,061**	
	$ - Various		11,798,741	**2,214,546**	
	$ - Maintenance/Upgrades		888,376	**55,357**	
	$ - Additional Capital Projects		76,000,000	**0**	
	Total ($)		**211,227,103**	**153,762,301**	***see note 2**
Savings by ECM Category	$ - Lighting		4,303,619	**3,288,169**	
	$ - Renewable Energy		2,080,939	**8,233,060**	
	$ - HVAC		2,486,640	**11,163,620**	***see note 4**
	$ - Water Conservation		1,309,804	**132,749**	
	$ - Envelope		2,806	**22,895**	
	$ - Various		463,040	**450,658**	
	Total ($)		**10,646,848**	**23,291,151**	***see note 3**

1. not all water/sewage use was reported for both ESCOs
2. previous $12.5 million discrepancy in ECM cost has been corrected Johnson Controls
3. previous $5 million discrepancy in ECM savings has been corrected by Johnson Controls
4. $5 million savings discrepancy in HVAC between summary and page 6

Department of Transportation ESPC Proposal Comparison
Task Order No. 3.B
December 22, 2011

2 - BASELINE ENERGY COMPARISON BY DIVISION

	Ameresco - Attachment A-1, Section 2, pg.12-14 of 97											**Johnson Controls**				
	Annual Demand (kW)	**Energy (kWh)**	**Total Energy Cost $**	**$/kWh**	**Water (kGal)**	**Total Water $**	**Water $/kGal**	**Total Sewer $**	**Sewer $/kGal**	**Total Water/Sewer $**	**Total Utilities $**	**Energy (kWh)**	**$/kWh**	**Water (kGal)**	**Water/Sewer $/kGal**	**Total Utilities $**
Airports																
Dillingham Airport	n/a	231,012	49,991	0.22	n/a					n/a	49,991	n/a	0.28			52,514
Hana Airport	n/a	22,136	6,965	0.31	5,741	7,133	1.24			7,133	14,098	13,865	0.37			6,485
Hilo International Airport	7,411	3,569,380	1,094,867	0.31	61,652	300,796	4.88			300,796	1,395,663	3,371,312	0.32			1,042,838
Honolulu International Airport	175,290	98,838,020	21,216,173	0.21	403,630	1,275,345	3.16	3,661,499	9.07	4,936,844	26,153,017	100,035,441	0.23	344,336	6.56	23,966,191
Kahului Airport	23,072	11,153,221	3,135,155	0.28	48,309	211,278	4.37	257,504	5.33	468,782	3,603,937	12,448,569	0.37			3,902,898
Kalaeloa Airport	n/a	927,001	200,603	0.22	2,438	6,239	2.56	12,604	5.17	18,843	219,446	n/a	0.23		2.81	200,604
Kalaupapa Airport	n/a	n/a	n/a	n/a	n/a					n/a		184,043	n/a	219		58,285
Kapulua Airport	490	179,879	53,089	0.30	209	2,188	10.47			2,188	55,277	184,043	0.30	219		58,285
Kona International Airport	12,288	6,680,783	1,939,739	0.29	52,303	255,185	4.88			255,185	2,194,924	6,414,944	0.32			1,879,455
Lanai Airport	1,183	466,600	184,711	0.40	1,208	2,070	1.71			2,070	186,781	474,600	0.41			179,013
Lihue Airport	7,387	4,601,643	1,776,043	0.39	63,589	271,619	4.27			271,619	2,047,662	4,649,292	0.37	26,586	11.65	1,735,181
Molokai Airport	583	222,229	84,919	0.38	138	1,776	12.87			1,776	86,695	224,835	0.42			89,352
Waimea Kohala Airport	198	74,967	27,132	0.36	116	1,980	17.07			1,980	29,112	74,840	0.44			27,704
Totals	227,902	126,966,871	29,769,387		639,333	2,335,609	6.14	3,931,607	6.52	6,267,216	36,036,603	128,075,784	0.34	371,360	7.01	33,198,805
Harbors																
Hilo Harbor	n/a	48,723	22,004	0.45	13,785	57,764	4.19			57,764	79,768	48,723	0.44	15,998	4.23	89,714
Honolulu Harbor	n/a	3,988,127	1,017,403	0.26	64,717	194,852	3.01	362,723	5.60	557,575	1,574,978	3,735,760	0.28	66,898	4.78	1,236,357
Kahului Harbor	2,561	459,105	149,012	0.32	3,055	22,639	7.41			22,639	171,651	146,743	0.37	6,572	6.61	89,684
Kalaeloa Barbers Point Harbor	n/a	392,214	104,072	0.27	10,242	29,015	2.83	267,958	26.16	296,973	401,045	411,138	0.28	11,411	2.82	136,059
Kaumalapau Harbor	n/a	n/a	n/a	n/a	n/a					n/a	0	n/a	0.45			n/a
Kaunakakai Harbor	n/a	22,918	10,917	0.48	n/a					n/a	10,917	12,310	0.47			5,487
Kawaihae Harbor	n/a	11,289	6,034	0.53	866	6,263	7.23			6,263	12,297	12,046	0.44	2,185	5.52	18,496
Nawilliwili Harbor	n/a	192,698	72,880	0.38	33,808	141,166	4.18			141,166	214,046	242,887	0.44	22,539		195,625
Port Allen Harbor	n/a	42,926	16,957	0.40	2,283	11,535	5.05			11,535	28,492	242,887	0.44	22,539		195,625
Totals	2,561	5,158,000	1,399,279		128,756	463,234	4.84	630,681	15.88	1,093,915	2,493,194	4,852,494	0.40	148,142	4.79	1,967,047
Highways																
Hilo Highways Labs and Baseyard	994	232,080	78,086	0.34	n/a					n/a	78,086	n/a	0.23		4.23	n/a
Kahului Hyws Maint Baseyard	n/a	210,525	68,390	0.32	6,533	40,138	6.14			40,138	108,528	467,087	0.30	13,318		237,138
Kauai Hwys Baseyard	n/a	25,124	9,638	0.38	n/a					n/a	9,638	33,527	0.23			13,428
Keanae Hwys Maint Baseyard	49	25,200	7,686	0.31	735	3,037	4.13			3,037	10,723	26,160	0.37	703	4.12	12,993
Lanai Hwys Baseyard	n/a	2,586	1,396	0.54	n/a					n/a	1,396	14,068	0.45			5,457
Molokai District Hwys Baseyard	1,844	55,940	23,355	0.42	55	585	10.64			585	23,940	59,260	0.47	55		23,578
Oahu Highways Maint Baseyard	487	93,534	20,164	0.22	397	4,390	11.06			4,390	24,554	93,534	0.23	397		26,996
Totals	3,374	644,989	208,715		7,720	48,150	7.99			48,150	256,865	693,636	0.33	14,473	4.18	319,590
											256,865					
Total Cost	**233,837**	**132,769,860**	**31,377,381**		**775,809**	**2,846,993**	**3.67**	**4,562,288**	**5.88**	**7,409,281**	**38,786,662**	**133,621,914**	**0.36**	**533,975**	**5.33**	**35,485,442**
Total Cost per Ap-1, pg. 12 of 97																

Note: Blank fields denote values not provided by ESCO

3 - ECM COST COMPARISON

Facility	Ameresco Measure Cost ($)	Johnson Controls Measure Cost ($)	
Airports			
Dillingham Airport	51,098	2,512,452	
Hana Airport	283,383	9,890	*not surveyed
Hilo International Airport	7,582,258	4,151,996	
Honolulu International Airport	55,990,627	83,216,900	*partial survey
Kahului Airport	20,072,193	21,098,467	*partial survey
Kalaeloa Airport	1,533,711	4,465,338	
Kalaupapa Airport	68,267	n/a	*not surveyed
Kapulua Airport	1,288,467	333,571	
Kona International Airport, Kaehol	8,122,618	4,255,918	
Lanai Airport	1,556,575	1,143,598	*fire station to be demolished and rebuilt
Lihue Airport	4,266,667	4,871,580	*partial survey
Molokai Airport	967,185	788,523	*fire station to be demolished and rebuilt
Waimea Kohala Airport	290,180	28,295	* Occupied periodically
Airport Totals	**102,073,229**	**126,876,528**	
Harbors			
Hilo Harbor	2,413,070	1,938,441	
Honolulu Harbor	23,711,379	11,975,137	*partial survey, pier 2, 10, 11 occupied periodically
Kahului Harbor	779,697	759,607	*pier 1 only occupied periodically
Kalaeloa Barbers Point Harbor	1,061,315	259,860	
Kaumalapau Harbor	4,120	8,498	
Kaunakakai Harbor	17,832	79,713	
Kawaihae Harbor	40,761	1,209	*to be demolished
Nawilliwili Harbor	1,517,170	4,412,832	
Port Allen Harbor	210,030	724,282	
Harbor Totals	**29,755,374**	**20,159,579**	
Highways			
Hilo Highways Labs and Baseyard	1,250,030	187,425	
Maui Hyws Maint Baseyard	805,870	385,396	
Kauai Hwys Baseyard	455,571	2,905,706	
Keanae Hwys Maint Baseyard	18,562	30,642	*not surveyed
Lanai Hwys Baseyard	1,967	987	*not normally occupied
Molokai District Hwys Baseyard	198,012	73,999	
Oahu Highways Maint Baseyard	668,491	3,142,040	
Highway Totals	**3,398,503**	**6,726,195**	
Total Cost	**135,227,106**	**153,762,302**	

4 - ECM SAVINGS COMPARISON

Facility	Ameresco Measure Savings ($)	Johnson Controls Measure Savings ($)	
Airports			
Dillingham Airport	7,289	212,789	
Hana Airport	8,796	2,133	*not surveyed
Hilo International Airport	744,048	662,837	
Honolulu International Airport	5,703,893	13,380,357	*partial survey
Kahului Airport	1,515,803	3,543,630	*partial survey
Kalaeloa Airport	18,701	480,982	
Kalaupapa Airport	3,034	0	*not surveyed
Kapulua Airport	45,371	47,292	
Kona International Airport, Kaehol	394,760	576,867	
Lanai Airport	156,373	189,386	*fire station to be demolished and rebuilt
Lihue Airport	920,710	1,121,262	*partial survey
Molokai Airport	84,007	91,063	*fire station to be demolished and rebuilt
Waimea Kohala Airport	20,533	6,118	
		0	
Airport Totals	**9,623,318**	**20,314,718**	
Harbors			
Hilo Harbor	29,260	127,554	
Honolulu Harbor	621,975	1,230,621	*partial survey, pier 2 and 10, 11 only occupied periodically
Kahului Harbor	19,981	174,840	*pier 1 only occupied periodically
Kalaeloa Barbers Point Harbor	56,909	96,614	
Kaumalapau Harbor	162	5,597	
Kaunakakai Harbor	2,096	15,700	
Kawaihae Harbor	5,023	427	*to be demolished
Nawilliwili Harbor	59,133	562,112	
Port Allen Harbor	17,439	105,875	
Harbor Totals	**811,978**	**2,319,341**	
Highways			
Hilo Highways Labs and Baseyard	71,244	47,636	
Kahului Hyws Maint Baseyard	48,065	35,297	
Kauai Hwys Baseyard	30,271	88,722	
Keanae Hwys Maint Baseyard	1,790	2,042	*not surveyed
Lanai Hwys Baseyard	327	0	*not normally occupied
Molokai District Hwys Baseyard	23,651	18,246	
Oahu Highways Maint Baseyard	35,603	465,150	
Highway Totals	**210,951**	**657,093**	
Total Savings	**10,646,248**	**23,291,152**	

5 - ECM BREAKDOWN COST

Ameresco			Johnson Controls			ISE Comments
ECM #	ECM Description	Measure Cost - $	ECM #	ECM Description	Measure Cost - $	
			1.1	T12 to T8 Retrofit	7,781,789	
			1.2	8' T12 to 4' T8 Retrofit	0	
			1.3	T8 to T8 Retrofit	0	
			1.4	De-lamp Fixtures	0	
			1.5	Interior Lighting Replacement	0	
			1.6	Interior Lighting Retrofit	0	
			1.7	Incandescent to CF Replacement or LED Retrofit	0	
			1.8	Compact Replacement to LED Conversion	0	
			1.9	U-Bend to Linear Fluorescent Retrofit	0	
			1.10	Exit Sign to LED Replacement	0	
			1.11	Lens Replacement	0	
			1.12	Reflector Installation	0	
			1.13	HID to T8 Retrofit/ Replacement	0	
			1.14	Parking Garage Retrofit/Replacement	0	
			1.15	Exterior Lighting HPS to PSMH Retrofit	0	
			1.16	Exterior Lighting HPS to Induction Retrofit	0	
			1.17	Exterior Lighting HPS to LED Retrofit/Replacement	0	
			1.18	Runway Lighting to LED Conversion	0	
			1.19	Low Fixture Count - Miscellaneous	0	
			1.20	Miscellaneous	0	
			2.1	Photocell Control - Exterior Lighting	0	
			2.2	Daylight Harvesting	0	
			2.3	Daylight Control w/Dimming Ballast	0	
			2.4	Twist Timer Control	0	
			2.5	Digital Timer Control	0	
			2.6	Astronomical Time Clock Control	0	
1	Premium Efficiency Lighting	18,136,822	2.7	Occupancy Sensor - Dual Tech Ultrasonic and IR	25,238	**Lighting: See electrical facility site survey analysis for more detail. Ameresco has over twice**
2	Lighting Controls	1,054,082	2.8	Wireless Sensors	0	**the investment in energy efficient lighting but their lighting analysis is not as detailed. All**
	Subtotal, Lighting	19,190,904		Subtotal, Lighting	7,807,027	**ECM's recommended appear to be feasible**
			7.1	Solar Photovoltaic	97,022,857	
			7.2	Solar Thermal	53,135	
			7.3	Micro-Wind Generators	0	
			7.4	PV Electrical Vehicle Charging Station	0	**Renewables: See electrical facility site survey analysis for more detail. Johnson Controls has**
			7.5	Solar/Wind Parking Lights	0	**over 2.5 times the investment in PV. JC is also proposing to install PV at two hangers at**
			7.6	SolaTube/ Day lighting	0	**Kalaeloa, Piers 39-40 and 52-53in Honolulu Harbor, and various buildings at Kahului Airport**
3	PV Lighting Systems	88,081	7.7	Solar Exhaust Fans	0	**that are not included in the project. It appears doubtful that all of the PV that Johnson**
4	PV Power Generation	36,980,522	7.8	Solar Golf Cart Charging Station	0	**Controls is proposing can be installed on existing roofs without additional roofing repairs or**
5	Wind Power Generation	285,836	7.9	Solar PV for Runway Lighting	0	**reroofing. All ECM's recommended appear to be feasible, except that the amount of PV that**
	Subtotal, Renewable Energy	37,354,439		Subtotal, Renewable Energy	97,075,992	**can be installed needs to be confirmed with the electrical utility companies.**
			3.2	Window Air Conditioners	113,932	
			3.3	Chillers	175,995	
			3.4	Cooling Towers	0	
			3.5	Pumps	23,172	
			3.6	Replace Roof Top Units	63,182	
			3.7	Split System	645,720	
			3.8	Terminal Unit Replacement	96,554	
			3.9	High Efficiency Motors	582,387	
			3.10	Packaged DX Units	138,840	
			3.11	Thermal Energy Storage System	3,658,466	
			3.12	Fan Coils Units Replacement	18,159	
			3.13	Wall A/C Units Replacement	45,554	
			3.14	Replace Exhaust Fans	8,648	
			4.1	Pneumatic to DDC Conversion	0	
			4.2	Upgrade existing DDC or new DDC	5,454,382	
			4.3	Demand Control Ventilation	0	
			4.4	TOD Scheduling /Night Setback	0	
			4.5	Window A/C unit monitor and control	0	
			4.6	Occupancy Sensors for A/C control	0	
			4.7	Exhaust Fan Interlocks	0	
			4.8	Install Utility Meters	0	
			4.9	CO2 Monitoring and Fan Control	0	
			4.10	Enterprise-wide Continuous Monitoring	881,291	
			4.11	Eco Stats - on/off schedule for AC units	0	
			4.12	Tie in FID System with Building Automation System	224,871	
			4.13	Integration of DDC Controls	40,451	
			5.1	Bearings/ Belts	30,307	
			5.2	System Cleaning	33,619	
			5.3	Air Balancing	0	
			5.4	Controls Adjustment	0	
			5.5	Code Compliance	0	
			5.6	Optimization protocols	845,194	
			5.7	Compressed Air Leak Repair	0	
			6.1	Cross Connect Cooling Towers	277,606	
			6.2	Variable Pumping (VFDs on pumps, 3-way valve swap	203,462	
			6.3	System Isolation for Independent Rotation	13,317	
			6.4	Constant Volume to VAV Conversion	18,689	
6	Energy Management and Control System	17,136,414	6.5	Install Control Valves	99,025	
7	Chiller Plant Upgrades	4,698,870	6.6	Install Hot Water Heater	0	**HVAC: See mechanical facility site survey analysis for more detail. Johnson Controls has**
8	Cooling Tower System Measures	826,403	6.7	Utilize Chilled water as primary cooling in spaces	0	**over 40% in additional investment in HVAC upgrades. All ECM's recommended appear to be**
9	Replace HVAC Equipment	5,463,927	6.8	Variable Frequency Drives	1,066,906	**feasible, except we do not recommend implementing JC ECM 6.13, Microgrid Central Plant.**
10	Replace Window Air Conditioners	271,364	6.9	Variable Refrigerant Flow (VRF) System	0	**The Ewa chiller plant should be constructed to match the recently completed Diamond Head**
11	Variable Volume Pumping	432,095	6.10	Replace Air Compressor	0	**plant and the Overseas Terminal plant to allow all three plants to operate as back-up to each**
12	Fan VFD's	1,357,909	6.11	Replace/ Repair Fire Life Safety	0	**other and to share the load during off-peak hours. Isolation of the Ewa plant on a micro-gird**
13	Replace Exhaust Fans	283,796	6.12	Convert D/X AHU to Chilled Water AHU	49,201	**will not allow the plant to serve as back-up to the other plants, and the output from the plant**
18	Premium Efficiency Motors	321,444	6.13	Microgrid Central Plant	27,946,158	**will vary significantly with the actual daily solar insolation.**
	Subtotal, HVAC	30,792,222		Subtotal, HVAC	42,755,088	
			8.1	Metered Sink Faucets	1,217,519	
			8.2	Infrared Controls	0	
			8.3	Flush Valve Diaphragm change out	0	
			8.4	Low Flow Toilets/ Urinals	0	
			8.5	Pozzolan Soil Amendment	0	
			8.6	Irrigation Controls	0	
			8.7	Chemical Free Water Treatment	0	
			8.8	Low Flow Shower Heads	0	
21	Water Conservation Plumbing Measures	1,847,818	8.9	Plumbing Issues	0	
22	Irrigation Controls	44,246	8.10	Lift Station Upgrades/Replacement	0	**Water Conservation: Ameresco has 50% more investment in water conserving fixtures. All**
	Subtotal Water Conservation	1,892,064		Subtotal, Water Conversation	1,217,519	**ECM's recommended appear feasible.**
			9.1	Cool Roof	3,269,633	**Envelope: Ameresco has 10 times the investment in roof replacements and roof repairs. It is**
			9.2	Window Replacement	0	**also doubtful that Johnson Controls can accomplish all of the PV installation work that they**
			9.3	Window Film	0	**are proposing without additional roof repairs to ensure that the roofs will last for the lifetime**
			9.4	Skylights	0	**of the PV panels. All ECM's appear feasible. Also, envelope factors including infiltration**
23	Replace or Reseal Roofs	32,747,192	9.5	Roof Replacement	0	**reduction and insulation improvements need to be considered before any major HVAC**
24	Window Measures	563,165	9.6	Building Infiltration Reduction	0	**installion. Johnson Controls does not address these improvements now but may be**
	Subtotal, Envelope	33,310,357		Subtotal, Envelope	3,269,633	**evaluated in more detail during the IGA phase.**
			11.1	PC Power Management	8,346	
			11.2	Transformer Replacement	1,513,670	
			11.3	Vending Miser	12,757	
			11.4	Plug/ Monitor Miser	0	
			11.5	Parking Meters	0	
			11.6	Trash Compactor	0	
			11.7	Replace Refrigerated Water Fountains	6,775	
14	Energy Efficient Transformers	2,666,789	11.8	Replace Standalone Refrigerator	63,108	
15	Replace DOT-owned Refrigerators	108,949	11.9	State Vehicle Purchase Program	0	
16	Ice Machine Measures	57,137	11.10	Replace small IC Vehicle w/ Electric Vehicle	0	
17	Energy Efficient Water Heaters	128,903	11.11	Replace CRT with LCD Monitors	0	
19	Vending Machine Controls	27,783	11.12	Replace Leaking Solar Hot Water 80 Gal Storage Tank	4,895	
20	Energy Efficient Water Fountains	342,499	11.13	Replace Ice Machines	0	
25	Jetway Power Conditioners & AC Units	5,759,255	11.14	Copier Miser	0	
26	Upgrade Runway Lights	2,696,519	11.15	Voice Over Internet Protocol (VoIP)	0	
28	Computer Power Management	10,907	11.16	Heat Recovery off Ice Machine	0	**Various: Ameresco has 7 times the investment in other various ECM's, primarily in jetway**
	Subtotal, Various	11,798,741		Subtotal, Various	1,609,551	**power conditioners and ac units, and in runway lighting. All ECM's appear feasible.**
			10.1	Provide Maintenance Services	27,489	
			10.2	Access Door to AHUs	0	**Maintenance: Ameresco has 30 times the investment in maintenance, but the details are**
27	Deferred Maintenance Projects & Capital Upgrades	888,376		Subtotal, Maintenance	27,489	**lacking.**
	Additional Capital Projects	76,000,000				**Additional Capital Projects: Ameresco has developed their proposal to balance all of the savings against the cost of the ECM's plus an additional $76M that could be applied to other deferred maintenance and capital projects. Johnson controls has tailored their proposal so that any additional savings created by the implementation of their ECM's is returned back to the DOT as realized utility and operational cost savings.**
	Totals - Measure Cost	**211,227,103**		**Totals - Measure Cost**	**153,762,299**	

6 - ECM BREAKDOWN SAVINGS

Ameresco			Johnson Controls		
ECM #	ECM Description	Measure Savings - $	ECM #	ECM Description	Measure Savings - $
			1.1	T12 to T8 Retrofit	3,188,455
			1.2	8' T12 to 4' T8 Retrofit	0
			1.3	T8 to T8 Retrofit	0
			1.4	De-lamp Fixtures	0
			1.5	Interior Lighting Replacement	0
			1.6	Interior Lighting Retrofit	0
			1.7	Incandescent to CF Replacement or LED Retrofit	0
			1.8	Compact Replacement to LED Conversion	0
			1.9	U-Bend to Linear Fluorescent Retrofit	0
			1.10	Exit Sign to LED Replacement	0
			1.11	Lens Replacement	0
			1.12	Reflector Installation	0
			1.13	HID to T8 Retrofit/ Replacement	0
			1.14	Parking Garage Retrofit/Replacement	0
			1.15	Exterior Lighting HPS to PSMH Retrofit	0
			1.16	Exterior Lighting HPS to Induction Retrofit	0
			1.17	Exterior Lighting HPS to LED Retrofit/Replacement	0
			1.18	Runway Lighting to LED Conversion	0
			1.19	Low Fixture Count - Miscellaneous	0
			1.20	Miscellaneous	0
			2.1	Photocell Control - Exterior Lighting	0
			2.2	Daylight Harvesting	0
			2.3	Daylight Control w/Dimming Ballast	0
			2.4	Twist Timer Control	0
			2.5	Digital Timer Control	0
			2.6	Astronomical Time Clock Control	0
1	Premium Efficiency Lighting	3,961,533	2.7	Occupancy Sensor - Dual Tech Ultrasonic and IR	609
2	Lighting Controls	342,086	2.8	Wireless Sensors	0
	Subtotal, Lighting	4,303,619		Subtotal, Lighting	3,189,064
			7.1	Solar Photovoltaic	8,283,566
			7.2	Solar Thermal	10,264
			7.3	Micro-Wind Generators	0
			7.4	PV Electrical Vehicle Charging Station	0
			7.5	Solar/Wind Parking Lights	0
			7.6	SolaTube/ Day lighting	0
3	PV Lighting Systems	13,930	7.7	Solar Exhaust Fans	0
4	PV Power Generation	2,050,874	7.8	Solar Golf Cart Charging Station	0
5	Wind Power Generation	16,135	7.9	Solar PV for Runway Lighting	0
	Subtotal, Renewable Energy	2,080,939		Subtotal, Renewable Energy	8,293,830
			3.2	Window Air Conditioners	19,790
			3.3	Chillers	10,429
			3.4	Cooling Towers	0
			3.5	Pumps	0
			3.6	Replace Roof Top Units	2,729
			3.7	Split System	74,388
			3.8	Terminal Unit Replacement	0
			3.9	High Efficiency Motors	133,216
			3.10	Packaged DX Units	28,048
			3.11	Thermal Energy Storage System	179,817
			3.12	Fan Coils Units Replacement	0
			3.13	Wall A/C Units Replacement	5,237
			3.14	Replace Exhaust Fans	0
			4.1	Pneumatic to DDC Conversion	0
			4.2	Upgrade existing DDC or new DDC	**1,512,966**
			4.3	Demand Control Ventilation	**297,459**
			4.4	TOD Scheduling /Night Setback	**341,836**
			4.5	Window A/C unit monitor and control	0
			4.6	Occupancy Sensors for A/C control	0
			4.7	Exhaust Fan Interlocks	0
			4.8	Install Utility Meters	0
			4.9	CO2 Monitoring and Fan Control	**339,107**
			4.10	Enterprise-wide Continuous Monitoring	**255,192**
			4.11	Eco Stats - on/off schedule for AC units	0
			4.12	Tie in FID System with Building Automation System	0
			4.13	Integration of DDC Controls	**54,710**
			5.1	Bearings/ Belts	0
			5.2	System Cleaning	0
			5.3	Air Balancing	0
			5.4	Controls Adjustment	92,662
			5.5	Code Compliance	0
			5.6	Optimization protocols	187,829
			5.7	Compressed Air Leak Repair	0
			6.1	Cross Connect Cooling Towers	70,742
			6.2	Variable Pumping (VFDs on pumps, 3-way valve swap)	532,960
			6.3	System Isolation for Independent Rotation	0
			6.4	Constant Volume to VAV Conversion	2,099
6	Energy Management and Control System	1,085,043	6.5	Install Control Valves	0
7	Chiller Plant Upgrades	506,894	6.6	Install Hot Water Heater	0
8	Cooling Tower System Measures	91,154	6.7	Utilize Chilled water as primary cooling in spaces	0
9	Replace HVAC Equipment	74,261	6.8	Variable Frequency Drives	653,533
10	Replace Window Air Conditioners	10,864	6.9	Variable Refrigerant Flow (VRF) System	0
11	Variable Volume Pumping	226,969	6.10	Replace Air Compressor	0
12	Fan VFD's	481,066	6.11	Replace/ Repair Fire Life Safety	0
13	Replace Exhaust Fans	10,389	6.12	Convert D/X AHU to Chilled Water AHU	88,297
18	Premium Efficiency Motors	27,286	6.13	Microgrid Central Plant	1,070,461
	Subtotal, HVAC	2,513,926		Subtotal, HVAC ***see note 4 in Summary, page 1**	**5,953,507**
			8.1	Metered Sink Faucets	0
			8.2	Infrared Controls	0
			8.3	Flush Valve Diaphragm change out	133,734
			8.4	Low Flow Toilets/ Urinals	0
			8.5	Pozzolan Soil Amendment	0
			8.6	Irrigation Controls	0
			8.7	Chemical Free Water Treatment	0
			8.8	Low Flow Shower Heads	0
21	Water Conservation Plumbing Measures	1,308,680	8.9	Plumbing Issues	0
22	Irrigation Controls	1,124	8.10	Lift Station Upgrades/Replacement	0
	Subtotal Water Conservation	1,309,804		Subtotal, Water Conversation	133,734
			9.1	Cool Roof	23,065
			9.2	Window Replacement	0
			9.3	Window Film	0
			9.4	Skylights	0
23	Replace or Reseal Roofs	0	9.5	Roof Replacement	0
24	Window Measures	2,806	9.6	Building Infiltration Reduction	0
	Subtotal, Envelope	2,806		Subtotal, Envelope	23,065
			11.1	PC Power Management	17,358
			11.2	Transformer Replacement	366,479
			11.3	Vending Miser	7,783
			11.4	Plug/ Monitor Miser	0
			11.5	Parking Meters	0
			11.6	Trash Compactor	0
			11.7	Replace Refrigerated Water Fountains	0
14	Energy Efficient Transformers	298,059	11.8	Replace Standalone Refrigerator	0
15	Replace DOT-owned Refrigerators	12,749	11.9	State Vehicle Purchase Program	0
16	Ice Machine Measures	1,616	11.10	Replace small IC Vehicle w/ Electric Vehicle	0
17	Energy Efficient Water Heaters	4,430	11.11	Replace CRT with LCD Monitors	0
19	Vending Machine Controls	11,537	11.12	Replace Leaking Solar Hot Water 80 Gal Storage Tank	0
20	Energy Efficient Water Fountains	11,620	11.13	Replace Ice Machines	0
25	Jetway Power Conditioners & AC Units	0	11.14	Copier Miser	0
26	Upgrade Runway Lights	88,205	11.15	Voice Over Internet Protocol (VoIP)	0
28	Computer Power Management	7,538	11.16	Heat Recovery off Ice Machine	0
	Subtotal, Various	435,754		Subtotal, Various	391,620
			10.1	Provide Maintenance Services	0
			10.2	Access Door to AHUs	0
27	Deferred Maintenance Projects & Capital Upgrades	0		Subtotal, Maintenance	0
	Additional Capital Projects	0			
	Totals - Measure Savings	**10,646,848**		**Totals - Measure Savings**	**17,984,820**

Department of Transportation ESPC Proposal Comparison
Task Order No. 3.B
December 22, 2011

7 - PRELIMINARY CASH FLOW ANALYSIS COMPARISON

		Ameresco		Johnson Controls	
		Base Project	**Alternate Project**	**w/out PPA**	**w/ PPA**
Project Cost					
	Est Value of Hard Costs*	195,580,652	172,913,502	153,762,302	66,709,123
	Investment Grade Audit	488,952	488,952	595,046	595,046
	Design Engineering Fees	5,280,678	4,668,665	4,551,136	3,932,222
	Construction Mngmt	6,454,162	5,706,146	4,928,005	3,925,467
	System Commissioning	684,532	605,197	753,138	753,138
	Initial Training Fees	293,371	259,370	45,000	45,000
	Contingency Costs	included in hard costs	included in hard costs	2,042,528	2,042,528
	Construction Interest	2,444,758	2,104,751	16,667,715	7,800,252
	Total Financed Project Costs	211,227,105	186,746,583	183,344,870	85,802,776
Proposed Annual Service Fees					
	Measurement & Verification	79,332	79,332	452,600	452,600
	Maintenance	TBD	TBD	9,100	9,100
	Performance Monitoring	included in M&V	included in M&V	7,280	7,280
	On-going Training Services	20,194	20,194	19,600	19,600
	Verification Reports	included in M&V	included in M&V	14,000	14,000
	Total First Year Annual Services	99,526	99,526	502,580	502,580
Cash Flow Analysis					
20-year performance	Electric Cost Savings	331,128,639	257,492,340	505,576,924	349,981,565
	Water Cost Savings	46,729,190	46,729,190	3,734,546	3,734,546
	Rebates			3,779,239	3,779,239
	PPA Cost Savings	0	29,583,722		
	Capital Avoidance			550,000	550,000
	Operation Cost Savings	677,448	677,448	46,108,955	46,108,955
	Total Cost Savings	378,535,277	334,482,700	560,749,665	404,154,306
	Maintenance, Monitoring, Training Fees	2,330,341	2,330,341	80,700,141	72,180,921
	Guaranteed Savings	378,033,188	333,755,405	560,749,665	404,154,306
	Financial Payment	375,702,847	331,425,065	268,846,474	125,830,345
	Net Savings	**502,089**	**727,295**	**211,173,050**	**206,143,041**
	Double-check Net Savings	**502,089**	**727,294**	**211,203,050**	**206,143,040**

*total value of hard costs include:
subcontracted and direct labor costs, cost of materials and equipment, temporary facilities, permits, bonds, general excise tax, insurance, overhead and profit

Attachment M1.1

Mechanical Field Survey - Airports

Site	Area Served	Equipment Tag	Equipment Description	Size	Qty	Date Ma	Ameresco Operating Condition	Johnson Controls	Insynergy	Notes
Dillingham Airport			no inventory provided							2-RTUs Ok, Trailers Bard a/c units
Hana Airport			no inventory provided							
Hilo Int Airport	Chiller Room	CH-1	Trane Water Helical Rotary Chiller	200 tons	1	2002	Retrofit	Good condition	Good condition	Ameresco - new compressors
	Chiller Room	CH-2	Trane Water Helical Rotary Chiller	200 tons	1	2002	Retrofit	Good condition	Good condition	Ameresco - new compressors
	Chiller Room	P-1	Aurora CHW Pump 344	480 GPM, 160' TDH	1	2002	Retrofit	Good condition	Good condition	Ameresco - new VFD
	Chiller Room	P-2	Aurora CHW Pump 344	480 GPM, 160' TDH	1	2002	Retrofit	Good condition	Good condition	Ameresco - new VFD
	Chiller Room	FCU-1	Trane Fan Coil Unit BCHB0361G	1200 CFM, 1 HP	1	2002	Not mentioned	Good condition	Good condition	
	Chiller Room	EF-1	Cook Exhaust Fan 180 SQN-B	3600 CFM, 2 HP	1		Not mentioned	Good condition	Good condition	
	Chiller Room	Chiller Plant Controls	Trane Chiller Controls Tracer		1		Not mentioned	Good condition	Good condition	
	Chiller Room	Air Compressor/Drier	Johnson compressor/air drier		1		Not mentioned	Good condition	Good condition	
	Mech Equip Room West Roof	CT-1	Evapco Cooling Tower LSTA 10125	60 HP, VFD	1	2002	Serviceable	Good condition	Good condition	Ameresco - new filter
	Mech Equip Room West Roof	CT-2	Evapco Cooling Tower LSTB 8P318H	VFD	1	2002	Serviceable	Good condition	Good condition	Ameresco - new filter
	Mech Equip Room West Roof	CWP-1	Aurora Condenser Water Pump 342	600 GPM, 85' TDH	1	2002	Retrofit	Good condition	Good condition	Ameresco - new VFD
	Mech Equip Room West Roof	CWP-2	Aurora Condenser Water Pump 342	600 GPM, 85' TDH	1	2002	Retrofit	Good condition	Good condition	Ameresco - new VFD
	Mech Equip Room West Roof	CWP-3	Aurora Condenser Water Pump 382A	600 GPM, 85' TDH	1	2002	Retrofit	Good condition	Good condition	Ameresco - new VFD
	Mech Equip Room West Roof	CWP-4	Aurora Condenser Water Pump 382A	600 GPM, 85' TDH	1	2002	Retrofit	Good condition	Good condition	Ameresco - new VFD
	Mech Equip Room West Roof	AH-1	Trane Air Handling Unit 006	2800 CFM	1	2008	Not mentioned	Good condition	Good condition	
	Mech Equip Room West Roof	AH-5	Trane Air Handling Unit 006	2800 CFM	1	2008	Not mentioned	Good condition	Good condition	
	Mech Equip Room West Roof	AH-2	Trane Air Handling Unit MCCB-050	20500 CFM	1	2008	Not mentioned	Good condition	Good condition	
	Mech Equip Room West Roof	AH-6	Trane Air Handling Unit 006	2700 CFM	1	2008	Not mentioned	Good condition	Good condition	
	Mech Equip Room West Roof	AH-7	Trane Air Handling Unit 006	2700 CFM	1	2008	Not mentioned	Good condition	Good condition	
	Overseas Check-In Building	FC-4	Fan Coil unit, ground fl	1400 CFM	1	2002	Not mentioned	Good condition	Good condition	
	Overseas Check-In Building	FC-3	Fan Coil unit, ground fl	1200 CFM	1	2002	Not mentioned	Good condition	Good condition	
	Overseas Check-In Building	AH-8	Air Handling Unit, 2nd fl	4100 CFM	1	2002	Not mentioned	Good condition	Good condition	
	Interisland Check-in Bldg.	FC-5	Fan Coil Unit, ground fl	1200 CFM	1	2002	Not mentioned	Good condition	Good condition	
	Interisland Check-in Bldg.	FC-6	Fan Coil Unit, ground fl	1200 CFM	1	2002	Not mentioned	Good condition	Good condition	
	Interisland Check-in Bldg.	AH-9	Air Handling Unit, 2nd fl	4000 CFM	1	2002	Not mentioned	Good condition	Good condition	
	Passenger Lounge Bldg.	AH-4	Trane Air Handling Unit MCCB-017	7400 CFM	1	2002	Not mentioned	Good condition	Good condition	
	Passenger Lounge Bldg.	AH-3	Trane Air Handling Unit MCCB-014	6800 CFM	1	2008	Not mentioned	Good condition	Good condition	
	East Storage Room, Arcade Bldg.	RAC-1	Window AC Unit		1		Not mentioned	Good condition	Good condition	
	East Storage Room, Arcade Bldg.	RAC-2	Window AC Unit		1		Not mentioned	Good condition	Good condition	
	State Agriculture Office	FC-1	Fan Coil Unit	1200 CFM	1	2002	Not mentioned	Good condition	Good condition	
	U.S. Agriculture Office	FC-2	Fan Coil Unit	1000 CFM	1	2002	Not mentioned	Good condition	Good condition	
	Century Aviation Op. Office	Fan Coil Unit	N/A		1	2002	Not mentioned	Good condition	Good condition	
	Telephone Equipment Rm 310	Split System Unit	LG LS122CE	11,500 BTU	1		Not mentioned	Good condition	Good condition	
	Security Office (control room)	Split System Unit	Mitsubishi PU42EK2	42,200 BTU	1		Not mentioned	Good condition	Good condition	
	Security Office (control room)	Split System Unit	Mitsubishi PU42EK2	42,200 BTU	1		Not mentioned	Good condition	Good condition	
	Baseyard Lighting Systems Rm	Packaged Unit	Carrier M-50SS-042-301AA	42,000 BTU	1	1996	Recommend replacement	Recommend replacement	Recommend replacement, need envelope seal and duc	Bldg has gaps btwn wall and roof, no duct insulation
	Baseyard Shop Office	Window AC Unit	N/A	24,000 BTU	1		Not mentioned	Serviceable	Serviceable	
	Baseyard Office	Window AC Unit	LG	10,000 BTU	1		Not mentioned	Serviceable	Serviceable	
	Baseyard Carpenter Shop	Window AC Unit	Carrier	23,000 BTU	1		Not mentioned	Serviceable	Serviceable	
	Baseyard Paint Shop	Window AC Unit	Carrier	23,000 BTU	1		Not mentioned	Serviceable	Serviceable	
	Baseyard Electrical Shop	Window AC Unit	Carrier	23,000 BTU	1		Not mentioned	Serviceable	Serviceable	
	Baseyard Office	Window AC Unit	Panasonic	24,000 BTU	1		Not mentioned	Serviceable	Serviceable	
	Baseyard Break Room	Window AC Unit	Electrolux FAS226R2A	22,000 BTU	1	2008	Not mentioned	Serviceable	Serviceable	
	Aircraft Rescue/Firefighting	Split System Unit	Fujitsu AOU24LRX	24,000 BTU	1		Not mentioned	Good condition	Good condition	
	Aircraft Rescue/Firefighting	Split System Unit	Mitsubishi PUY-A42NHA2	42,000 BTU	1		Not mentioned	Good condition	Good condition	
	Aircraft Rescue/Firefighting	Split System Unit	Mitsubishi PU42EK2	42,000 BTU	1		Not mentioned	Recommend replacement	Recommend replacement	
Kahalui Airport	A	AHU-A3	Carrier Air Handling Unit 39D17	7.5 hp	1	1989	Recommend replacement	Serviceable	Serviceable	
	A	AHU-A4	Carrier Air Handling Unit 39D11	5 hp	1	1989	Recommend replacement	Serviceable	Serviceable	
	A	AHU-A5	Carrier Air Handling Unit 39D17	7.5 hp	1	1989	Recommend replacement	Serviceable	Serviceable	
	A	AHU-1	Trane Air Handling Unit	5 hp	1	1989	Not mentioned	Serviceable	Serviceable	
	B	AHU-A3	Carrier Air Handling Unit 39D17	7.5 hp	1	1989	Recommend replacement	Serviceable	Serviceable	
	B	AHU-A4	Carrier Air Handling Unit 39D11	5 hp	1	1989	Recommend replacement	Serviceable	Serviceable	
	B	AHU-A5	Carrier Air Handling Unit 39D17	7.5 hp	1	1989	Recommend replacement	Serviceable	Serviceable	
	B	AHU-A4	Carrier Air Handling Unit 39D11	5 hp	1	1989	Recommend replacement	Serviceable	Serviceable	
	B	AHU-B13	N/A	N/A	1	1989	Not mentioned	Serviceable	Serviceable	
	CEN BLDG	AHU-CT1	Carrier Air Handling Unit 39B060	68,377 Btuh	1	1989	Not mentioned	Serviceable	Serviceable	
	CEN BLDG	AHU-CT3	Carrier Air Handling Unit 39B060	60,281 Btuh	1	1989	Not mentioned	Serviceable	Serviceable	
	CEN BLDG	AHU-CT14	Carrier Air Handling Unit 39B040	23,648 Btuh	1	1989	Not mentioned	Serviceable	Serviceable	
	CEN BLDG	AHU-CT14A	Carrier Air Handling Unit 39B040	23,648 Btuh	1	1989	Not mentioned	Serviceable	Serviceable	
	CEN BLDG	AHU-CT15	Carrier Air Handling Unit 39B040	37,539 Btuh	1	1989	Not mentioned	Serviceable	Serviceable	

Site	Area Served	Equipment Tag	Equipment Description	Size	Qty	Date Ma	Ameresco Operating Condition	Johnson Controls	Insynergy	Notes
	CEN BLDG	AHU-CT15A	Carrier Air Handling Unit 39B040	37,539 Btuh	1	1989	Not mentioned	Serviceable	Serviceable	
	C	AHU-C2	Trane Air Handling Unit	7.5 hp	1	2004	Not mentioned	Good condition	Serviceable	
	C	AHU-C3	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	
	C	AHU-C4	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	
	C	AHU-C5	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	
	C	AHU-C6	Trane Air Handling Unit	7.5 hp	1	2004	Not mentioned	Good condition	Serviceable	
	C	AHU-2	Trane Air Handling Unit	3 hp	1	2008	Not mentioned	Good condition	Serviceable	
	D	AHU-D2	Trane Air Handling Unit	7.5 hp	1	2004	Not mentioned	Good condition	Serviceable	
	D	AHU-D3	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	
	D	AHU-D4	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	
	D	AHU-D5	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	D	AHU-D6	Trane Air Handling Unit	5 hp	1	2004	Not mentioned	Good condition	Serviceable	
	D	AHU-D7	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E2	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E3	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E4	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E5	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E6	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E11	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E12	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E13	Trane Air Handling Unit	7.5 hp	1	2004	Not mentioned	Good condition	Serviceable	
	F	AHU-F2	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	F	AHU-F3	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	
	F	AHU-F4	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	
	F	AHU-F5	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	F	AHU-F6	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	A	FCU-A1	McQuay Fan Coil Unit SCB 081	31,248 btuh	1		Not mentioned	Not mentioned	Serviceable	
	A	FCU-A2	McQuay Fan Coil Unit SCB 081	35,719 btuh	1		Not mentioned	Not mentioned	Serviceable	
	A	FCU-A6	McQuay Fan Coil Unit SCB 081	35,719 btuh	1		Not mentioned	Not mentioned	Serviceable	
	A	FCU-A7	McQuay Fan Coil Unit SCB 121	34,422 btuh	1		Not mentioned	Not mentioned	Serviceable	
	A	FCU-A8	McQuay Fan Coil Unit SCB 161	59,170 btuh	1		Not mentioned	Not mentioned	Serviceable	
	A	FCU-A9	McQuay Fan Coil Unit SCB 161	59,170 btuh	1		Not mentioned	Not mentioned	Serviceable	
	A	FCU-A10	McQuay Fan Coil Unit SCB 061B	3,860 btuh	1		Not mentioned	Not mentioned	Serviceable	
	B	FCU-B1	McQuay Fan Coil Unit SCB 081	31,248 btuh	1		Not mentioned	Not mentioned	Serviceable	
	B	FCU-B2	McQuay Fan Coil Unit SCB 081	35,719 btuh	1		Not mentioned	Not mentioned	Serviceable	
	B	FCU-B6	McQuay Fan Coil Unit SCB 081	35,719 btuh	1		Not mentioned	Not mentioned	Serviceable	
	B	FCU-B7	McQuay Fan Coil Unit SCB 121	34,422 btuh	1		Not mentioned	Not mentioned	Serviceable	
	B	FCU-B8	McQuay Fan Coil Unit SCB 161	59,170 btuh	1		Not mentioned	Not mentioned	Serviceable	
	B	FCU-B9	McQuay Fan Coil Unit SCB 161	59,170 btuh	1		Not mentioned	Not mentioned	Serviceable	
	B	FCU-B10	McQuay Fan Coil Unit SCB 081	14,706 btuh	1		Not mentioned	Not mentioned	Serviceable	
	B	FCU-B11	McQuay Fan Coil Unit SCB 081	n/a	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT2	McQuay Fan Coil Unit SCB 081	39,309 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT4	McQuay Fan Coil Unit SCD 061B	3,860 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT5	McQuay Fan Coil Unit SCB 081	10,888 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT6	Carrier Fan Coil Unit 42CE-8	19,671 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT7	Carrier Fan Coil Unit 42CE-5	7,393 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT8	Carrier Fan Coil Unit 42CE-5	7,054 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT9	Carrier Fan Coil Unit 42CE-8	14,706 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT10	Carrier Fan Coil Unit 42CE-6	14,927 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT11	Carrier Fan Coil Unit 42CE-6	12,057 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT12	McQuay Fan Coil Unit SCB 081	40,208 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT13	Carrier Fan Coil Unit 42CE-5	6,277 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT16	McQuay Fan Coil Unit SCB 121	n/a	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT17	McQuay Fan Coil Unit SCB 061B	5,850 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT18	McQuay Fan Coil Unit SCB 061B	15,900 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT19	McQuay Fan Coil Unit SCB 061B	15,050 btuh	1		Not mentioned	Not mentioned	Serviceable	
	CEN BLDG	FCU-CT21	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT22	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT23	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT23A	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	C	FCU-C1	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	C	FCU-C7	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	C	FCU-DOG HANDL	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	D	FCU-D1	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	D	FCU-D8	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		

Site	Area Served	Equipment Tag	Equipment Description	Size	Qty	Date Ma	Ameresco Operating Condition	Johnson Controls	Insynergy	Notes
	E	FCU-E1	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	E	FCU-E7	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	E	FCU-E8	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	E	FCU-E9	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	E	FCU-E10	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	E	FCU-E14	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	F	FCU-F1	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	F	FCU-F7	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	F	FCU-F8	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	BAG CL	FCU-BC1	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	BAG CL	FCU-BC2	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	BAG CL	FCU-BC3	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	BAG CL	FCU-BC4	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	BAG CL	FCU-BC5	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	BAG CL	FCU-BC6	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	A	Chiller Ch-1	Carrier Water Cooled Chiller		1	2006	Not mentioned	Good condition	Serviceable	
	A	Chiller Ch-2	Carrier Water Cooled Chiller		1	2006	Not mentioned	Good condition	Serviceable	
	A	Chiller Ch-3	Carrier Water Cooled Chiller		1	2006	Not mentioned	Good condition	Serviceable	
	A	Cooling Tower	Marley Cooling Tower QF-23224	500 tons	1		Not mentioned	Serviceable		
	A	Cooling Tower	Marley Cooling Tower QF-23224	500 tons	1		Not mentioned	Serviceable		
	A	Cooling Tower	Marley Cooling Tower QF-23224	500 tons	1		Not mentioned	Serviceable		
	A	CHWP #1	Aurora CHWR Pump	125 hp	1		Retrofit	Serviceable	Serviceable	
	A	CHWP #2	Aurora CHWR Pump	125 hp	1		Retrofit	Serviceable	Serviceable	
	A	CHWP #3	Aurora CHWR Pump	125 hp	1		Retrofit	Serviceable	Serviceable	
	A	CDWP #1	Aurora CDW Pump	50 hp	1		Retrofit	Serviceable	Serviceable	
	A	CDWP #2	Aurora CDW Pump	50 hp	1		Retrofit	Serviceable	Serviceable	
	A	CDWP #3	Aurora CDW Pump	50 hp	1		Retrofit	Serviceable		
	Office	Window AC Unit	Panasonic	1 ton	1		Not mentioned	Serviceable		
	A	AHU-A3	Carrier Air Handling Unit 39ED17	7.5 hp	1	1989	Not mentioned	Serviceable	Serviceable	
	A	AHU-A4	Carrier Air Handling Unit 39ED11	5 hp	1	1989	Not mentioned	Serviceable	Serviceable	
	A	AHU-A5	Carrier Air Handling Unit 39ED17	7.5 hp	1	1989	Not mentioned	Serviceable	Serviceable	
	A	AHU-1	Trane Air Handling Unit	5 hp	1	1989	Not mentioned	Serviceable	Serviceable	
	A	AHU-B3	Carrier Air Handling Unit 39ED17	7.5 hp	1	1989	Not mentioned	Serviceable	Serviceable	
	A	AHU-B4	Carrier Air Handling Unit 39ED11	5 hp	1	1989	Not mentioned	Serviceable	Serviceable	
	A	AHU-B5	Carrier Air Handling Unit 39ED17	7.5 hp	1	1989	Not mentioned	Serviceable	Serviceable	
	A	AHU-B12	Carrier Air Handling Unit 39ED11	n/a	1	1989	Not mentioned	Serviceable		
	A	AHU-B13	n/a	n/a	1	1989	Not mentioned	Serviceable		
	CEN BLDG	AHU-CT1	Carrier Air Handling Unit 39B 060	68,377 btuh	1	1989	Not mentioned	Serviceable	Serviceable	
	CEN BLDG	AHU-CT3	Carrier Air Handling Unit 39B 060	60,281 btuh	1	1989	Not mentioned	Serviceable	Serviceable	
	CEN BLDG	AHU-CT14	Carrier Air Handling Unit 39B 040	23,648 Btuh	1	1989	Not mentioned	Serviceable	Serviceable	
	CEN BLDG	AHU-CT14A	Carrier Air Handling Unit 39B 040	23,648 Btuh	1	1989	Not mentioned	Serviceable	Serviceable	
	CEN BLDG	AHU-CT15	Carrier Air Handling Unit 39B 050	37,539 btuh	1	1989	Not mentioned	Serviceable	Serviceable	
	CEN BLDG	AHU-CT15A	Carrier Air Handling Unit 39B 050	37,539 btuh	1	1989	Not mentioned	Serviceable	Serviceable	
	C	AHU-C2	Trane Air Handling Unit	7.5 hp	1	2004	Not mentioned	Good condition	Serviceable	
	C	AHU-C3	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	
	C	AHU-C4	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	
	C	AHU-C5	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	
	C	AHU-C6	Trane Air Handling Unit	7.5 hp	1	2004	Not mentioned	Good condition	Serviceable	
	C	AHU-2	Trane Air Handling Unit	3 hp	1	2008	Not mentioned	Good condition	Serviceable	
	D	AHU-D2	Trane Air Handling Unit	7.5 hp	1	2004	Not mentioned	Good condition	Serviceable	
	D	AHU-D3	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	
	D	AHU-D4	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	
	D	AHU-D5	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	D	AHU-D6	Trane Air Handling Unit	5 hp	1	2004	Not mentioned	Good condition	Serviceable	
	D	AHU-D7	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E2	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E3	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E4	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E5	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E6	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E11	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E12	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	E	AHU-E13	Trane Air Handling Unit	7.5 hp	1	2004	Not mentioned	Good condition	Serviceable	
	F	AHU-F2	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	F	AHU-F3	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	

Site	Area Served	Equipment Tag	Equipment Description	Size	Qty	Date Ma	Ameresco Operating Condition	Johnson Controls	Insynergy	Notes
	F	AHU-F4	Trane Air Handling Unit	15 hp	1	2004	Not mentioned	Good condition	Serviceable	
	F	AHU-F5	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	F	AHU-F6	Trane Air Handling Unit	10 hp	1	2004	Not mentioned	Good condition	Serviceable	
	A	FCU-A1	McQuay Fan Coil Unit SCB081	31,248 btuh	1		Not mentioned	Not mentioned		
	A	FCU-A2	McQuay Fan Coil Unit SCB081	35,719 btuh	1		Not mentioned	Not mentioned		
	A	FCU-A3	McQuay Fan Coil Unit SCB081	35,719 btuh	1		Not mentioned	Not mentioned		
	A	FCU-A7	McQuay Fan Coil Unit SCB121	34,422 btuh	1		Not mentioned	Not mentioned		
	A	FCU-A8	McQuay Fan Coil Unit SCB161	59,170 btuh	1		Not mentioned	Not mentioned		
	A	FCU-A9	McQuay Fan Coil Unit SCB161	59,170 btuh	1		Not mentioned	Not mentioned		
	A	FCU-A10	McQuay Fan Coil Unit SCD061B	3,860 btuh	1		Not mentioned	Not mentioned		
	B	FCU-B1	McQuay Fan Coil Unit SCB081	31,248 btuh	1		Not mentioned	Not mentioned		
	B	FCU-B2	McQuay Fan Coil Unit SCB081	35,719 btuh	1		Not mentioned	Not mentioned		
	B	FCU-B6	McQuay Fan Coil Unit SCB081	35,719 btuh	1		Not mentioned	Not mentioned		
	B	FCU-B7	McQuay Fan Coil Unit SCB121	34,442 btuh	1		Not mentioned	Not mentioned		
	B	FCU-B8	McQuay Fan Coil Unit SCB161	59,170 btuh	1		Not mentioned	Not mentioned		
	B	FCU-B9	McQuay Fan Coil Unit SCB161	59,170 btuh	1		Not mentioned	Not mentioned		
	B	FCU-B10	McQuay Fan Coil Unit 42CE-8	14,706 btuh	1		Not mentioned	Not mentioned		
	B	FCU-B11	n/a	n/a	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT2	McQuay Fan Coil Unit SCB 801	39,309 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT4	McQuay Fan Coil Unit SCD 061B	3,860 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT5	McQuay Fan Coil Unit SCB 081	10,888 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT6	McQuay Fan Coil Unit SCB 42CE-8	19,671 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT7	McQuay Fan Coil Unit SCB 42CE-5	7,393 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT8	McQuay Fan Coil Unit SCB 801	7,054 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT9	McQuay Fan Coil Unit SCD 061B	14,706 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT10	McQuay Fan Coil Unit SCB 081	14,927 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT11	McQuay Fan Coil Unit SCB 42CE-8	12,057 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT12	McQuay Fan Coil Unit SCB 42CE-5	40,208 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT13	McQuay Fan Coil Unit SCB 081	6,277 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT16	McQuay Fan Coil Unit SCB 42CE-8	n/a	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT17	McQuay Fan Coil Unit SCB 42CE-5	5,850 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT18	McQuay Fan Coil Unit SCB 081	15,900 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT19	McQuay Fan Coil Unit SCB 42CE-8	15,050 btuh	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT21	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT22	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT23	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	CEN BLDG	FCU-CT23A	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	C	FCU-C1	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	C	FCU-C7	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	C	FCU-DOG HANDL	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	C	FCU-D1	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	C	FCU-D8	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	E	FCU-E1	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	E	FCU-E7	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	E	FCU-E8	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	E	FCU-E9	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	E	FCU-E10	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	E	FCU-E14	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	F	FCU-F1	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	F	FCU-F7	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	F	FCU-F8	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	BAG CL	FCU-BC1	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	BAG CL	FCU-BC2	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	BAG CL	FCU-BC3	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	BAG CL	FCU-BC4	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	BAG CL	FCU-BC5	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	BAG CL	FCU-BC6	Fan Coil Unit	n/a	1		Not mentioned	Not mentioned		
	Maintenance Baseyard	Package Unit	Carrier Pacakge Unit	34,600 btuh	1	2010	Not mentioned	Good Condition	Serviceable	
	Maintenance Baseyard	Window Unit	LG Window Unit	2 tons	2		Not mentioned	Recommend Replacement		
	Maintenance Baseyard	Window Unit	n/a	1 tons	1		Not mentioned	Recommend Replacement		
	Maintenance Baseyard	Window Unit	n/a	2 tons	1		Not mentioned	Recommend Replacement		
	Maintenance Baseyard	Window Unit	Frigidaire Window Unit	25,000 btuh	1		Not mentioned	Serviceable		
	Maintenance Baseyard	Window Unit	Friedrich	2 tons	1		Not mentioned	Serviceable		
	Maintenance Baseyard	Window Unit	Friedrich	2 tons	1		Not mentioned	Serviceable		
	Maintenance Baseyard	Window Unit	n/a	1 ton	1		Not mentioned	Serviceable		

Site	Area Served	Equipment Tag	Equipment Description	Size	Qty	Date Ma	Ameresco Operating Condition	Johnson Controls	Insynergy	Notes
	Fire Station	Window Unit	Fedders	2 tons	1		Not mentioned	Recommend Replacement		
	Fire Station	Condenser	Carrier Split System	15 tons	1	1992	Not mentioned	Recommend Replacement		
	Fire Station	Air Handler	Carrier Split System	15 tons	1	1991	Not mentioned	Recommend Replacement		
Kalaeloa Airport			no inventory provided						Window units ok, 3 RTU's serviceable, Split-systems ok	
Kapalua Airport		AHU-1	Trane Air Handler	10 tons	1		Not mentioned	Serviceable	Serviceable	
		AHU-2	Magic Aire Air Handler	4 tons	1		Not mentioned	Serviceable	Serviceable	
		AHU-3	Trane Air Handler	n/a	1		Not mentioned	Serviceable	Serviceable	
		FCU	Fan Coil Unit	3,000 btuh	1		Not mentioned	Recommend Replacement	Recommend Replacement	
		AHU-4	na	1 hp	1		Not mentioned	Recommend Replacement	Recommend Replacement	
		AHU-5&6	na	2 hp	2		Not mentioned	Serviceable	Serviceable	
		Chiller	Trane air cooled Chiller	40 tons	1	2005	Not mentioned	Serviceable	Serviceable	
		Window Unit	Frigidaire Window Unit	n/a	1		Not mentioned	Serviceable	Serviceable	
		Window Unit	n/a	n/a	1		Not mentioned	Serviceable	Serviceable	
		CHW Pump	n/a	3 hp	2		Not mentioned	Serviceable	Serviceable	
Kona Int Airport	Foreign Inspection Tent	Package Unit	York	12.5 tons	1	1996	Recommend Replacement	Recommend Replacement		
	Foreign Inspection Tent	Package Unit	York	12.5 tons	1	1996	Recommend Replacement	Recommend Replacement		
	Foreign Inspection Tent	Package Unit	York	12.5 tons	1	1996	Recommend Replacement	Recommend Replacement		
	Foreign Inspection Tent	Package Unit	York	12.5 tons	1	1996	Recommend Replacement	Recommend Replacement		
	Foreign Inspection Tent	Package Unit	York	12.5 tons	1	1996	Recommend Replacement	Recommend Replacement		
	Foreign Inspection Tent	Package Unit	York	15 tons	1	1996	Recommend Replacement	Recommend Replacement		
	Foreign Inspection Tent	Package Unit	York	10 tons	1	1996	Recommend Replacement	Recommend Replacement		
	Foreign Inspection Tent	Window Unit	York	1 ton	2	1996	Not mentioned	Serviceable		
	Admin Complex	Chiller	Carrier Air Cooled Chiller	40 tons	1	1992	Not mentioned	Recommend Replacement		
	Admin Complex	Chiller	Carrier Air Cooled Chiller	15 tons	1	1992	Not mentioned	Recommend Replacement		
	Admin Complex	CHW Pump	Emerson	5 hp	1	1992	Retrofit	Recommend Replacement		
	Admin Complex	CHW Pump	n/a	n/a	1	1992	Retrofit	Recommend Replacement		
	Admin Complex	AHU #1	Carrier Split System	n/a	1	1992	Not mentioned	Serviceable		
	Admin Complex	AHU #2	Carrier Split System	n/a	1	1992	Not mentioned	Serviceable		
	Admin Complex	FCU-1-10	Carrier Fan Coil Unit	n/a	10	1992	Not mentioned	Serviceable		
	Admin Complex	FCU-11-16	Carrier Fan Coil Unit	n/a	6	1992	Not mentioned	Serviceable		
	Agriculture Bldg	Condenser Unit	Carrier Split System	12 tons	1		Not mentioned	Recommend Replacement		
	Agriculture Bldg	Air Handler	Carrier	n/a	1		Not mentioned	Recommend Replacement		
	Agriculture Bldg	Window Unit	Carrier	n/a	1		Not mentioned	Serviceable		
	Visitor Lounge	Split System	Mitsubishi Split System	n/a	1		Not mentioned	Serviceable		
	North Terminal	Split System	Mitsubishi Split System	n/a	1		Not mentioned	Serviceable		
	South Terminal	Split System	Mitsubishi Split System	n/a	1		Not mentioned	Serviceable		
	South Terminal	Split System	Mitsubishi Split System	n/a	1		Not mentioned	Serviceable		
	Commuter Terminal	Split System	Intertherm	n/a	1		Not mentioned	Serviceable		
	Emergency Medical Supply	Window Unit	Quasar	1 ton	1		Not mentioned	Recommend Replacement		
	Telephone Equipmt Room	Package Unit	Carrier	5 tons	1		Not mentioned	Serviceable		
	Hawaii Air Express check in	Split System	Mitsubishi Split System	0.75 ton	1		Not mentioned	Serviceable		
	Aloha Air Express check in	Split System	Mitsubishi Split System	0.75 ton	1		Not mentioned	Serviceable		
	Check pt 1	Condenser Unit	Carrier Split System	4 tons	1		Not mentioned	Serviceable		
	Check pt 1	Fan Coil Unit	Carrier Split System	4 tons	1		Not mentioned	Serviceable		
	Check pt 1	Condenser Unit	Carrier Split System	4 tons	1		Not mentioned	Serviceable		
	Check pt 1	Fan Coil Unit	Carrier Split System	4 tons	1		Not mentioned	Serviceable		
	Airport Baseyard Office	Window Unit	Electrolux	1 ton	1	2008	Not mentioned	Serviceable		
	Airport Baseyard Office	Window Unit	Panasonic	1 ton	1		Recommend Replacement	Recommend Replacement		
	Airport Baseyard Office	Window Unit	Friedrich	1 ton	1		Recommend Replacement	Recommend Replacement		
	Office	Window Unit	Electrolux	1 ton	1	2008	Not mentioned	Serviceable		
	Kitchen	Window Unit	Carrier	1 ton	1	2006	Not mentioned	Serviceable		
	Kitchen	Window Unit	Carrier	1.5 tons	1	2007	Not mentioned	Serviceable		
	Shop Office	Window Unit	Carrier	1.5 tons	1		Not mentioned	Recommend Replacement		
	Fire Station	Window Unit	Carrier	1 ton	1	2007	Not mentioned	Good condition		
	Fire Station	Window Unit	Carrier	1 ton	1	2008	Not mentioned	Good condition		
	Fire Station	Split System	Carrier	2 tons	1		Not mentioned	Recommend Replacement		
	Fire Station	Window Unit	Carrier	1 ton	1	2007	Not mentioned	Good condition		
	Fire Station	Window Unit	Carrier	1 ton	1	2007	Not mentioned	Good condition		
Lanai Airport	Lanai Airport	ACCU-1	Carrier 38ARD014---601	12.5 tons	1	2005	Not mentioned	Good condition	Needs maintenance	
	Lanai Airport	ACCU-2	Carrier 38ARD014---601	12.5 tons	1	2005	Not mentioned	Good condition	Needs maintenance	
	Lanai Airport	ACCU-3	Carrier 38ARD014---601	12.5 tons	1	2005	Not mentioned	Good condition	Needs maintenance	

Site	Area Served	Equipment Tag	Equipment Description	Size	Qty	Date Ma	Ameresco Operating Condition	Johnson Controls	Insynergy	Notes
	Lanai Airport	ACCU-4	Carrier 38ARD014---601	12.5 tons	1	2005	Not mentioned	Good condition	Needs maintenance	
	Lanai Airport	ACCU-5	Carrier 38ARD008---601	7.5 tons	1	2006	Not mentioned	Good condition	Needs maintenance	
	Lanai Airport	ACCU-6	Carrier 38ARD008---601	7.5 tons	1	2006	Not mentioned	Good condition	Needs maintenance	
	Lanai Airport	AHU-1	Carrier	12.5 tons	1	2005	Not mentioned	Good condition	Not evaluated	
	Lanai Airport	AHU-2	Carrier	12.5 tons	1	2005	Not mentioned	Good condition	Not evaluated	
	Lanai Airport	AHU-3	Carrier	12.5 tons	1	2005	Not mentioned	Good condition	Not evaluated	
	Lanai Airport	AHU-4	Carrier	12.5 tons	1	2005	Not mentioned	Good condition	Not evaluated	
	Lanai Airport	AHU-5	Carrier	7.5 tons	1	2006	Not mentioned	Good condition	Not evaluated	
	Lanai Airport	AHU-6	Carrier	7.5 tons	1	2006	Not mentioned	Good condition	Not evaluated	
	Lanai Airport Baseyard	NO HVAC					No HVAC	No HVAC	No HVAC	
	Operations/Maint Office	Window Units	Fredrich CP12E	1 ton	1		Recommend replacement	Serviceable	Recommend replacement	
	Operations/Maint Office	Window Units	Panasonic CP12E	1 ton	1		Recommend replacement	Serviceable	Recommend replacement	
	Operations/Maint Office	Window Units	Quasar	1 ton	1		Recommend replacement	Serviceable	Recommend replacement	
	Operations/Maint Office	Packaged Unit	Carrier 50HJ009SZV55926	7.5 tons	1		Not mentioned	Serviceable	Serviceable	
	Aircraft Resuce/Firefighting	Window Units	Worldpool	1 ton	1		Recommend replacement	Recommend replacement	Recommend replacement, bldg to be demolished	
	Aircraft Resuce/Firefighting	Window Units	Electrolux FAR125S1A	1 ton	1	2008	Recommend replacement	Serviceable	Recommend replacement, bldg to be demolished	
Lihue Airport	Apron Level	FCU-1	Fan Coil Unit	600 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Apron Level	FCU-8	Trane Fan Coil Unit	400 CFM	1	2009	Not mentioned	Good condition	Not evaluated	
	Apron Level	FCU-8A	Fan Coil Unit	600 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Apron Level	FCU-16	Wall mounted package unit	1330 BTU/H	1		Not mentioned	Not evaluated	Not evaluated	
	Apron Level	AHU-1	Trane Air Handling Unit MCCB021UA0COU	8555 CFM	1	2008	Not mentioned	Good condition	Not evaluated	
	Apron Level	AHU-2	Trane Air Handling Unit MCCB017UA0COU	8200 CFM	1	2008	Not mentioned	Good condition	Not evaluated	
	Apron Level	AHU-3	Trane Air Handling Unit MCCB017UA0COU	8200 CFM	1	2008	Not mentioned	Good condition	Not evaluated	
	Apron Level	AHU-4	Trane Air Handling Unit MCCB021UA0COU	8555 CFM	1	2008	Not mentioned	Good condition	Not evaluated	
	Apron Level	CH-1	Trane Water Chiller CVHE320	200 tons	1	2008	Not mentioned	Good condition	Not evaluated	
	Apron Level	CH-2	Trane Water Chiller CVHE320	200 tons	1	2008	Not mentioned	Good condition	Not evaluated	
	Apron Level	CT-1	Evapco Cooling Tower USS 1969	200 tons	1	2008	Serviceable	Good condition	Not evaluated	Ameresco - new filter
	Apron Level	CT-2	Evapco Cooling Tower USS 1969	200 tons	1	2008	Serviceable	Good condition	Not evaluated	Ameresco - new filter
	Apron Level	CHWP-1	Paco CHWR Pump 2013-5/6	15 HP	1	2008	Retrofit	Good condition	Not evaluated	Ameresco - new VFD
	Apron Level	CHWP-2	Paco CHWR Pump 2013-5/6	15 HP	1	2008	Retrofit	Good condition	Not evaluated	Ameresco - new VFD
	Apron Level	CHWP-3	Paco CHWR Pump 2013-5/6	15 HP	1	2008	Retrofit	Good condition	Not evaluated	Ameresco - new VFD
	Apron Level	CHWP-4	Paco CHWR Pump 2013-5/6	15 HP	1	2008	Retrofit	Good condition	Not evaluated	Ameresco - new VFD
	Apron Level	CWP-1	Paco Condenser Water Pump 3095-7/8	300 GPM	1	2008	Retrofit	Good condition	Not evaluated	Ameresco - new VFD
	Apron Level	CWP-2	Paco Condenser Water Pump 3095-7/8	300 GPM	1	2008	Retrofit	Good condition	Not evaluated	Ameresco - new VFD
	Apron Level	CWP-3	Paco Condenser Water Pump 3095-7/8	300 GPM	1	2008	Retrofit	Good condition	Not evaluated	Ameresco - new VFD
	Apron Level	CWP-4	Paco Condenser Water Pump 3095-7/8	300 GPM	1	2008	Retrofit	Good condition	Not evaluated	Ameresco - new VFD
	Apron Level	Window AC Unit	Window Unit	1 ton	1		Not mentioned	Serviceable	Not evaluated	
	Apron Level	Window AC Unit	Frigidaire Window Unit	1 ton	1		Not mentioned	Serviceable	Not evaluated	
	Apron Level	Split System Unit	Sanyo KS1271	1 ton	1	2009	Not mentioned	Good condition	Not evaluated	
	Terminal Level	FCU-3	Fan Coil Unit	600 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Terminal Level	FCU-4	Fan Coil Unit	600 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Terminal Level	FCU-5	Fan Coil Unit	300 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Terminal Level	FCU-6	Fan Coil Unit	1000 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Terminal Level	FCU-9	Fan Coil Unit	450 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Terminal Level	FCU-10	Carrier Fan Coil Unit 40RMS008	7.5 tons	1	2006	Not mentioned	Good condition	Not evaluated	
	Terminal Level	FCU-11	Fan Coil Unit	580 CFM	1	2006	Not mentioned	Not evaluated	Not evaluated	
	Terminal Level	AHU-13	Carrier Air Handling Unit	1800 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Terminal Level	AHU-14	Carrier Air Handling Unit	3200 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Terminal Level	AHU-14A	Carrier Air Handling Unit	3200 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Terminal Level	FCU-10A	Trane Split System Fan Coil Unit	700 CFM	1		Not mentioned	Good condition	Not evaluated	
	Terminal Level	CU-10A	Trane Split System Condenser Unit	17450 BTUH	1	2008	Not mentioned	Good condition	Not evaluated	
	Terminal Level	FCU	Fan Coil Unit	900 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Mezzanine Level	FCU-13	Fan Coil Unit	720 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Mezzanine Level	FCU-14	Fan Coil Unit	720 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Mezzanine Level	FCU-17	Fan Coil Unit	840 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Mezzanine Level	FCU-19	Fan Coil Unit	800 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Mezzanine Level	FCU-20	Fan Coil Unit	700 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Mezzanine Level	FCU-23	Fan Coil Unit	500 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Mezzanine Level	FCU-24	Trane Fan Coil Unit	3 tons, 1200 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Mezzanine Level	FCU-Admin	Carrier Fan Coil Unit 42BHB08	7.5 tons	1		Not mentioned	Not evaluated	Not evaluated	
	Mezzanine Level	AHU-20	Carrier Air Handling Unit	1000 CFM	1		Not mentioned	Not evaluated	Not evaluated	
	Mezzanine Level	AHU-Admin	Carrier Air Handling Unit 39LC10	N/A	1		Not mentioned	Not evaluated	Not evaluated	
		Exhaust Fans			20		Not mentioned	Recommend Replacement	Not evaluated	
	Baseyard Brake Room	Window AC Unit	C200NU	20,000 BTU/H	1	2008	Not mentioned	Recommend Replacement	Recommend Replacement, dysfunctional	

Site	Area Served	Equipment Tag	Equipment Description	Size	Qty	Date Ma	Ameresco Operating Condition	Johnson Controls	Insynergy	Notes
	Baseyard Office	Window AC Unit	LG	24,000 BTU/H	1		Recommend Replacement	Recommend Replacement	Recommend Replacement	
	Baseyard Shop Area	Window AC Unit	Panasonic	12,000 BTU/H	1		Not mentioned	Serviceable	Recommend Replacement	
	Baseyard Shop Area	Window AC Unit	N/A	12,000 BTU/H	1		Recommend Replacement	Recommend Replacement	Recommend Replacement	
	Baseyard Shop Area	Window AC Unit	Goldstar	12,000 BTU/H	1		Not mentioned	Serviceable	Recommend Replacement	
	Baseyard Shop Area	Window AC Unit	N/A	12,000 BTU/H	1		Recommend Replacement	Recommend Replacement	Recommend Replacement	
	Baseyard Shop Area	Window AC Unit	Quasar	12,000 BTU/H	1		Recommend Replacement	Recommend Replacement	Recommend Replacement	
	Fire Station	ACCU-1	Carrier Split System Unit 38AKS028---500	25 tons	1	1994	Not mentioned	Recommend Replacement	Recommend Replacement	
	Fire Station	AHU-1	Carrier Air Handling Unit 39LB1213AB1031	25 tons	1	1994	Not mentioned	Recommend Replacement	Recommend Replacement	
							Not mentioned			
Molokai Airport	Molokai Airport	Window Unit	N/A	2 tons	1		Not mentioned	Serviceable	Serviceable	
	Molokai Airport	Window Unit	N/A	1 ton	1		Not mentioned	Serviceable	Serviceable	
	Baseyard Office	Split System Unit	Goodman CRT30-1	2.5 tons	1	2006	Not mentioned	Good condition	Serviceable	
	Molokai Airport Fire Station	Window Unit	Panasonic CW-C60YU	5,800 btu/h	1	2002	Not mentioned	Serviceable	Serviceable, bldg to be demolished	
	Molokai Airport Fire Station	Window Unit	Panasonic CW-12	11,500 btu/h	1	1994	Recommend replacement	Serviceable	Recommend replacement	
	Molokai Airport Fire Station	Window Unit	Goldstar GWHD6507R	6,500 btu/h	1		Not mentioned	Serviceable	Serviceable, bldg to be demolished	
	Molokai Airport Fire Station	Window Unit	Goldstar GWHD6507R	6,500 btu/h	1		Not mentioned	Serviceable	Serviceable, bldg to be demolished	
	Molokai Airport Fire Station	Window Unit	Goldstar GWHD6507R	6,500 btu/h	1		Not mentioned	Serviceable	Serviceable, bldg to be demolished	
	Molokai Airport Fire Station	Window Unit	Goldstar GWHD6507R	6,500 btu/h	1		Not mentioned	Serviceable	Serviceable, bldg to be demolished	
	Molokai Airport Fire Station	Window Unit	LG LWHD1800RY7	17,500 btu/h	1		Not mentioned	Serviceable	Serviceable, bldg to be demolished	
	Molokai Airport Fire Station	Window Unit	LG LWHD1800RY7	17,500 btu/h	1		Not mentioned	Serviceable	Serviceable, bldg to be demolished	
Waimea Kohala Airport	Waimea Kohala Airport	Window Unit	n/a	1 ton	1		Not mentioned	Recommend Replacement	Serviceable	None one available to verify sizes
	Waimea Kohala Fire Station	Exhaust Fan	n/a	300 CFM	1		Not mentioned		Serviceable	None one available to verify sizes

Attachment M1.2

Mechanical Field Survey – Honolulu International Airport

Date Manfct	Ameresco Operating Condition	Johnson Controls Equipment Tag	Equipment Description	Johnson Controls Size	Qty	Date Manfct	Operating Condition	Ameresco ECM #	Johnson Controls ECM #	Notes
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6 -EMCS upgrades throughout Identified Buildings	ECM #4.3 DDC Control systems into a single network, system wide.	Ameresco has listed great detail about the systems they propose, JCI has "broadbrushed" this ECM
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	JCI Upgrade or new DDC, network to allow DOT monitoring of Temps, Status& ability to change system Setpoints, modify Schedules, Add Demand Control Ventilation, Time of Day scheduling, Exhaust fan interlocks, CO2 Monitoring & fan control, Enterprise-wide Continuous Monitoring, Tenant Sub-metering, and provide Flight Information Display to drive lighting and HVAC Schedules.
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same

Date Manfct	Ameresco Operating Condition	Johnson Controls Equipment Tag	Equipment Description	Johnson Controls Size	Qty	Date Manfct	Operating Condition	Ameresco ECM #	Johnson Controls ECM #	Notes
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	

Date Manfct	Ameresco Operating Condition	Johnson Controls Equipment Tag	Equipment Description	Johnson Controls Size	Qty	Date Manfct	Operating Condition	Ameresco ECM #	Johnson Controls ECM #	Notes
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
										same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same

Date Manfct	Ameresco Operating Condition	Johnson Controls Equipment Tag	Equipment Description	Johnson Controls Size	Qty	Date Manfct	Operating Condition	Ameresco ECM #	Johnson Controls ECM #	Notes
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #6	ECM#4.3	same
Smardt Chiller	Abandon Trane chillers in place.	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #7 -Chiller Plant Upgrades	ECM #3.3 Chiller Replacements	Again, Ameresco has listed great detail about the systems they propose, JCI has "broadbrushed" this ECM
Trane	Remove & Replace	None Provided	None Provided	1000-ton oiless bearing Chiller		2 None Provided	McQuay Chiller Model PEH126 - poor condition	ECM #7-1000-ton Chillers to replace existing with Hi-Eff units	ECM #3.32, 1,000 tons oiless Chillers on a Micro Grid at (4160v) & one in	Johnson has not consider impact of Microgrid system (3.0 MW battery system and change-over issues) or to reduce voltage levels to make use of variable frequency drives made in the 480 volt range. Owner has already had Ewa Chiller plant redesigned to allow use of chilled water throughout the airport chilled water loop to operate in concert with the other plants.
Spiro-therm	Add	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #8, 1-Spirotherm Spirotrap Dirt Filter	No Matching ECM	Johnson did not list this ECM item.
None Provided	None Provided	None Provided	Air cooled water chiller on roof with VFD on compressors and/or hot gas bypass circuit.	15-Ton		1 None Provided	None Provided	None	ECM 3.3 Chiller replacement in Admin tower	Ameresco did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.

Date Manfct	Ameresco Operating Condition	Johnson Controls Equipment Tag	Equipment Description	Johnson Controls Size	Qty	Date Manfct	Operating Condition	Ameresco ECM #	Johnson Controls ECM #	Notes
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
Carrier	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #9 Replace HVAC Equipment	No Matching ECM	Johnson did not list this ECM item.
LG	Remove & Replace	None Provided	Replace Window Unit A/C unit	1-ton		7 None Provided	None Provided	ECM #10 Replace window units	ECM 3.2 Window A/C unit replacement	Similar in power savings estimates per unit.
not given	Remove & Replace	None Provided	none provided	Replace Chilled water pump	None Provided	None Provided	None Provided	ECM #11 Variable Volume Pumping	not specific	Johnson did not list specific pump hp's sizes.
not given	Remove & Replace	None Provided	none provided	Add VFD to Chilled water pump	None Provided	None Provided	None Provided	ECM #11 Variable Volume Pumping	not specific	Johnson did not list specific pump hp's sizes.
not given	Remove & Replace	None Provided	none provided	Add VFD to Condenser water pump	None Provided	None Provided	None Provided	ECM #11 Variable Volume Pumping	not specific	Johnson did not list specific pump hp's sizes.
not given	Remove & Replace	None Provided	none provided	Add VFD to Chilled water pump	None Provided	None Provided	None Provided	ECM #11 Variable Volume Pumping	not specific	Johnson did not list specific pump hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.

Date Manfct	Ameresco Operating Condition	Johnson Controls Equipment Tag	Equipment Description	Johnson Controls Size	Qty	Date Manfct	Operating Condition	Ameresco ECM #	Johnson Controls ECM #	Notes
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.

Date Manfct	Ameresco Operating Condition	Johnson Controls Equipment Tag	Equipment Description	Johnson Controls Size	Qty	Date Manfct	Operating Condition	Ameresco ECM #	Johnson Controls ECM #	Notes
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #12 Variable Volume Fan Control	ECM 6.8 Variable Frequency Drives	Johnson did not list specific fan hp's sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.

Date Manfct	Ameresco Operating Condition	Johnson Controls Equipment Tag	Equipment Description	Johnson Controls Size	Qty	Date Manfct	Operating Condition	Ameresco ECM #	Johnson Controls ECM #	Notes
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #13 Replace Exhaust Fans	No Matching ECM	Johnson did not list specific exhaust fan cfm sizes.
not given	Remove & Replace	None Provided	None Provided	None Provided	None Provided	None Provided	None Provided	ECM #20 Replace Electric Water Coolers with Hi-Eff type	No Matching ECM	Notes indicated up to 200 Watts per unit can be realized. A good approach to reducing plug loads.

Attachment E1

Electrical Field Survey - Airports

		Ameresco	Johnson Controls		Installation verified for site?	Installation comment for site	Comment for site
DOT Site	**Location**	**ECM #**	**ECM #**	**ECM Description**			
Dillingham Airport	**Control Tower/Airplane Hangers**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology where possible	**Yes**	Lots of fixtures detoriated and diffusers missing. Recommend replacement.	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Lots of fixtures detoriated and diffusers missing. Recommend replacement.	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**No**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**		PV is to be installed on buildings that use very little power. May have to trench power back to the main utility service.
Dillingham Airport	**Maintenance**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Lots of fixtures detoriated and diffusers missing. Recommend replacement.	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Lots of fixtures detoriated and diffusers missing. Recommend replacement.	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**NA**		
Hilo Airport	**Terminals**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology where possible	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Power & Lights used often at terminals, gates.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Check with Hilo Ordinance before doing exterior lighting work. Manager Steven Santiago prefers prototype LED installed at high bay near his office. Manager says has been shutting down wing of airport power to cut costs
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	Check with Hilo Ordinance before doing exterior lighting work. Power & Lights used often at terminals
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**Yes**	Replace exist 20 dry types with new	Located in Electric Rms
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Integrate exist PV system with new	High amount of roof area for new PV system
Hilo Airport	**Maintenance**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Check with Hilo Ordinance before doing exterior lighting work. Only Emergency nightime work use most lights
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	Check with Hilo Ordinance before doing exterior lighting work. Only Emergency nightime work use most lights
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Install new PV system using roof	
Hilo Airport	**Fire Station**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Check with Hilo Ordinance before doing exterior lighting work. Only Emergency nightime work use most lights
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	Check with Hilo Ordinance before doing exterior lighting work. Only Emergency nightime work use most lights
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Install new PV system using roof	
Honolulu Airport	**Terminals**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology where possible	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	

		Ameresco	Johnson Controls		Installation verified for site?	Installation comment for site	Comment for site
DOT Site	**Location**	**ECM #**	**ECM #**	**ECM Description**			
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**No**		Could not Get Access
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**		
Honolulu Airport	**Maintenance**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**No**		Could not get access.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**No**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**No**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**NA**		
Honolulu Airport	**Fire Station**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**No**		Could not get access.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**No**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**No**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**NA**		
Kahului Airport	**Terminals**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology where possible	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Some fixtures detoriated, need to replace as required.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Make sure replacements meet Maui Lighiting Ordinance.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	Make sure replacements meet Maui Lighiting Ordinance.
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**No**		Could not get access
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**		Some roof's need repair. Some of Johnson's PV to be installed on buildings not in job scope.
Kahului Airport	**Maintenance**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**No**		Could not get access.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**No**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**No**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**NA**		
Kahului Airport	**Fire Station**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**No**		Could not get access.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**No**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**No**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**NA**		

DOT Site	Location	Ameresco ECM #	Johnson Controls ECM #	ECM Description	Installation verified for site?	Installation comment for site	Comment for site
Kalaeloa Airport		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology where possible	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	About 1/3 of Building not used at all, abandoned.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**No**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**		Johnson's PV to be installed on buildings not in job scope. (Next Door on Hangars)
Kapalua Airport		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology where possible	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Airport only operates 6am-6pm normally. No lights in runway.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Roof looks OK	
Kona Airport	**Terminals**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology where possible	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**No**		Did not verify, could not access electric rooms.
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**		Some of Johnson's PV is to be installed on buildings not in job scope.
Kona Airport	**Maintenance**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**No**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**No**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Roof looks OK	
Kona Airport	**Fire Station**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**No**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**No**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Roof looks OK	
Lanai Airport	**Terminals**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology where possible	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Worker is Gordon, has office at baggage terminal. Securitas and TSA present mostly. Roof repairs needed before electrical work, water leaks.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Power & Lights used often at terminals, taxiway at Night. Many lights not working at all. Need repair and replacement for Security and Safety.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	Power & Lights used often at terminals, taxiway at Night. Many lights not working at all. Need repair and replacement for Security and Safety. Include new bollard type parking lot fixtures.

DOT Site	Location	Ameresco ECM #	Johnson Controls ECM #	ECM Description	Installation verified for site?	Installation comment for site	Comment for site
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	Yes	Replace 2 dry type transformers	Located in Electric Rm
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	Yes	Integrate exist PV system with new	High amount of roof area for PV system, repair roof first.
Lanai Airport	Maintenance	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	Yes	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Securitas has office space located in building.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	Yes	Clean fixture lense, retrofit or replace entire fixture if necessary	Only Emergency nightime work use most lights
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	Yes		Only Emergency nightime work use most lights
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	NA		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	Yes	Install new PV system using roof & ground	Ground array PV area near parking area and roof area for PV system
Lanai Airport	Fire Station	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	Yes	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	New ARFF under construction, foundation is complete observed 11/10/11.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	Yes	Clean fixture lense, retrofit or replace entire fixture if necessary	Only Emergency nightime work use most lights
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide	NA		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	NA		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	Yes	Install new PV system using roof & ground	Ground array PV area near parking area and roof area for PV system
Lihue Airport	Terminals	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology where possible	Yes	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Manager is Tim Skinner. Urges state for better manufacturer training for lighting/signage. LED runway lighting, hard to replace he says.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	Yes	Clean fixture lense, retrofit or replace entire fixture if necessary	Check with Kauai sheerwater bird ordinance before doing lighting work. Power & Lights used often at terminals, taxiway at night
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	Yes	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	Check with Kauai sheerwater bird ordinance before doing lighting work. Power & Lights used often at terminals, taxiway at night
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	Yes	Replace 24 existing drytype with new	Assumption: Located in Electric Rms.
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	Yes	Integrate exist PV system with new	High amount of roof area for PV system
Lihue Airport	Maintenance	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	Yes	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Employee Escort was Machado
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	Yes	Clean fixture lense, retrofit or replace entire fixture if necessary	Check with Kauai sheerwater bird ordinance before doing lighting work. Only Emergency nightime work use most lights
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	Yes	Pole only presently. Fixture heads needed at back lot.	Check with Kauai sheerwater bird ordinance before doing lighting work. Only Emergency nightime work use most lights
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	NA		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	Yes	Install new PV system using roof	
Lihue Airport	Fire Station	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	Yes	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Fairly new ARFF constructed in 1990s, located oceanside of runway.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	Yes	Clean fixture lense, retrofit or replace entire fixture if necessary	Check with Kauai sheerwater bird ordinance before doing lighting work. Only Emergency nightime work use most lights
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide	NA		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	NA		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	Yes	Install new PV system using roof	
Molokai Airport	Terminals	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology where possible	Yes	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Manager Carl Britto office is located at maintenance yard office.

		Ameresco	Johnson Controls		Installation verified for site?	Installation comment for site	Comment for site
DOT Site	**Location**	**ECM #**	**ECM #**	**ECM Description**			
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Power & Lights used often at terminals at night. Roof/Bldg repairs to do, before lighting work.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	Power & Lights used often at terminals at night. Roof/Bldg repairs to do, before lighting work.
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Integrate exist PV system with new	High amount of roof area for PV system, repair roof first as needed.
Molokai Airport	**Maintenance**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Only Emergency nightime work use most lights
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		Only Emergency nightime work use most lights
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Install new PV system using roof & ground	Ground array PV area west of maintenance bldg and roof area for PV system
Molokai Airport	**Fire Station**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Fairly new ARFF, one man working. Only Emergency nightime work use most lights
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Only Emergency nightime work use most lights
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Install new PV system using roof	
Waimea-Kohala Airport		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology where possible	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Terminal was abandoned when we went at 12:00. Majority of lights left on.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**NA**		

Attachment M2

Mechanical Field Survey - Harbors

Site	Area Served	Equipment Tag	Equipment Description	Size	Qty	Date Manf	Ameresco Operating Condition	Johnson Controls	Insynergy	Notes
Hilo Harbor	Harbors Division Office	Split System	Carrier 40BA-009---300	5 tons	1	1998	Recommend Replacement	Recommend Replacement	Recommend Replacement	Ameresco calls this AHU 1, 10 tons?, 1988
	Harbors Division Office	Window Units	LG LW510ER	15,000 Btu/h	1		NM - Good condition	Serviceable	Serviceable	jalouise windows in conditioned space
	Harbors Division Office	Window Units	Panasonic	15,000 Btu/h	1		NM - Good condition	Serviceable	Serviceable	
	Maintenance Shop	Window Units	Panasonic CW-C120MU	11,500 Btu/h	1		Recommend Replacement	Serviceable	Serviceable	
	Maintenance Shop	Window Units	LG LWHD1006RYR	10,000 Btu/h	1		Recommend Replacement	Serviceable	Serviceable	
	Pier 1	NO HVAC					No HVAC	No HVAC	No HVAC	
Honolulu Harbor	Pier 19 Ferry Terminal	AHU-1	Mammoth Split System	n/a	1	2002	Not mentioned	Good condition		Not visited
	Pier 19 Ferry Terminal	CU-1	Mammoth Split System	n/a	1	2002	Not mentioned	Good condition		Not visited
	Pier 19 Ferry Terminal	Split System	Carrier Split System	3 tons	1	2002	Not mentioned	Good condition		Not visited
	Pier 19 Ferry Terminal	Split System	Carrier Split System	2.5 tons	1	2002	Not mentioned	Good condition		Not visited
	Pier 31-33	No HVAC								Not visited
	Pier 38	No HVAC							EF only for restrooms	
	Pier 2 Passenger Terminal	AHU-1	Trane Air Handler	43,500 cfm	1	2005	Not mentioned	Good condition	Serviceable	
	Pier 2 Passenger Terminal	AHU-2	Trane Air Handler	40,000 cfm	1	2005	Not mentioned	Good condition	Serviceable	
	Pier 2 Passenger Terminal	Chiller 1	Trane Chiller RTHD UC1F	225 tons	1	2005	Not mentioned	Good condition	Serviceable	
	Pier 2 Passenger Terminal	Chiller 2	Trane Chiller RTHD UC1F	225 tons	1	2005	Not mentioned	Good condition	Serviceable	
	Pier 2 Passenger Terminal	PCHWP-1	n/a	7.5 hp	1	2005	Retrofit	Good condition	Serviceable	
	Pier 2 Passenger Terminal	PCHWP-2	n/a	7.5 hp	1	2005	Retrofit	Good condition	Serviceable	
	Pier 2 Passenger Terminal	SCHWP-1	n/a	25 hp	1	2005	Retrofit	Good condition	Serviceable	
	Pier 2 Passenger Terminal	SCHWP-2	n/a	25 hp	1	2005	Retrofit	Good condition	Serviceable	
	Pier 2 Passenger Terminal	CWP-1	n/a	15 hp	1	2005	Retrofit	Good condition	Serviceable	
	Pier 2 Passenger Terminal	CWP-2	n/a	15 hp	1	2005	Retrofit	Good condition	Serviceable	
	Pier 2 Passenger Terminal	CT-1	Evapco LSTB8P112	225 tons	1	2005	Not mentioned	Good condition	Serviceable	
	Pier 2 Passenger Terminal	CT-2	Evapco LSTB8P112	225 tons	1	2005	Not mentioned	Good condition	Serviceable	
	Pier 2 Office	Split System	Mitsubishi	2 tons	1			Good condition		
	Pier 2 Office	Split System	Trane	5 tons	1	1998	Not mentioned	Recommend Replacement		
	Pier 2 Office	Split System	Trane	5 tons	1	1998	Not mentioned	Recommend Replacement		
	Pier 2 Passenger Terminal	Aire Curtains	Powered Aire BCE-2-72	4,838 cfm	1	2005	Not mentioned	Good condition	Serviceable	
	Pier 2 Passenger Terminal	Aire Curtains	Powered Aire BCE-2-72	4,838 cfm	1	2005	Not mentioned	Good condition	Serviceable	
	Pier 2 Passenger Terminal	Aire Curtains	Powered Aire BCE-2-72	4,838 cfm	1	2005	Not mentioned	Good condition	Serviceable	
	Pier 2 Passenger Terminal	Aire Curtains	Powered Aire BCE-2-72	4,838 cfm	1	2005	Not mentioned	Good condition	Serviceable	
	Pier 2 Passenger Terminal	Aire Curtains	Powered Aire BCE-2-72	4,838 cfm	1	2005	Not mentioned	Good condition	Serviceable	
	Pier 11 Passenger Terminal	Split System	Daikin	11,500 btuh	1		Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Air Door	Air Door	9,676 btuh	1		Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Air Door	Air Door	4,250 btuh	1		Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Window Units	Friedrich	1 ton	1		Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Split System	Mitsubishi	9,000 btuh	1		Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Split System	Mitsubishi	9,000 btuh	1		Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Split System	Mitsubishi	9,000 btuh	1		Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Split System	Mitsubishi	12,000 btuh	1		Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Air Door	Air Door	2,820 btuh	3		Not mentioned	Serviceable	Serviceable	
	Operations Supervisors	Split System	Carrier	2 tons	1	2000	Not mentioned	Serviceable	Serviceable	
	Operations Supervisors	Split System	Carrier	2 tons	1	2000	Not mentioned	Serviceable	Serviceable	
	Operations Supervisors	Split System	Carrier	3/4 tons	1	2000	Not mentioned	Serviceable	Serviceable	
	Operations Supervisors	Split System	Carrier	3/4 tons	1	2000	Not mentioned	Serviceable	Serviceable	
	Operations Supervisors	Split System	Carrier	1.5 tons	1	1999	Not mentioned	Serviceable	Serviceable	
	Operations Supervisors	Split System	Carrier	2 tons	10	2000	Not mentioned	Recommend Replacement		Not visited
	Pier 11 Passenger Terminal	Package Rooftop	Carrier	25 tons	1	2003	Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Package Rooftop	Carrier	25 tons	1	2003	Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Package Rooftop	Carrier	25 tons	1	2003	Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Package Rooftop	Carrier	25 tons	1	2003	Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Split System	Fujitsu	1.5 tons	1		Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Split System	Fujitsu	1.5 tons	1		Not mentioned	Serviceable	Serviceable	
	Pier 11 Passenger Terminal	Split System	Fujitsu	2 tons	1		Not mentioned	Serviceable	Serviceable	
	Pier 10	Package Rooftop	Carrier	20 tons	1	1993	Not mentioned	Abandoned		Not visited
	Pier 10	Package Rooftop	Carrier	20 tons	1	1993	Not mentioned	Abandoned		Not visited
	Pier 10	Package Rooftop	Carrier	20 tons	1	1993	Not mentioned	Abandoned		Not visited
	Admin Building	AHU-1	Magic Aire Chilled Water Coil	4 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-2	Magic Aire Chilled Water Coil	4 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-3	Magic Aire Chilled Water Coil	3 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-4	Magic Aire Chilled Water Coil	3 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-5	Magic Aire Chilled Water Coil	3 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-6	Magic Aire Chilled Water Coil	4 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-7	Magic Aire Chilled Water Coil	1 ton	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-8	Magic Aire Chilled Water Coil	3 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-9	Magic Aire Chilled Water Coil	4 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-10	Magic Aire Chilled Water Coil	4 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-11	Magic Aire Chilled Water Coil	4 tons	1	2007	Not mentioned	Good condition	Serviceable	

Site	Area Served	Equipment Tag	Equipment Description	Size	Qty	Date Manf	Ameresco Operating Condition	Johnson Controls	Insynergy	Notes
	Admin Building	AHU-12	Magic Aire Chilled Water Coil	4 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-13	Magic Aire Chilled Water Coil	4 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-14	Magic Aire Chilled Water Coil	5 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-15	Magic Aire Chilled Water Coil	4 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-16	Magic Aire Chilled Water Coil	4 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-17	Magic Aire Chilled Water Coil	3 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-18	Magic Aire Chilled Water Coil	4 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	AHU-19	Magic Aire Chilled Water Coil	5 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	Ch-1	Carrier Air Cooled Chiller	80 tons	1	1996	Not mentioned	Recommend Replacement	Serviceable	
	Admin Building	Ch-2	Carrier Air Cooled Chiller	80 tons	1	2007	Not mentioned	Good condition	Serviceable	
	Admin Building	CHWP-1	Baldorm	10 hp	1		Retrofit	Recommend Replacement	Recommend Replacement	
	Admin Building	CHWP-2	Baldorm	10 hp	1		Retrofit	Recommend Replacement	Recommend Replacement	
	Sand Island Baseyard	AHU-1	Carrier Package Unit	10 tons	1	1992	Not mentioned	Recommend Replacement	Recommend Replacement	
	Sand Island Baseyard	Window Units	Friedrich	2 tons	1		Recommend Replacement	Serviceable	Serviceable	
	Sand Island Baseyard	Window Units	Friedrich	2 tons	1		Recommend Replacement	Serviceable	Serviceable	
	Sand Island Baseyard	Window Units	Friedrich	2 tons	1		Recommend Replacement	Serviceable	Serviceable	
	Sand Island Baseyard	Window Units	Carrier	2 tons	1		Recommend Replacement	Recommend Replacement	Serviceable	
	Sand Island Baseyard	Window Units	Panasonic	1 ton	1		Recommend Replacement	Serviceable	Serviceable	
	Sand Island Baseyard	Window Units	Friedrich	1 ton	1		Recommend Replacement	Serviceable	Serviceable	
	Sand Island Baseyard	Window Units	Carrier	1 ton	1		Recommend Replacement	Recommend Replacement	Serviceable	
	Sand Island Baseyard	Window Units	Carrier	2 tons	1		Recommend Replacement	Recommend Replacement	Serviceable	
	Sand Island Baseyard	Window Units	Friedrich	1.5 tons	1		Recommend Replacement	Serviceable	Serviceable	
	Sand Island Baseyard	Window Units	Friedrich	1 ton	1		Recommend Replacement	Serviceable	Serviceable	
	Sand Island Baseyard	Window Units	Quasar	1 ton	1		Recommend Replacement	Recommend Replacement	Serviceable	
	Sand Island Baseyard	Window Units	Friedrich	2 tons	1		Recommend Replacement	Serviceable	Serviceable	
	Sand Island Baseyard	Window Units	Friedrich	2 tons	1		Recommend Replacement	Recommend Replacement	Serviceable	
	Sand Island Baseyard	Window Units	Carrier	2 tons	1		Recommend Replacement	Recommend Replacement	Serviceable	
	Pier 24 Harbor Police	AHU-1	Carrier Split System	20 tons	1	1994	Not mentioned	Recommend Replacement	Serviceable	
	Pier 24 Harbor Police	CU-1	Carrier Split System	10 tons	1	1992	Not mentioned	Recommend Replacement	Serviceable	
	Pier 24 Harbor Police	CU-2	Carrier Split System	10 tons	1	1992	Not mentioned	Recommend Replacement	Serviceable	
Kahului Harbor	Pier 1	Window Unit	Panasonic Window Unit	17,800 btuh	1		Not mentioned	Recommend Replacement	Serviceable	
	Pier 1	Aire Curtains	Mars Air Doors	4,838 CFM	1	2008	Not mentioned	Good Condition	Serviceable	
	Pier 1	PAC-1	Airdale CHX5	54500	1	2008	Not mentioned	Good Condition	Serviceable	
	Pier 1	PAC-2	Airdale CHX5	54500	1	2008	Not mentioned	Good Condition	Serviceable	
	Pier 1	PAC-3	Airdale CHX5	54500	1	2008	Not mentioned	Good Condition	Serviceable	
	Pier 1	PAC-4	Airdale CHX5	54500	1	2008	Not mentioned	Good Condition	Serviceable	
	Pier 1	PAC-5	Airdale CHX5	54500	1	2008	Not mentioned	Good Condition	Serviceable	
	Pier 2	No HVAC								
	Pier 3	No HVAC								
	Harbors Division Maui	ACCU-1	Carrier	7.5 tons	1	2004	Recommend Replacement	Recommend Replacement	Serviceable	
	Harbors Division Maui	AHU-1	Carrier	7.5 tons	1	2004	Recommend Replacement	Recommend Replacement	Serviceable	
	Harbors Division Maui	Window Unit	Panasonic Window Unit	7,800 btuh	1		Recommend Replacement	Recommend Replacement	Serviceable	
	Harbors Division Maui	Window Unit	Friedrich	14,000 btuh	1	2007	Recommend Replacement	Serviceable	Serviceable	
	Harbors Division Maui	Window Unit	Frigidaire Window Unit	14,000 btuh	1		Recommend Replacement	Recommend Replacement	Serviceable	
Kalaeloa Brbrs Pt Harbor	Office	Window Units	Panasonic Window Unit	1 ton	1		Recommend Replacement	Good Condition		
		Window Units	Panasonic Window Unit	1 ton	1		Recommend Replacement	Good Condition		
Kaumalapau Harbor		NO HVAC					No HVAC	No HVAC	No HVAC	
Kaunakakai Harbor	Harbor Business Office	Window Unit	N/A	1 ton	1		Not mentioned	Recommend Replacement	Recommend Replacement	
Kawaihae Harbor	Harbor Office	Window Unit	Panasonic Window Unit	11,500 btuh	1	1997	Not mentioned	Serviceable	Good condition	Building on list to be demolished
	Harbor Office	Window Unit	Panasonic Window Unit	11,500 btuh	1	1997	Not mentioned	Serviceable	Good condition	Building on list to be demolished
	Harbor Office	Window Unit	Panasonic Window Unit	18,000 btuh	1	2002	Not mentioned	Serviceable	Good condition	Building on list to be demolished
Nawiliwili Harbor	Harbors Division Office	AHU-1	Carrier 50BYN01352	12 tons	1	2006	Not mentioned	Serviceable	Good condition	
	Harbors Division Office	Split System	Trane TTR024C1100A1	2 tons	1	1996	Not mentioned	Recommend Replacement	Recommend Replacement, dysfunctional	
	Pier 2	NO HVAC					No HVAC	No HVAC	No HVAC	
	Pier 2	NO HVAC					No HVAC	No HVAC	No HVAC	
Port Allen Harbor	Admin Building	Package Unit	Bard WA231-A05	2 tons	1	1998	Not mentioned	Recommend Replacement	Recommend Replacement, corroded	

Attachment E2

Electrical Field Survey - Harbors

		Ameresco	Johnson Controls		Installation verified for site?	Installation comment for site	Comment for site
DOT Site	**Location**	**ECM #**	**ECM #**	**ECM Description**			
Hilo Harbor		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Check with Hilo Ordinance before doing exterior lighting work. Only Emergency nightime work use most lights
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	Check with Hilo Ordinance before doing exterior lighting work. Only Emergency nightime work use most lights. Many High mast shipping lights to upgrade. Split bills with YB,Matson. Manager says lot will be expanded larger in future, Manager urges state for overall lighting/equipment needs new efficient technology
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Install new PV system using roof	Manager urges PV installation. High amount of roof area for new PV system
Honolulu Harbor	**Piers 1 &2 Container Yard**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**NA**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**NA**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**No**		
					NA		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**NA**		
Honolulu Harbor	**Pier 2 (Passenger Terminal)**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS/HIGH BAY: Propose Replace most existing floodlight/high bay with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**Yes**		Did not verify all transfromers
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**NA**		
Honolulu Harbor	**Pier 10 and 11**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS/HIGH BAY: Propose Replace most existing floodlight/high bay with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**Yes**		Did not verify all transfromers
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**		Need to verify layouts, some shadows on the roof.
Honolulu Harbor	**Harbors Division Administration Building**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**NA**		

		Ameresco	Johnson Controls		Installation verified for site?	Installation comment for site	Comment for site
DOT Site	**Location**	**ECM #**	**ECM #**	**ECM Description**			
Honolulu Harbor	**Sand Island Maintenance Baseyard**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Lots of lighting not used in the daytime.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**Yes**		Did not verify all transfromers
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**		Some buildings that the PV is to be installed, do not draw too much power. May have to trench power back to the main building.
Honolulu Harbor	**Piers 31-33**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**no**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**no**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**no**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**no**		
Honolulu Harbor	**Pier 24 (Harbor Police)**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**no**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**no**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**no**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**no**		
Honolulu Harbor	**Pier 38**	Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**NA**		
Kahului Harbor		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Some occupancy sensors in exising Matson restroom not working properly.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS/HIGH BAY: Propose Replace most existing floodlight/high bay with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**Yes**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Did not verify condition of roof.	
Kalaeloa Barbers Point Harbor		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS/HIGH BAY: Propose Replace most existing floodlight/high bay with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**Yes**		Not all transformers verified.
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**		

		Ameresco	Johnson Controls		Installation verified for site?	Installation comment for site	Comment for site
DOT Site	**Location**	**ECM #**	**ECM #**	**ECM Description**			
Kaumalapau Harbor		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Tony Hernandez is YB manager. Securitas contracted, and YB lease. DOT Split bills with YB.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Coordinate with YB.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	Many High mast shipping lights to upgrade. DOT Split bills with YB.
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**NA**	Investigate Steel roof before PV work.	No Ground Array space, near cliffs. Need to confirm land ownership.
Kaunakakai Harbor		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Manager Bernie Staller office is at restroom bldg with power meters &service entrances. Split bills with YB, DLNR
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	Many High mast shipping lights to upgrade. Split bills with YB,Matson, DLNR
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Install new PV system using roof	High amount of roof area for PV system
Kawaihae Harbor		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Some fixtures changed to T-8. Told building to be Demolished soon.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**NA**		
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**NA**		
Nawiliwili Harbor		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Manager is Bob Crowell
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Check with Kauai sheerwater bird ordinance before doing lighting work.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	Check with Kauai sheerwater bird ordinance before doing lighting work.
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**Yes**	1 wall mounted transformer, shed 3	
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Integrate exist PV system with new	Admin Bldg has exist PV system. High amount of roof area for PV system at sheds.
Port Allen Harbor		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Manager is Richard Watjen. Trailer office located in shed.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Check with Kauai sheerwater bird ordinance before doing lighting work. Hardly used at nightime. Tourism businesses in daytime used often. Navy uses other side.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	Check with Kauai sheerwater bird ordinance before doing lighting work. A few High mast shipping lights to upgrade. Split bills with tourist businesses & Navy
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**Yes**	1 wall mounted transformer, middle shed	
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Install new PV system using roof	High amount of roof area for PV system, sunny weather often at Port Allen.

Attachment M3

Mechanical Field Survey - Highways

Site	Area Served	Equipment Tag	Equipment Description	Size	Qty	Date	Manf	Operating Condition	Ameresco	Johnson Controls	Insynergy	Notes
Hilo Hghwys Design/Lab	Office Building	Ductless Split System	Carrier 38HD024331	2 tons	1	2000		not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	all buildings using R-22 in systems
	Office Building	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	envelope issues need to be addressed
	Office Building	Ductless Split System	Carrier 38HD036321	3 tons	1	2000		Recommend Replacement	Serviceable	Serviceable	Serviceable, envelope needs upgrade	including insulation in roof, infiltration
	Office Building	Ductless Split System	Carrier 38HD036321	3 tons	1	2000		Recommend Replacement	Serviceable	Serviceable	Serviceable, envelope needs upgrade	through door entrances, and jalouise
	Office Building	Ductless Split System	Carrier 38HD036321	3 tons	1	2000		Recommend Replacement	Serviceable	Serviceable	Serviceable, envelope needs upgrade	windows in restrooms connected to
	Office Building	Ductless Split System	Carrier 38HD024331	2 tons	1	2000		not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	conditioned areas
	Office Building	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Office Building	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Office Building	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Office Building	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Office Building	Ductless Split System	Carrier 38HD030331	2.5 tons	1	2000		not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Office Building	Ductless Split System	Carrier 38HD036321	3 tons	1	2000		Recommend Replacement	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Office Building	Ductless Split System	Carrier 38HD036321	3 tons	1	2000		Recommend Replacement	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Office Building	Window Unit	Panasonic CW-C101MU	10,000 BTU	1			not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Design Building	Packaged Unit	Bard WA241A05	2 tons	1	1994		not mentioned	Recommend Replacement	Recommend Replacement		
	Design Building	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		Recommend Replacement	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Design Building	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		Recommend Replacement	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Design Building	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		Recommend Replacement	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Design Building	Ductless Split System	Carrier 38HD036321	3 tons	1	2000		not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Design Building	Ductless Split System	Carrier 38HD036321	3 tons	1	2000		not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Lab Building	Ductless Split System	Carrier 38HD030331	2.5 tons	1	2000		not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Lab Building	Ductless Split System	Carrier 38HD048321	4 tons	1	2000		Recommend Replacement	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Lab Building	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		Recommend Replacement	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Lab Building	Ductless Split System	Carrier 38HD030331	2.5 tons	1	2000		not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Lab Building	Ductless Split System	Carrier 38HD030331	2.5 tons	1	2000		not mentioned	Serviceable	Serviceable	Serviceable, envelope needs upgrade	
	Garage Building E	NO HVAC						No HVAC	No HVAC	No HVAC		
	Garage Building F	Window Units	LG	12,000 BTU	1			Recommend Replacement	Good Condition	Serviceable, envelope needs upgrade		
	MVSO	Window Units	Friedrich CP18E30	18,000 BTU	1			Recommend Replacement	Good Condition	Serviceable, envelope needs upgrade		
	Maintenance Section Office	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		Recommend Replacement	Serviceable	Serviceable, envelope needs upgrade		
	Maintenance Section Office	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		not mentioned	Serviceable	Serviceable, envelope needs upgrade		
	Maintenance Section Office	Ductless Split System	Carrier 38HD036321	3 tons	1	2000		not mentioned	Serviceable	Serviceable, envelope needs upgrade		
	Maintenance Section Office	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		not mentioned	Serviceable	Serviceable, envelope needs upgrade		
	Building D	Ductless Split System	Carrier 38HD048321	4 tons	1	2000		Recommend Replacement	Serviceable	Serviceable, envelope needs upgrade		
	Building D	Ductless Split System	Carrier 38HD024331	2 tons	1	2000		not mentioned	Serviceable	Serviceable, envelope needs upgrade		
	Building D	Ductless Split System	Carrier 38HD048321	4 tons	1	2000		Recommend Replacement	Serviceable	Serviceable, envelope needs upgrade		
	Building C	Ductless Split System	Carrier 38HD036321	3 tons	1	2000		not mentioned	Serviceable	Serviceable, envelope needs upgrade		
	Building C	Ductless Split System	Carrier 38HD024C300	2 tons	1	2000		Recommend Replacement	Serviceable	Recommend Replacement		
	Building C	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		not mentioned	Serviceable	Serviceable, envelope needs upgrade		
	Building B	Ductless Split System	Carrier 38HD018341	1.5 tons	1	2000		Recommend Replacement	Serviceable	Serviceable, envelope needs upgrade		
	Building B	Ductless Split System	Carrier 38HD024C300	2 tons	1	2000		not mentioned	Serviceable	Serviceable, envelope needs upgrade		
Kahului Hghwys Baseyard	Admin	Chiller 1	Trane	40 tons	1	2002		not mentioned	Serviceable	Serviceable		Considered near end of useful life
	Admin	CHWP-1	n/a	3 hp	1			not mentioned	Serviceable	Serviceable		Considered near end of useful life
	Admin	CHWP-2	n/a	3 hp	1			not mentioned	Serviceable	Serviceable		Considered near end of useful life
	Admin	AHU #1-6	Carrier AHU's	1700-3000	6	1991		not mentioned	Serviceable	Serviceable		Considered near end of useful life
	Building 2	Window Unit	Friedrich	17,800 btu	1			not mentioned	Recommend Replacement	Serviceable		
	Building 2	Window Unit	Panasonic Window Unit	17,800 btuh				not mentioned	Recommend Replacement	Serviceable		
	Building 2	Window Unit	Friedrich	17,800 btuh				not mentioned	Recommend Replacement	Serviceable		
	Building 3	Window Unit	n/a	12,800 btuh				not mentioned	Serviceable	Serviceable		
	Building 3	Window Unit	Panasonic Window Unit	24,000 btuh				not mentioned	Serviceable	Serviceable		
Kauai Highways Baseyard	Main Office	Mini Split System	Mitsubishi Electric MS17TN	1.5 tons	1	2002		not mentioned	Good Condition	Not evaluated		
	Main Office	ACCU 1-1	Carrier Air-Cooled Cond Unit :	50 tons	1	2002		not mentioned	Recommend Replacement	Recommend Replacement		
	Main Office	AHU 1-1	Carrier Air Handling Unit 39TH	50 tons	1	2002		not mentioned	Serviceable	Serviceable		
	Lab Building	Mini Split System	Carrier 40QNB024N	2 tons	1	2002		not mentioned	Recommend Replacement	Serviceable, not in use		
	Lab Building	Mini Split System	Carrier 40QNB048N	4 tons	1	2002		not mentioned	Recommend Replacement	Serviceable		
	Lab Building	Mini Split System	Carrier 38HDC024331	2 tons	1	2002		not mentioned	Recommend Replacement	Serviceable, not in use		
	Lab Building	Mini Split System	Carrier 38HDC048331	4 tons	1	2002		not mentioned	Recommend Replacement	Serviceable		
	Maintenance Office Bldg	ACCU 2-1	Carrier Air Cooled Cond Unit :	15 tons	1	2002		not mentioned	Serviceable	Not evaluated		
	Maintenance Office Bldg	AHU 2-1	Carrier Air Handling Unit 39LA	15 tons	1	2002		not mentioned	Good Condition	Not evaluated		
	Shop Building	Mini Split System	Carrier 40QNB012N	1 ton	1	2002		not mentioned	Serviceable	Good condition		
	Shop Building	Mini Split System	Carrier 38AN012310	1 ton	1	2002		not mentioned	Serviceable	Good condition		
	Shop Building	Mini Split System	Carrier 40QNB012N	1 ton	1	2002		not mentioned	Serviceable	Good condition		
	Shop Building	Mini Split System	Carrier 38AN012310	1 ton	1	2002		not mentioned	Serviceable	Good condition		

Site	Area Served	Equipment Tag	Equipment Description	Size	Qty	Date	Manf	Operating Condition	Ameresco	Johnson Controls	Insynergy	Notes
	Shop Building	Mini Split System	Carrier 40QNB012N	1 ton	1	2002		not mentioned		Serviceable	Good condition	
	Shop Building	Mini Split System	Carrier 38AN012310	1 ton	1	2002		not mentioned		Serviceable	Good condition	
	Shop Building	Window Units	N/A	1 ton	1	2002		not mentioned		Serviceable	Good condition	
Keanae Hghwys Baseyard	Office	Condenser	Carrier Split System	4 tons	1	1998		not mentioned		Recommend Replacement		
Lanai Highways Baseyad		NO HVAC						No HVAC		No HVAC	No HVAC	
Molokai Hghwys Bsyrd	Main Office	Split System Unit	Rheen RAKB-060JAZ	5 tons	1	2004		not mentioned		Good Condition	Good Condition	
	Shop Office	Window Unit	Friedrich Window AC	6,000 BTU/	1			Recommend Replacement		Serviceable	Serviceable, Energy Star	
Oahu Hghways Baseyard	Admin Bldg	Package Unit	York	15 tons	1	2002		not mentioned		Recommend Replacement		
	Admin Bldg	Split System	Carrier	25 tons	1	1993		not mentioned		Recommend Replacement		
	Admin Bldg	Split System	n/a	2 tons	1			not mentioned		Good condition		
	Motor Pool Bldg	Window Unit	n/a	1 ton	1			not mentioned		Good condition		
	Heavy Equipt Shop	Window Unit	n/a	2 tons	1			not mentioned		Good condition		
	Maintenance Shop	Split System	n/a	2 tons	1			not mentioned		Good condition		
	Warehouse Bldg	Window Unit	n/a	2 tons	1			not mentioned		Good condition		
	Warehouse Bldg	Window Unit	n/a	2 tons	1			not mentioned		Recommend Replacement		

Attachment E3

Electrical Field Survey - Highways

		Ameresco	Johnson Controls		Installation verified for site?	Installation comment for site	Comment for site
DOT Site	**Location**	**ECM #**	**ECM #**	**ECM Description**			
Hilo Highway Labs and Baseyard		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Manager Sal urges state for overall lighting/equipment needs new efficient technology
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Check with Hilo Ordinance before doing exterior lighting work. Only Emergency nightime work use lights.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	Check with Hilo Ordinance before doing exterior lighting work. Only Emergency nightime work use lights.
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Install new PV system using roof	High amount of roof area for new PV system
Maui Hwys Maint Baseyard		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Some lights are T-12 and some are missing diffusers - need to replace fixture or diffuser as necessary.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Check with Maui Ordinance before doing exterior lighting work.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Install new PV system using roof	Some of the buildings that PV to be installed have very little electricity use. Will have to trench to main building to connect.
Kauai Highway Labs and Baseyard		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Manager is Raymond Mccormick. Fairly new Bldg 1998
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Check with Kauai sheerwater bird ordinance before doing lighting work. Only Emergency nightime work use lights.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		Check with Kauai sheerwater bird ordinance before doing lighting work. Only Emergency nightime work use lights.
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**Yes**	3 drytype transformers to replace.	
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Integrate exist PV system with new	Exist PV system at Shop Building. High amount of roof area for PV system
Lanai Highway Labs and Baseyard		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Integrate exist PV system with new	Ground array PV area near parking area and roof area for PV system
Molokai Highway Maintenance		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Workers Charles & Daryl. New Bldg built 2006.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	Only Emergency nightime work use lights.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**NA**		
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**		
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**	Integrate exist PV system with new	High amount of roof area for PV system. PV system is installed at Shop Building 23KW.
Oahu Highways Maint Baseyard		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	INTERIORS: Propose Retrofit most existing fixtures with 25W T8 lamps and electronic or instant start ballast. Change switches to occupancy sensor technology	**Yes**	Clean fixture lense, retrofit with new bulbs & ballasts or replace entire fixture if necessary	Lots of the lighting not used in the daytime.
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	EXTERIORS: Propose Replace most existing floodlight/exteriors with induction type or lower wattage, better lighting controls efficiency	**Yes**	Clean fixture lense, retrofit or replace entire fixture if necessary	
		Premium Efficiency Lighting and Lighting Controls	Efficient Lighting and Controls ECMs: 1.1-2.8	LOTS/YARDS: Propose Replace most Pole Mounted High mast HPS with Pulse Start metal hallide, better lighting controls efficiency	**Yes**	Replace fixture heads, re-use pole or replace entire pole and fixture if necessary	
		Transformer Audit	Transfomer Replacement ECM 11.2	Propose Replace existing dry type transformers with new energy efficient type	**NA**	NA	
		PV Power Generation	PV - Renewable Energy	Propose Roof or Ground Arrays, with inverter systems	**Yes**		Some of the buildings that PV to be installed have very little electricity use. Will have to trench to main building to connect.

APPENDIX 2.18

DOT ESPC Proposal Comparison

1 - SUMMARY - BASELINE ENERGY USAGE, ECM COST AND SAVINGS

			Ameresco	Johnson Controls	
Averaged Utility Rates					
	Electricity ($/kwh)	Oahu	0.23	0.25	
	Electricity ($/kwh)	Maui	0.31	0.32	
	Electricity ($/kwh)	Molokai	0.43	0.47	
	Electricity ($/kwh)	Hawaii	0.38	0.33	
	Electricity ($/kwh)	Kauai	0.39	0.35	
	Electricity ($/kwh)	Lanai	0.47	0.43	
	Water/Sewer ($/kgal)	Oahu	12.078	4.243	*see note 1
	Water/Sewer ($/kgal)	Maui	8.422	5.365	
	Water/Sewer ($/kgal)	Molokai	12.233	0	
	Water/Sewer ($/kgal)	Hawaii	4.832	4.660	
	Water/Sewer ($/kgal)	Kauai	4.257	11.650	
	Water/Sewer ($/kgal)	Lanai	1.714	0	
Current Baseline Energy Use	Electricity (kwh/year)	Airports	126,966,871	128,075,784	
	Electricity (kwh/year)	Harbors	5,158,000	4,852,494	
	Electricity (kwh/year)	Highways	644,989	693,636	
	Electricity (kwh/year)	**Total**	**132,769,860**	**133,621,914**	
	Water (kgal/year)	Airports	639,333	371,360	
	Water (kgal/year)	Harbors	128,756	148,142	
	Water (kgal/year)	Highways	7,720	14,473	
	Water (kgal/year)	**Total**	**775,809**	**533,975**	*see note 1
Current Baseline Energy Cost	Electricity ($/year)	Airports	29,769,387	not given	
	Electricity ($/year)	Harbors	1,399,279	not given	
	Electricity ($/year)	Highways	208,715	not given	
	Electricity ($)	**Total**	**31,377,381**	not given	
	Water ($/year)	Airports	2,335,609	not given	
	Water ($/year)	Harbors	463,234	not given	
	Water ($/year)	Highways	48,150	not given	
	Water ($)	**Total**	**2,846,993**	not given	
	Sewer ($/year)	Airports	3,931,607	not given	
	Sewer ($/year)	Harbors	630,681	not given	
	Sewer ($/year)	Highways	0	not given	
	Sewer ($/year)	**Total**	**4,562,288**	not given	
	Utility ($/yr) = elec + water/sewer	Airports	36,036,603	33,198,805	
	Utility ($/yr) = elec + water/sewer	Harbors	2,493,194	1,967,047	
	Utility ($/yr) = elec + water/sewer	Highways	256,865	319,590	
	Utility ($/yr) = elec + water/sewer	**Total**	**38,786,662**	**35,485,442**	
ECM Cost	$	Airports	102,073,229	**126,876,528**	
	$	Harbors	29,755,374	**20,159,579**	
	$	Highways	3,398,503	**6,726,195**	
	$ - Subtotal		135,227,106	**153,762,302**	
	$ - Additional capital projects		76,000,000	**0**	
	$	**Total**	**211,227,106**	**153,762,302**	***see note 2**
ECM Savings	Electricity (kwh/year)	Airports	not given	48,746,292	
	Electricity (kwh/year)	Harbors	not given	8,460,439	
	Electricity (kwh/year)	Highways	not given	1,789,817	
	Electricity (kwh/year)	**Total**	not given	**58,996,548**	
	Water/Sewer (kgal/year)	Airports	not given	15,515	
	Water/Sewer (kgal/year)	Harbors	not given	426	
	Water/Sewer (kgal/year)	Highways	not given	35	
	Water/Sewer (kgal/year)	**Total**	not given	**15,976**	
	$/year	Airports	9,623,318	**20,314,718**	
	$/year	Harbors	811,978	2,319,341	
	$/year	Highways	210,951	657,093	
	$/year	**Total**	**10,646,247**	**23,291,152**	***see note 3**
Cost by ECM Category	$ - Lighting		19,190,904	**9,851,836**	
	$ - Renewable Energy		37,354,439	**83,363,776**	
	$ - HVAC		30,792,222	**52,170,876**	
	$ - Water Conservation		1,892,064	**1,720,849**	
	$ - Envelope		33,310,357	**4,385,061**	
	$ - Various		11,798,741	**2,214,546**	
	$ - Maintenance/Upgrades		888,376	**55,357**	
	$ - Additional Capital Projects		76,000,000	**0**	
	Total ($)		**211,227,103**	**153,762,301**	***see note 2**
Savings by ECM Category	$ - Lighting		4,303,619	**3,288,169**	
	$ - Renewable Energy		2,080,939	**8,233,060**	
	$ - HVAC		2,486,640	**11,163,620**	***see note 4**
	$ - Water Conservation		1,309,804	**132,749**	
	$ - Envelope		2,806	**22,895**	
	$ - Various		463,040	**450,658**	
	Total ($)		**10,646,848**	**23,291,151**	***see note 3**

1. not all water/sewage use was reported for both ESCOs
2. previous $12.5 million discrepancy in ECM cost has been corrected Johnson Controls
3. previous $5 million discrepancy in ECM savings has been corrected by Johnson Controls
4. $5 million savings discrepancy in HVAC between summary and page 6

Department of Transportation ESPC Proposal Comparison
Task Order No. 3.B
December 22, 2011

2 - BASELINE ENERGY COMPARISON BY DIVISION

	Ameresco - Attachment A-1, Section 2, pg.12-14 of 97											**Johnson Controls**				
	Annual Demand (kW)	**Energy (kWh)**	**Total Energy Cost $**	**$/kWh**	**Water (kGal)**	**Total Water $**	**Water $/kGal**	**Total Sewer $**	**Sewer $/kGal**	**Total Water/Sewer $**	**Total Utilities $**	**Energy (kWh)**	**$/kWh**	**Water (kGal)**	**Water/Sewer $/kGal**	**Total Utilities $**
Airports																
Dillingham Airport	n/a	231,012	49,991	0.22	n/a					n/a	49,991	n/a	0.28			52,514
Hana Airport	n/a	22,136	6,965	0.31	5,741	7,133	1.24			7,133	14,098	13,865	0.37			6,485
Hilo International Airport	7,411	3,569,380	1,094,867	0.31	61,652	300,796	4.88			300,796	1,395,663	3,371,312	0.32			1,042,838
Honolulu International Airport	175,290	98,838,020	21,216,173	0.21	403,630	1,275,345	3.16	3,661,499	9.07	4,936,844	26,153,017	100,035,441	0.23	344,336	6.56	23,966,191
Kahului Airport	23,072	11,153,221	3,135,155	0.28	48,309	211,278	4.37	257,504	5.33	468,782	3,603,937	12,448,569	0.37			3,902,898
Kalaeloa Airport	n/a	927,001	200,603	0.22	2,438	6,239	2.56	12,604	5.17	18,843	219,446	n/a	0.23		2.81	200,604
Kalaupapa Airport	n/a	n/a	n/a	n/a	n/a					n/a		184,043	n/a	219		58,285
Kapulua Airport	490	179,879	53,089	0.30	209	2,188	10.47			2,188	55,277	184,043	0.30	219		58,285
Kona International Airport	12,288	6,680,783	1,939,739	0.29	52,303	255,185	4.88			255,185	2,194,924	6,414,944	0.32			1,879,455
Lanai Airport	1,183	466,600	184,711	0.40	1,208	2,070	1.71			2,070	186,781	474,600	0.41			179,013
Lihue Airport	7,387	4,601,643	1,776,043	0.39	63,589	271,619	4.27			271,619	2,047,662	4,649,292	0.37	26,586	11.65	1,735,181
Molokai Airport	583	222,229	84,919	0.38	138	1,776	12.87			1,776	86,695	224,835	0.42			89,352
Waimea Kohala Airport	198	74,967	27,132	0.36	116	1,980	17.07			1,980	29,112	74,840	0.44			27,704
Totals	227,902	126,966,871	29,769,387		639,333	2,335,609	6.14	3,931,607	6.52	6,267,216	36,036,603	128,075,784	0.34	371,360	7.01	33,198,805
Harbors																
Hilo Harbor	n/a	48,723	22,004	0.45	13,785	57,764	4.19			57,764	79,768	48,723	0.44	15,998	4.23	89,714
Honolulu Harbor	n/a	3,988,127	1,017,403	0.26	64,717	194,852	3.01	362,723	5.60	557,575	1,574,978	3,735,760	0.28	66,898	4.78	1,236,357
Kahului Harbor	2,561	459,105	149,012	0.32	3,055	22,639	7.41			22,639	171,651	146,743	0.37	6,572	6.61	89,684
Kalaeloa Barbers Point Harbor	n/a	392,214	104,072	0.27	10,242	29,015	2.83	267,958	26.16	296,973	401,045	411,138	0.28	11,411	2.82	136,059
Kaumalapau Harbor	n/a	n/a	n/a	n/a	n/a					n/a	0	n/a	0.45			n/a
Kaunakakai Harbor	n/a	22,918	10,917	0.48	n/a					n/a	10,917	12,310	0.47			5,487
Kawaihae Harbor	n/a	11,289	6,034	0.53	866	6,263	7.23			6,263	12,297	12,046	0.44	2,185	5.52	18,496
Nawilliwili Harbor	n/a	192,698	72,880	0.38	33,808	141,166	4.18			141,166	214,046	242,887	0.44	22,539		195,625
Port Allen Harbor	n/a	42,926	16,957	0.40	2,283	11,535	5.05			11,535	28,492	242,887	0.44	22,539		195,625
Totals	2,561	5,158,000	1,399,279		128,756	463,234	4.84	630,681	15.88	1,093,915	2,493,194	4,852,494	0.40	148,142	4.79	1,967,047
Highways																
Hilo Highways Labs and Baseyard	994	232,080	78,086	0.34	n/a					n/a	78,086	n/a	0.23		4.23	n/a
Kahului Hyws Maint Baseyard	n/a	210,525	68,390	0.32	6,533	40,138	6.14			40,138	108,528	467,087	0.30	13,318		237,138
Kauai Hwys Baseyard	n/a	25,124	9,638	0.38	n/a					n/a	9,638	33,527	0.23			13,428
Keanae Hwys Maint Baseyard	49	25,200	7,686	0.31	735	3,037	4.13			3,037	10,723	26,160	0.37	703	4.12	12,993
Lanai Hwys Baseyard	n/a	2,586	1,396	0.54	n/a					n/a	1,396	14,068	0.45			5,457
Molokai District Hwys Baseyard	1,844	55,940	23,355	0.42	55	585	10.64			585	23,940	59,260	0.47	55		23,578
Oahu Highways Maint Baseyard	487	93,534	20,164	0.22	397	4,390	11.06			4,390	24,554	93,534	0.23	397		26,996
Totals	3,374	644,989	208,715		7,720	48,150	7.99			48,150	256,865	693,636	0.33	14,473	4.18	319,590
											256,865					
Total Cost	**233,837**	**132,769,860**	**31,377,381**		**775,809**	**2,846,993**	**3.67**	**4,562,288**	**5.88**	**7,409,281**	**38,786,662**	**133,621,914**	**0.36**	**533,975**	**5.33**	**35,485,442**
Total Cost per Ap-1, pg. 12 of 97																

Note: Blank fields denote values not provided by ESCO

3 - ECM COST COMPARISON

Facility	Ameresco Measure Cost ($)	Johnson Controls Measure Cost ($)	
Airports			
Dillingham Airport	51,098	2,512,452	
Hana Airport	283,383	9,890	*not surveyed
Hilo International Airport	7,582,258	4,151,996	
Honolulu International Airport	55,990,627	83,216,900	*partial survey
Kahului Airport	20,072,193	21,098,467	*partial survey
Kalaeloa Airport	1,533,711	4,465,338	
Kalaupapa Airport	68,267	n/a	*not surveyed
Kapulua Airport	1,288,467	333,571	
Kona International Airport, Kaehol	8,122,618	4,255,918	
Lanai Airport	1,556,575	1,143,598	*fire station to be demolished and rebuilt
Lihue Airport	4,266,667	4,871,580	*partial survey
Molokai Airport	967,185	788,523	*fire station to be demolished and rebuilt
Waimea Kohala Airport	290,180	28,295	* Occupied periodically
Airport Totals	**102,073,229**	**126,876,528**	
Harbors			
Hilo Harbor	2,413,070	1,938,441	
Honolulu Harbor	23,711,379	11,975,137	*partial survey, pier 2, 10, 11 occupied periodically
Kahului Harbor	779,697	759,607	*pier 1 only occupied periodically
Kalaeloa Barbers Point Harbor	1,061,315	259,860	
Kaumalapau Harbor	4,120	8,498	
Kaunakakai Harbor	17,832	79,713	
Kawaihae Harbor	40,761	1,209	*to be demolished
Nawilliwili Harbor	1,517,170	4,412,832	
Port Allen Harbor	210,030	724,282	
Harbor Totals	**29,755,374**	**20,159,579**	
Highways			
Hilo Highways Labs and Baseyard	1,250,030	187,425	
Maui Hyws Maint Baseyard	805,870	385,396	
Kauai Hwys Baseyard	455,571	2,905,706	
Keanae Hwys Maint Baseyard	18,562	30,642	*not surveyed
Lanai Hwys Baseyard	1,967	987	*not normally occupied
Molokai District Hwys Baseyard	198,012	73,999	
Oahu Highways Maint Baseyard	668,491	3,142,040	
Highway Totals	**3,398,503**	**6,726,195**	
Total Cost	**135,227,106**	**153,762,302**	

4 - ECM SAVINGS COMPARISON

Facility	Ameresco Measure Savings ($)	Johnson Controls Measure Savings ($)	
Airports			
Dillingham Airport	7,289	212,789	
Hana Airport	8,796	2,133	*not surveyed
Hilo International Airport	744,048	662,837	
Honolulu International Airport	5,703,893	13,380,357	*partial survey
Kahului Airport	1,515,803	3,543,630	*partial survey
Kalaeloa Airport	18,701	480,982	
Kalaupapa Airport	3,034	0	*not surveyed
Kapulua Airport	45,371	47,292	
Kona International Airport, Kaehol	394,760	576,867	
Lanai Airport	156,373	189,386	*fire station to be demolished and rebuilt
Lihue Airport	920,710	1,121,262	*partial survey
Molokai Airport	84,007	91,063	*fire station to be demolished and rebuilt
Waimea Kohala Airport	20,533	6,118	
		0	
Airport Totals	**9,623,318**	**20,314,718**	
Harbors			
Hilo Harbor	29,260	127,554	
Honolulu Harbor	621,975	1,230,621	*partial survey, pier 2 and 10, 11 only occupied periodically
Kahului Harbor	19,981	174,840	*pier 1 only occupied periodically
Kalaeloa Barbers Point Harbor	56,909	96,614	
Kaumalapau Harbor	162	5,597	
Kaunakakai Harbor	2,096	15,700	
Kawaihae Harbor	5,023	427	*to be demolished
Nawilliwili Harbor	59,133	562,112	
Port Allen Harbor	17,439	105,875	
Harbor Totals	**811,978**	**2,319,341**	
Highways			
Hilo Highways Labs and Baseyard	71,244	47,636	
Kahului Hyws Maint Baseyard	48,065	35,297	
Kauai Hwys Baseyard	30,271	88,722	
Keanae Hwys Maint Baseyard	1,790	2,042	*not surveyed
Lanai Hwys Baseyard	327	0	*not normally occupied
Molokai District Hwys Baseyard	23,651	18,246	
Oahu Highways Maint Baseyard	35,603	465,150	
Highway Totals	**210,951**	**657,093**	
Total Savings	**10,646,248**	**23,291,152**	

5 - ECM BREAKDOWN COST

Ameresco			Johnson Controls			ISE Comments
ECM #	ECM Description	Measure Cost - $	ECM #	ECM Description	Measure Cost - $	
			1.1	T12 to T8 Retrofit	7,781,789	
			1.2	8' T12 to 4' T8 Retrofit	0	
			1.3	T8 to T8 Retrofit	0	
			1.4	De-lamp Fixtures	0	
			1.5	Interior Lighting Replacement	0	
			1.6	Interior Lighting Retrofit	0	
			1.7	Incandescent to CF Replacement or LED Retrofit	0	
			1.8	Compact Replacement to LED Conversion	0	
			1.9	U-Bend to Linear Fluorescent Retrofit	0	
			1.10	Exit Sign to LED Replacement	0	
			1.11	Lens Replacement	0	
			1.12	Reflector Installation	0	
			1.13	HID to T8 Retrofit/ Replacement	0	
			1.14	Parking Garage Retrofit/Replacement	0	
			1.15	Exterior Lighting HPS to PSMH Retrofit	0	
			1.16	Exterior Lighting HPS to Induction Retrofit	0	
			1.17	Exterior Lighting HPS to LED Retrofit/Replacement	0	
			1.18	Runway Lighting to LED Conversion	0	
			1.19	Low Fixture Count - Miscellaneous	0	
			1.20	Miscellaneous	0	
			2.1	Photocell Control - Exterior Lighting	0	
			2.2	Daylight Harvesting	0	
			2.3	Daylight Control w/Dimming Ballast	0	
			2.4	Twist Timer Control	0	
			2.5	Digital Timer Control	0	
			2.6	Astronomical Time Clock Control	0	
1	Premium Efficiency Lighting	18,136,822	2.7	Occupancy Sensor - Dual Tech Ultrasonic and IR	25,238	**Lighting: See electrical facility site survey analysis for more detail. Ameresco has over twice**
2	Lighting Controls	1,054,082	2.8	Wireless Sensors	0	**the investment in energy efficient lighting but their lighting analysis is not as detailed. All**
	Subtotal, Lighting	19,190,904		Subtotal, Lighting	7,807,027	**ECM's recommended appear to be feasible**
			7.1	Solar Photovoltaic	97,022,857	
			7.2	Solar Thermal	53,135	
			7.3	Micro-Wind Generators	0	
			7.4	PV Electrical Vehicle Charging Station	0	**Renewables: See electrical facility site survey analysis for more detail. Johnson Controls has**
			7.5	Solar/Wind Parking Lights	0	**over 2.5 times the investment in PV. JC is also proposing to install PV at two hangers at**
			7.6	SolaTube/ Day lighting	0	**Kalaeloa, Piers 39-40 and 52-53in Honolulu Harbor, and various buildings at Kahului Airport**
3	PV Lighting Systems	88,081	7.7	Solar Exhaust Fans	0	**that are not included in the project. It appears doubtful that all of the PV that Johnson**
4	PV Power Generation	36,980,522	7.8	Solar Golf Cart Charging Station	0	**Controls is proposing can be installed on existing roofs without additional roofing repairs or**
5	Wind Power Generation	285,836	7.9	Solar PV for Runway Lighting	0	**reroofing. All ECM's recommended appear to be feasible, except that the amount of PV that**
	Subtotal, Renewable Energy	37,354,439		Subtotal, Renewable Energy	97,075,992	**can be installed needs to be confirmed with the electrical utility companies.**
			3.2	Window Air Conditioners	113,932	
			3.3	Chillers	175,995	
			3.4	Cooling Towers	0	
			3.5	Pumps	23,172	
			3.6	Replace Roof Top Units	63,182	
			3.7	Split System	645,720	
			3.8	Terminal Unit Replacement	96,554	
			3.9	High Efficiency Motors	582,387	
			3.10	Packaged DX Units	138,840	
			3.11	Thermal Energy Storage System	3,658,466	
			3.12	Fan Coils Units Replacement	18,159	
			3.13	Wall A/C Units Replacement	45,554	
			3.14	Replace Exhaust Fans	8,648	
			4.1	Pneumatic to DDC Conversion	0	
			4.2	Upgrade existing DDC or new DDC	5,454,382	
			4.3	Demand Control Ventilation	0	
			4.4	TOD Scheduling /Night Setback	0	
			4.5	Window A/C unit monitor and control	0	
			4.6	Occupancy Sensors for A/C control	0	
			4.7	Exhaust Fan Interlocks	0	
			4.8	Install Utility Meters	0	
			4.9	CO2 Monitoring and Fan Control	0	
			4.10	Enterprise-wide Continuous Monitoring	881,291	
			4.11	Eco Stats - on/off schedule for AC units	0	
			4.12	Tie in FID System with Building Automation System	224,871	
			4.13	Integration of DDC Controls	40,451	
			5.1	Bearings/ Belts	30,307	
			5.2	System Cleaning	33,619	
			5.3	Air Balancing	0	
			5.4	Controls Adjustment	0	
			5.5	Code Compliance	0	
			5.6	Optimization protocols	845,194	
			5.7	Compressed Air Leak Repair	0	
			6.1	Cross Connect Cooling Towers	277,606	
			6.2	Variable Pumping (VFDs on pumps, 3-way valve swap	203,462	
			6.3	System Isolation for Independent Rotation	13,317	
			6.4	Constant Volume to VAV Conversion	18,689	
6	Energy Management and Control System	17,136,414	6.5	Install Control Valves	99,025	
7	Chiller Plant Upgrades	4,698,870	6.6	Install Hot Water Heater	0	**HVAC: See mechanical facility site survey analysis for more detail. Johnson Controls has**
8	Cooling Tower System Measures	826,403	6.7	Utilize Chilled water as primary cooling in spaces	0	**over 40% in additional investment in HVAC upgrades. All ECM's recommended appear to be**
9	Replace HVAC Equipment	5,463,927	6.8	Variable Frequency Drives	1,066,906	**feasible, except we do not recommend implementing JC ECM 6.13, Microgrid Central Plant.**
10	Replace Window Air Conditioners	271,364	6.9	Variable Refrigerant Flow (VRF) System	0	**The Ewa chiller plant should be constructed to match the recently completed Diamond Head**
11	Variable Volume Pumping	432,095	6.10	Replace Air Compressor	0	**plant and the Overseas Terminal plant to allow all three plants to operate as back-up to each**
12	Fan VFD's	1,357,909	6.11	Replace/ Repair Fire Life Safety	0	**other and to share the load during off-peak hours. Isolation of the Ewa plant on a micro-gird**
13	Replace Exhaust Fans	283,796	6.12	Convert D/X AHU to Chilled Water AHU	49,201	**will not allow the plant to serve as back-up to the other plants, and the output from the plant**
18	Premium Efficiency Motors	321,444	6.13	Microgrid Central Plant	27,946,158	**will vary significantly with the actual daily solar insolation.**
	Subtotal, HVAC	30,792,222		Subtotal, HVAC	42,755,088	
			8.1	Metered Sink Faucets	1,217,519	
			8.2	Infrared Controls	0	
			8.3	Flush Valve Diaphragm change out	0	
			8.4	Low Flow Toilets/ Urinals	0	
			8.5	Pozzolan Soil Amendment	0	
			8.6	Irrigation Controls	0	
			8.7	Chemical Free Water Treatment	0	
			8.8	Low Flow Shower Heads	0	
21	Water Conservation Plumbing Measures	1,847,818	8.9	Plumbing Issues	0	
22	Irrigation Controls	44,246	8.10	Lift Station Upgrades/Replacement	0	**Water Conservation: Ameresco has 50% more investment in water conserving fixtures. All**
	Subtotal Water Conservation	1,892,064		Subtotal, Water Conversation	1,217,519	**ECM's recommended appear feasible.**
			9.1	Cool Roof	3,269,633	**Envelope: Ameresco has 10 times the investment in roof replacements and roof repairs. It is**
			9.2	Window Replacement	0	**also doubtful that Johnson Controls can accomplish all of the PV installation work that they**
			9.3	Window Film	0	**are proposing without additional roof repairs to ensure that the roofs will last for the lifetime**
			9.4	Skylights	0	**of the PV panels. All ECM's appear feasible. Also, envelope factors including infiltration**
23	Replace or Reseal Roofs	32,747,192	9.5	Roof Replacement	0	**reduction and insulation improvements need to be considered before any major HVAC**
24	Window Measures	563,165	9.6	Building Infiltration Reduction	0	**installion. Johnson Controls does not address these improvements now but may be**
	Subtotal, Envelope	33,310,357		Subtotal, Envelope	3,269,633	**evaluated in more detail during the IGA phase.**
			11.1	PC Power Management	8,346	
			11.2	Transformer Replacement	1,513,670	
			11.3	Vending Miser	12,757	
			11.4	Plug/ Monitor Miser	0	
			11.5	Parking Meters	0	
			11.6	Trash Compactor	0	
			11.7	Replace Refrigerated Water Fountains	6,775	
14	Energy Efficient Transformers	2,666,789	11.8	Replace Standalone Refrigerator	63,108	
15	Replace DOT-owned Refrigerators	108,949	11.9	State Vehicle Purchase Program	0	
16	Ice Machine Measures	57,137	11.10	Replace small IC Vehicle w/ Electric Vehicle	0	
17	Energy Efficient Water Heaters	128,903	11.11	Replace CRT with LCD Monitors	0	
19	Vending Machine Controls	27,783	11.12	Replace Leaking Solar Hot Water 80 Gal Storage Tank	4,895	
20	Energy Efficient Water Fountains	342,499	11.13	Replace Ice Machines	0	
25	Jetway Power Conditioners & AC Units	5,759,255	11.14	Copier Miser	0	
26	Upgrade Runway Lights	2,696,519	11.15	Voice Over Internet Protocol (VoIP)	0	
28	Computer Power Management	10,907	11.16	Heat Recovery off Ice Machine	0	**Various: Ameresco has 7 times the investment in other various ECM's, primarily in jetway**
	Subtotal, Various	11,798,741		Subtotal, Various	1,609,551	**power conditioners and ac units, and in runway lighting. All ECM's appear feasible.**
			10.1	Provide Maintenance Services	27,489	
			10.2	Access Door to AHUs	0	**Maintenance: Ameresco has 30 times the investment in maintenance, but the details are**
27	Deferred Maintenance Projects & Capital Upgrades	888,376		Subtotal, Maintenance	27,489	**lacking.**
	Additional Capital Projects	76,000,000				**Additional Capital Projects: Ameresco has developed their proposal to balance all of the savings against the cost of the ECM's plus an additional $76M that could be applied to other deferred maintenance and capital projects. Johnson controls has tailored their proposal so that any additional savings created by the implementation of their ECM's is returned back to the DOT as realized utility and operational cost savings.**
	Totals - Measure Cost	**211,227,103**		**Totals - Measure Cost**	**153,762,299**	

6 - ECM BREAKDOWN SAVINGS

Ameresco			Johnson Controls		
ECM #	ECM Description	Measure Savings - $	ECM #	ECM Description	Measure Savings - $
			1.1	T12 to T8 Retrofit	3,188,455
			1.2	8' T12 to 4' T8 Retrofit	0
			1.3	T8 to T8 Retrofit	0
			1.4	De-lamp Fixtures	0
			1.5	Interior Lighting Replacement	0
			1.6	Interior Lighting Retrofit	0
			1.7	Incandescent to CF Replacement or LED Retrofit	0
			1.8	Compact Replacement to LED Conversion	0
			1.9	U-Bend to Linear Fluorescent Retrofit	0
			1.10	Exit Sign to LED Replacement	0
			1.11	Lens Replacement	0
			1.12	Reflector Installation	0
			1.13	HID to T8 Retrofit/ Replacement	0
			1.14	Parking Garage Retrofit/Replacement	0
			1.15	Exterior Lighting HPS to PSMH Retrofit	0
			1.16	Exterior Lighting HPS to Induction Retrofit	0
			1.17	Exterior Lighting HPS to LED Retrofit/Replacement	0
			1.18	Runway Lighting to LED Conversion	0
			1.19	Low Fixture Count - Miscellaneous	0
			1.20	Miscellaneous	0
			2.1	Photocell Control - Exterior Lighting	0
			2.2	Daylight Harvesting	0
			2.3	Daylight Control w/Dimming Ballast	0
			2.4	Twist Timer Control	0
			2.5	Digital Timer Control	0
			2.6	Astronomical Time Clock Control	0
1	Premium Efficiency Lighting	3,961,533	2.7	Occupancy Sensor - Dual Tech Ultrasonic and IR	609
2	Lighting Controls	342,086	2.8	Wireless Sensors	0
	Subtotal, Lighting	4,303,619		Subtotal, Lighting	3,189,064
			7.1	Solar Photovoltaic	8,283,566
			7.2	Solar Thermal	10,264
			7.3	Micro-Wind Generators	0
			7.4	PV Electrical Vehicle Charging Station	0
			7.5	Solar/Wind Parking Lights	0
			7.6	SolaTube/ Day lighting	0
3	PV Lighting Systems	13,930	7.7	Solar Exhaust Fans	0
4	PV Power Generation	2,050,874	7.8	Solar Golf Cart Charging Station	0
5	Wind Power Generation	16,135	7.9	Solar PV for Runway Lighting	0
	Subtotal, Renewable Energy	2,080,939		Subtotal, Renewable Energy	8,293,830
			3.2	Window Air Conditioners	19,790
			3.3	Chillers	10,429
			3.4	Cooling Towers	0
			3.5	Pumps	0
			3.6	Replace Roof Top Units	2,729
			3.7	Split System	74,388
			3.8	Terminal Unit Replacement	0
			3.9	High Efficiency Motors	133,216
			3.10	Packaged DX Units	28,048
			3.11	Thermal Energy Storage System	179,817
			3.12	Fan Coils Units Replacement	0
			3.13	Wall A/C Units Replacement	5,237
			3.14	Replace Exhaust Fans	0
			4.1	Pneumatic to DDC Conversion	0
			4.2	Upgrade existing DDC or new DDC	**1,512,966**
			4.3	Demand Control Ventilation	**297,459**
			4.4	TOD Scheduling /Night Setback	**341,836**
			4.5	Window A/C unit monitor and control	0
			4.6	Occupancy Sensors for A/C control	0
			4.7	Exhaust Fan Interlocks	0
			4.8	Install Utility Meters	0
			4.9	CO2 Monitoring and Fan Control	**339,107**
			4.10	Enterprise-wide Continuous Monitoring	**255,192**
			4.11	Eco Stats - on/off schedule for AC units	0
			4.12	Tie in FID System with Building Automation System	0
			4.13	Integration of DDC Controls	**54,710**
			5.1	Bearings/ Belts	0
			5.2	System Cleaning	0
			5.3	Air Balancing	0
			5.4	Controls Adjustment	92,662
			5.5	Code Compliance	0
			5.6	Optimization protocols	187,829
			5.7	Compressed Air Leak Repair	0
			6.1	Cross Connect Cooling Towers	70,742
			6.2	Variable Pumping (VFDs on pumps, 3-way valve swap)	532,960
			6.3	System Isolation for Independent Rotation	0
			6.4	Constant Volume to VAV Conversion	2,099
6	Energy Management and Control System	1,085,043	6.5	Install Control Valves	0
7	Chiller Plant Upgrades	506,894	6.6	Install Hot Water Heater	0
8	Cooling Tower System Measures	91,154	6.7	Utilize Chilled water as primary cooling in spaces	0
9	Replace HVAC Equipment	74,261	6.8	Variable Frequency Drives	653,533
10	Replace Window Air Conditioners	10,864	6.9	Variable Refrigerant Flow (VRF) System	0
11	Variable Volume Pumping	226,969	6.10	Replace Air Compressor	0
12	Fan VFD's	481,066	6.11	Replace/ Repair Fire Life Safety	0
13	Replace Exhaust Fans	10,389	6.12	Convert D/X AHU to Chilled Water AHU	88,297
18	Premium Efficiency Motors	27,286	6.13	Microgrid Central Plant	1,070,461
	Subtotal, HVAC	2,513,926		Subtotal, HVAC ***see note 4 in Summary, page 1**	**5,953,507**
			8.1	Metered Sink Faucets	0
			8.2	Infrared Controls	0
			8.3	Flush Valve Diaphragm change out	133,734
			8.4	Low Flow Toilets/ Urinals	0
			8.5	Pozzolan Soil Amendment	0
			8.6	Irrigation Controls	0
			8.7	Chemical Free Water Treatment	0
			8.8	Low Flow Shower Heads	0
21	Water Conservation Plumbing Measures	1,308,680	8.9	Plumbing Issues	0
22	Irrigation Controls	1,124	8.10	Lift Station Upgrades/Replacement	0
	Subtotal Water Conservation	1,309,804		Subtotal, Water Conversation	133,734
			9.1	Cool Roof	23,065
			9.2	Window Replacement	0
			9.3	Window Film	0
			9.4	Skylights	0
23	Replace or Reseal Roofs	0	9.5	Roof Replacement	0
24	Window Measures	2,806	9.6	Building Infiltration Reduction	0
	Subtotal, Envelope	2,806		Subtotal, Envelope	23,065
			11.1	PC Power Management	17,358
			11.2	Transformer Replacement	366,479
			11.3	Vending Miser	7,783
			11.4	Plug/ Monitor Miser	0
			11.5	Parking Meters	0
			11.6	Trash Compactor	0
			11.7	Replace Refrigerated Water Fountains	0
14	Energy Efficient Transformers	298,059	11.8	Replace Standalone Refrigerator	0
15	Replace DOT-owned Refrigerators	12,749	11.9	State Vehicle Purchase Program	0
16	Ice Machine Measures	1,616	11.10	Replace small IC Vehicle w/ Electric Vehicle	0
17	Energy Efficient Water Heaters	4,430	11.11	Replace CRT with LCD Monitors	0
19	Vending Machine Controls	11,537	11.12	Replace Leaking Solar Hot Water 80 Gal Storage Tank	0
20	Energy Efficient Water Fountains	11,620	11.13	Replace Ice Machines	0
25	Jetway Power Conditioners & AC Units	0	11.14	Copier Miser	0
26	Upgrade Runway Lights	88,205	11.15	Voice Over Internet Protocol (VoIP)	0
28	Computer Power Management	7,538	11.16	Heat Recovery off Ice Machine	0
	Subtotal, Various	435,754		Subtotal, Various	391,620
			10.1	Provide Maintenance Services	0
			10.2	Access Door to AHUs	0
27	Deferred Maintenance Projects & Capital Upgrades	0		Subtotal, Maintenance	0
	Additional Capital Projects	0			
	Totals - Measure Savings	**10,646,848**		**Totals - Measure Savings**	**17,984,820**

Department of Transportation ESPC Proposal Comparison
Task Order No. 3.B
December 22, 2011

7 - PRELIMINARY CASH FLOW ANALYSIS COMPARISON

		Ameresco		Johnson Controls	
		Base Project	**Alternate Project**	**w/out PPA**	**w/ PPA**
Project Cost					
	Est Value of Hard Costs*	195,580,652	172,913,502	153,762,302	66,709,123
	Investment Grade Audit	488,952	488,952	595,046	595,046
	Design Engineering Fees	5,280,678	4,668,665	4,551,136	3,932,222
	Construction Mngmt	6,454,162	5,706,146	4,928,005	3,925,467
	System Commissioning	684,532	605,197	753,138	753,138
	Initial Training Fees	293,371	259,370	45,000	45,000
	Contingency Costs	included in hard costs	included in hard costs	2,042,528	2,042,528
	Construction Interest	2,444,758	2,104,751	16,667,715	7,800,252
	Total Financed Project Costs	211,227,105	186,746,583	183,344,870	85,802,776
Proposed Annual Service Fees					
	Measurement & Verification	79,332	79,332	452,600	452,600
	Maintenance	TBD	TBD	9,100	9,100
	Performance Monitoring	included in M&V	included in M&V	7,280	7,280
	On-going Training Services	20,194	20,194	19,600	19,600
	Verification Reports	included in M&V	included in M&V	14,000	14,000
	Total First Year Annual Services	99,526	99,526	502,580	502,580
Cash Flow Analysis					
20-year performance	Electric Cost Savings	331,128,639	257,492,340	505,576,924	349,981,565
	Water Cost Savings	46,729,190	46,729,190	3,734,546	3,734,546
	Rebates			3,779,239	3,779,239
	PPA Cost Savings	0	29,583,722		
	Capital Avoidance			550,000	550,000
	Operation Cost Savings	677,448	677,448	46,108,955	46,108,955
	Total Cost Savings	378,535,277	334,482,700	560,749,665	404,154,306
	Maintenance, Monitoring, Training Fees	2,330,341	2,330,341	80,700,141	72,180,921
	Guaranteed Savings	378,033,188	333,755,405	560,749,665	404,154,306
	Financial Payment	375,702,847	331,425,065	268,846,474	125,830,345
	Net Savings	**502,089**	**727,295**	**211,173,050**	**206,143,041**
	Double-check Net Savings	**502,089**	**727,294**	**211,203,050**	**206,143,040**

*total value of hard costs include:
subcontracted and direct labor costs, cost of materials and equipment, temporary facilities, permits, bonds, general excise tax, insurance, overhead and profit

APPENDIX 2.19

ESPC Life of Contract (LOC) Plan

ESPC Life of Contract (LOC) Plan:

Documents Management and Checklist for Energy Savings Performance Contracts (ESPC)

(SITE) ENERGY SAVINGS PERFORMANCE CONTRACT

Installed by (ESCO)
Contract Number
(Contract Title)
Contract Description

Acknowledgment
This material is based upon work supported by the U.S. Department of Energy (USDOE) under Award Number DEEE0000216 through State of Hawaiʻi Contract Number 59499, Supplement No. 1., with assistance from the USDOE Technical Assistance Program.

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Purpose

The purpose of this document, the ESPC Life of Contract (LOC) Plan is to provide guidance to project staff during the post-installation performance period of an Energy Savings Performance Contract (ESPC) project. This document will assist the staff in effective ESPC project management.

When the installation is complete and the acceptance period has begun, the agency staff should collect all the necessary information for project management during the performance phase of the contract. This includes vital contract documents, descriptive contractual data on which party will conduct Operations and Maintenance (O&M), Preventive Maintenance (PM), Repair and Replacement (R&R), and the Measurement and Verification (M&V) Plan for the performance period, and includes the specifics of which party, the Energy Services Company (ESCO) or their customer, will conduct the oversight of these operations. The post-installation document submittals, as they become available, also need to be collected and retained. Examples include M&V Reports and Commissioning Reports.

User Guidance

This guide is structured to provide information to the agency representative who has the responsibility for the management of the ESPC project during the performance period. This is accomplished first by a checklist to ensure that the proper documents are collected and stored in an accessible location. A second checklist is provided which lists annual activities that must be accomplished to properly manage the contract .The above-mentioned checklists are found in Appendices A and B.

Introduction

The intent of the ESPC Life of Contract Plan is to capture the performance data from the acceptance phase of the contract, to provide guidance on how to manage the contract for its remaining term to ensure proper performance of the equipment and the verification of the savings guarantees for the life of the contract.

The monitoring process begins with the Measurement and Verification (M&V) process which records and documents the parameters necessary to confirm savings. Maintenance tasks will likely be allocated to both the ESCO and the Agency. The ESCO can monitor the quality of Agency provided maintenance, but it does come with a cost that may partially be built into the M&V costs. If the ESCO identifies Agency maintenance failures, but the agency staff does not have the time, staff capability or budget to correct them, then these failures may result in adjustments to the savings guarantees. Agency staff will need to monitor ESCO provided maintenance. If they do not have the staff capability to effectively do so, then they need to consider using a third party auditor to monitor maintenance contract compliance. Data collection will be organized into a chronological set of activities designed to:

- Document the O&M requirements and the R&R requirements so that the ESPC stakeholders can determine, monitor and verify that the actions are accomplished as required to maintain the equipment performance, ensuring that the savings are realized. These requirements may include training for agency staff by the ESCO or project consultants.

- Define the activities suggested to support annual M&V verification and true-up processes to allow confirmation that all testing/inspections are accomplished and the M&V report can be accepted or rejected annually for the life of the contract.

- Document the results of initial commissioning of project equipment and subsequent commissioning of controls.

Those tasked with ultimate responsibility for the success of the ESPC can use these documents to assist in monitoring and documenting the performance period activities for the contract term. One of the largest project performance risks for both parties to an ESPC contract is the loss of staff continuity, savings data and budget resources over time. It is very expensive to reassemble or estimate missing data, train new staff or secure additional budget resources. Both the ESCO and the Agency need to keep a complete file of all project correspondence and contract documents. This file should be kept in chronological order. These documents can also be used to train and assist any staff replacements during the contract term to reduce the impact of staff turnover.

This document will record the location of all of the project management data.

Data Preparation, Annual Review and Storage Guidance Overview

Key correspondence and project documents should be kept and stored in a safe and easily accessible location. This ESPC LOC Plan provides both control for capturing what is necessary from both a project management and an M&V perspective. Some of the potential activities for consideration in the completion of this plan are included in the bullet point list below:

- Collect the performance data from the Contract, Commissioning and Acceptance efforts, and compile the information.

- Review the checklists with agency staff and train them to ensure understanding of the contents of the checklists.

- Insert the initial Points of Contact (POC) for site and ESCO personnel. The agency staff will be responsible for maintaining an up-to-date POC list for the life of the contract.

- Review the responsibilities for O&M, including Preventative Maintenance (PM) and R&R to ensure clear identification of which party is responsible for each activity. The party not responsible for the conduct of each activity is then responsible for monitoring and inspecting the efforts of the other party to ensure the work scope is accomplished that complies with the contract requirements.

Additional Guidance in the Appendices

Checklists are presented in Appendix A to assist the agency staff in collecting data needed during the Performance Period of the contract. A second checklist is provided in Appendix B for the annual activities required by the ESCO and agency staff to ensure essential data is collected and recorded.

Storage location information for commissioning documentation is listed in Appendix D. The storage location for annual M&V Reports is listed in Appendix E.

Also included in the Appendices is information regarding ENERGY STAR Benchmarking. Some buildings may qualify for ENERGY STAR ratings and building labels (Appendix C).

Operations and Maintenance

Equipment Identification

All equipment that is addressed by the above personnel for operation, preventative maintenance, and repair/replacement should be identified and marked in some manner such that personnel from both the ESCO and their customer can clearly determine who has what responsibilities for specific equipment. This can take the form of drawings, lists, or in complex equipment interfacing cases, by attaching bar codes to each piece of equipment. This is necessary so that each piece of equipment can be ensured of receiving the maintenance that it needs, regardless of who is responsible. When energy savings are large enough to pay for external maintenance contracts, it is recommended to maximize the maintenance responsibilities assumed by the ESCO.

All O&M, R&R, and preventative maintenance responsibilities are defined in the contract, typically by ECM, and any descriptions of responsibilities listed herein should document the specific contract schedule where responsibilities are defined. It is important to clearly distinguish the duties of the agency and the ESCO in terms of record keeping, limits of duties, schedules, and maintenance cost accounting. In the event of nonperformance of duties by either party, mutual discussions should be held to correct the problem. If the problem cannot be corrected at the agency staff level, the contract provisions for dispute resolution shall be used to negotiate a solution.

An operational log shall be maintained to note any variations in operations activities such as early turn-on or turn-off of equipment, bypassing of automatic controls, etc. This log shall be kept at or near the operator's workstation and shall be available at all times for updating or inspection.

Annual M&V Report

The M&V Plan, which governs M&V activities, is included in Appendix E of this plan. Added to this Appendix also is the current year M&V report from the ESCO. These two reports are the governing M&V documents at any particular time within the contract term. The Plan defines the requirements and methodology, and the report defines the current year's performance results. Appendix E shall be continually updated during the contract term so that it always contains both the original M&V plan and the latest annual M&V report. The ESCO or consulting resources can be used to educate Agency staff, because M&V is technically and economically complicated. Customer staff must take appropriate project performance responsibility for their contract requirements. Timely resolution of disputes is critical to maintain an effective partnership to support project performance.

The Annual M&V reports are essential to maintaining a historical set of performance, inspection, and testing information for the project, and the entire set of annual reports

shall be maintained in a known and safe location to support potential project performance evaluations and negotiations.

Contact Information

Editor's Note: All contact information should be verified and updated annually.

ESPC Customer Contact Information

Agency Representative
Name
Address
Telephone
Fax
Email

Agency Back Up Representative
Name
Address
Telephone
Fax
Email

ESPC Technical Support Contacts

DBEDT Technical Support Manager
Name
Address
Telephone
Email

Independent ESPC Consultant Contact (if applicable)
Name
Address
Telephone
Email

ESCO Contact Information

Primary Point of Contact for Contract Management
Name
Address
Telephone

Fax
Email

O&M Service Representative
Name
Address
Telephone
Fax
Email

Energy Service Manager
Name
Address
Telephone
Fax
Email

M&V Specialist
Name
Address
Telephone
Fax
Email

Emergency/Non-Emergency Contact(s)
Name
Address
Telephone
Fax
Email

Documentation Checklist

General Information

The Documentation Checklist identifies critical documents and provides the document storage location information. This matrix must be maintained and available to any person working on the project over the contract term. This places a burden on the ESCO and agency staff to maintain good records and contract documentation. The location of these documents and their status should be verified annually, since some documents may require updating during the contract term.

Pre-Award Documents	**Storage Location (electronic and/or hard copy)**	**Responsible Party/Date Delivered to LOC File**
Government Generated i. Invitation for Proposal ii. Technical Facility Profile data		
a. ESCO Proposal including preliminary technical and economic analysis		
b. Pre-negotiated ESCO Proposal/Investment Grade Audit including: i. ECM and Savings Description ii. Measurement and Verification (M&V) Plan iii. Management Plan iv. Repair and Replacement and Commissioning Plans v. Financial Schedules and Supporting Data vi. Meeting Minutes		
Award Documents	**Storage Location (electronic and/or hard copy)**	**Responsible Party/Date Delivered to LOC File**
a. Contract Documents of the Energy Services Agreement i. Negotiated Final ESCO Proposal a. ECM and Savings Descriptions b. Measurement and Verification (M&V) Plan c. Management Plan i. Repair and Replacement Plan ii. Operations & Maintenance (O&M) Responsibilities ii. Contract Modifications		
b. Key Correspondence i. Meeting Minutes ii. Project Schedules		

iii. Review Comments & Responses iv. Email Correspondence (e.g., text file)		
Project Implementation	**Storage Location (electronic and/or hard copy)**	**Responsible Party/Date Delivered to LOC File**
a. Drawings i. 100% Design/Red-lined ii. As Built Drawings		
b. Installation Plan/Schedule		
c. Commissioning/Acceptance Test Plan(s)		
d. Key Correspondence i. Requests for Information (RFIs) ii. Email Correspondence (text file) iii. Review Comments & Responses		
Final Submittals/Acceptance Documents	**Storage Location (electronic and/or hard copy)**	**Responsible Party/Date Delivered to LOC File**
a. Commissioning/Acceptance Report		
b. Manuals (e.g., O&M)		
c. Training Documents		
d. Key Correspondence i. Requests for Information (RFIs) ii. Email Correspondence (.pdf archives of emails /text file)		
Post-Acceptance Performance Period	**Storage Location (electronic and/or hard copy)**	**Responsible Party/Date Delivered to LOC File**
a. Annual M&V Reports Annual ESCO project inspection reports.		
b. Repair & Replacement (R&R) Documents		
c. Operations & Maintenance (O&M) Documents		
d. Payment Records		
e. Key Correspondence i. Requests for Information (RFIs) ii. Email Correspondence (text file)		
f. Utility Invoices (ongoing)		
g. Equipment Identification Document		

Appendices

Editor's Note: Update page listing, titles and sections as needed.

Appendix	Title	Page(s)
A	Checklist	
B	Annual Performance Support Checklist	
C	Energy Star Portfolio Manager Benchmarking Tool	
D	Commissioning Reports	
E	M&V Plan, Current M&V Annual Report	
F	Glossary of Terms	

Appendix A –Checklist

Item	Action	Completed Date
Initial Document Preparation		
1	All contractual submittals have been received and accepted	
2	Punch list completed and signed-off.	
3	Full Project Acceptance completed and signed	
4	Commissioning Report received, reviewed and approved	
5	Approved M&V Plan placed in LOC File	
6	ESA Contract and Financing Agreement placed in LOC File	
7	O&M and R&R Contracts placed in the LOC File.	
8	Obtain all agency Staff and ESCO contact information for the performance period and insert in LOC Plan	
9	Locate and list location of all material in 'Documentation Checklist'	
10	Conduct Review of LOC Plan with agency staff ensuring all items are complete and report is ready for ongoing management	
11	Train the agency staff in the use of the LOC Plan and File, including review of the data within it and how to use it to manage the contract.	
Actions at the End of the First Year of Performance Period		
12	After the end of the first year of the performance period, review the Annual M&V Report; insert the data into the LOC File after the report is approved	

Appendix B – Annual Performance Support Checklist

Item	Action	Completed Date
Items ideally conducted more than once throughout the year		
1	Audit the buildings checking controls settings for lights, temperature, and hours occupied or in operation, numbers of employees, etc., making sure automatic systems are not by-passed.	
2	Review logs for maintenance to check if planned activities did occur. Publish any findings to ESCO and Agency to keep them informed, especially if work scope is not occurring.	
3	Review trend log data and M&V operational parameters and assumptions to ensure they are within allowable limits.	
4	Read any and all meters installed and/or used by the M&V process on a monthly basis. This should be a coordinated activity with the ESCO representatives.	
5	Review the overall status of the DDC system operation and maintenance.	
6	*Collect interval data from the DDC for remote fault detection and equipment diagnostics.*	
Items ideally completed as part of the annual M&V True-up process.		
1	Review any new equipment or system commissioning reports.	
2	Coordinate with the ESCO for the annual M&V inspections and witness all testing, meter reading, and any other planned activities.	
3	Review each building with the agency staff to determine the quality of service being obtained from the ESCO.	
4	Review the contractual requirements to determine the guaranteed savings in both energy units and cost of energy (O&M) for the current year. These values change each year by inflation/escalation per the contract.	
5	Obtain and review the annual M&V report from the ESCO. Verify any calculations and/or claims.	
6	Obtain and determine if the agency staff made any substantial changes to the missions or usage of any building(s) or area(s) serviced by the equipment installed by the ESCO. Especially be aware of any changes that affect the guarantees of the ESCO. Make any adjustments necessary to bring all data to the same conditions of the original contract.	
7	Conduct an annual true-up meeting with the ESCO to determine any adjustments or payments necessary due to savings shortfalls.	
8	Review O&M requirements of the ESCO and Agency and make a determination of work scope accomplishment or the lack thereof.	
9	Review R&R requirements of the ESCO and Agency and make a determination of work scope accomplishment or the lack thereof.	
10	Verify the status of employee training for those working on or with the ESPC equipment to determine if additional training is required.	

Appendix C – ENERGY STAR Portfolio Manager Benchmarking Tool

Use of EPA/DOE Energy Star Portfolio Manager is optional and included in the LOC Plan as an assistance document for site informational purposes only. It is a free benchmarking program for utility data entry and analysis via the Internet at the following web address:
http://www.energystar.gov/index.cfm?c=evaluate_performance.bus_portfoliomanager

This tool can be used on the individual site level to obtain an Energy Star rating for individual facilities and to apply for a building label (if qualified).

The following sample report tables are examples automatically generated by the tool by entering monthly utility consumption data (energy and cost) from utility invoices. Complete reports can also be automatically generated by request using the tool, and are emailed to the requestor by ENERGY STAR. **It should be noted that this tool can be useful for individual building benchmarking but should not be used for comparison or tracking of ESPC performance or budgeting purposes**. Baselines listed in the Energy Star Portfolio Manager tool may **not** be the same as or an accurate representation of the ESPC baseline and should **not** be used as the methodology to measure and verify ESPC savings.

Blank ENERGY STAR Benchmarking Report Examples

Sample Report

My Portfolio: Example							
12/1/08							
Total Buildings:							
Facility Name	Current Rating (1-100)	Adjusted Percent Energy Reduction	Total Floor Space (Sq. Ft.)	Energy Use Alerts	Current Energy Period Ending Date	Eligibility for the ENERGY STAR	Last Modified

Sample Report

My Portfolio: Example						
12/1/08						
Total Buildings:						
Facility Name	Current Rating (1-100)	Current Source Energy Intensity (kBtu/Sq. Ft.)	Baseline Rating (1-100) (kBtu/Sq. Ft.)	Baseline Source Energy Intensity (kBtu/Sq. Ft.)	Adjusted Percent Energy Reduction	CO_2 Reduced (lbs)

Sample Report

My Portfolio: Example						
12/1/08						
Total Buildings:						
Facility Name	Cumulative Investment in Facility Upgrades (USD)	Cumulative Investment per Sq. Ft. (USD)	Annual Energy Cost (USD)	Total Energy Cost per Sq. Ft. (USD)	Indoor Water Cost (USD)	Outdoor Water Cost (USD)

Sample Report

My Portfolio: Example					
12/1/08					
Total Buildings:					
Facility Name	Baseline Energy Period Ending Date	Current Energy Period Ending Date	Baseline Rating (1-100)	Current Rating (1-100)	Adjusted Percent Energy Reduction

Sample Report

My Portfolio: Example					
12/1/08					
Total Buildings:					
Facility Name	Current Rating (1-100)	Current Site Energy Intensity (kBtu/Sq. Ft.)	Annual Energy Cost (USD)	Target Rating (1-100)	Target Site Energy Intensity (kBtu/Sq. Ft.)

Sample Report

My Portfolio: Example							
12/1/08							
Total Buildings:							
Facility Name	Total Indoor and Outdoor Water Use (kGal)	Total Indoor and Outdoor Water Cost (USD)	Indoor Water Use (kGal)	Indoor Water Use per Sq. Ft. (kGal)	Wastewater/Sewer use (kGal)	Wastewater/ Sewer Cost (USD)	Water Use Period Ending

Sample Report

My Portfolio: Example							
12/1/08							
Total Buildings:							
Facility Name	Current Rating (1-100)	Current Energy Period Ending Date	Current Site Energy Intensity (kBtu/Sq. Ft.)	Current Source Energy Intensity (kBtu/Sq. Ft.)	Energy Reduction per Sq. Ft. (kBtu/ Sq. Ft.)	Adjusted Energy Reduction per Sq. Ft. (kBtu/Sq. Ft.)	Energy Use Alerts

Sample Report

My Portfolio: Example						
12/1/08						
Total Buildings:						
Facility Name	Current Rating (1-100)	Current Source Energy Intensity (kBtu/Sq. Ft.)	Adjusted Percent Energy Reduction	Eligibility for the ENERGY STAR	ENERGY STAR Application Status	Building Profile Status

Appendix D – Commissioning Report

Insert Commissioning Report or Location Reference Information Here

Appendix E – M&V Plan and Annual Reports

Insert M&V Plan and Most Recent Annual M&V Report Here

Appendix F – Glossary of Terms

Adjusted Energy Baseline - An energy baseline that has been adjusted to compensate for factors that would have changed energy consumption in the absence of any energy conservation measures (i.e., factors affecting baseline energy use beyond the contractor's control). Examples of such factors include increases or decreases in conditioned or illuminated space, changes in occupancy or building use, facility renovation, or extremes in weather.

Annual Energy Audit - The term annual energy audit means a procedure including, but not limited to, verification of the achievement of guaranteed energy, water, and related cost savings and energy unit savings, resulting from implementation of energy conservation measures and a determination of whether an adjustment to the energy baseline is justified by conditions beyond the contractor's control. (Also known as Annual Measurement and Verification)

Commissioning – Procedures undertaken, generally by the contractor, to assure that energy conservation measures and building systems perform interactively in accordance with design documentation and intent.

Energy Baseline - The amount of energy that would have been consumed annually without implementation of energy conservation measures based on historical metered data, engineering calculations, sub-metering of buildings or energy consuming systems, building load simulation models, statistical regression analysis, or some combination of these methods.

Energy Conservation Measure (ECM) - A measure applied to a building or facility that improves energy efficiency, is life cycle cost effective, and involves energy conservation, cogeneration facilities, renewable energy sources, improvements in operation and maintenance efficiencies, or retrofit activities.

Energy Cost Savings - Energy cost savings are generally recurring savings - savings that occur year after year; however, one-time energy cost savings may come from energy savings in excess of guaranteed savings, either during the post-acceptance performance period or during the implementation period.

Energy-Related Cost Savings - Energy-related cost savings are generally recurring reductions in expenses (other than energy costs) related to energy-consuming equipment, generally affecting operations, and maintenance, renewal, or repair expenses of equipment. One-time energy-related cost savings can result from avoided expenditures of operations and maintenance, repair and replacement, or capital expenditures funds for projects (e.g., equipment replacement) that, because of the energy savings performance contract project, will not be necessary.

Estimated Energy Cost Savings - Estimated energy cost savings are the contractor-estimated energy cost savings in dollars per year for each energy conservation measure (ECM), and equal the estimated energy savings multiplied by the established energy prices in appropriate units. For ECMs with multiple energy type impacts, energy cost savings equals the sum of the products of the energy savings by energy type and established energy prices.

Guaranteed Annual Cost Savings - The guaranteed annual cost savings are the levels of annual cost savings the contractor is willing to guarantee for a project. The proposed values for these savings appear in financial schedules of the ESPC. After the IGA, the contractor revises the preliminary assessment and offers the final values in the financial schedules. The guaranteed annual cost savings must exceed the annual contractor payments in each year of the post-acceptance performance period. For the first interval (generally 12 months) after acceptance of construction, the contractor may be paid as if the

savings guarantee is being met. The annual energy audit establishes actual savings. If actual savings fall short of the guarantee, the contractor will pay back the amount of the shortfall to the customer.

Implementation Period - The implementation period is the period between the date of ESPC award to the date that all energy conservation measures (ECMs) are operational and accepted.

Investment Grade Audit (IGA) - A procedure which may include, but is not limited to, a detailed analysis of the energy cost savings and energy unit savings potential, building conditions, energy consumption, and hours of use or occupancy for a facility, for the purpose of preparing final technical and price proposals.

Measurement and Verification (M&V) – Process of measuring and verifying energy, water and related cost savings

Post-Acceptance Performance Period - The period (typically in years) from the date a project is operational and accepted, to the end of the contract term. The post-acceptance performance period may also be referred to herein as the service period.

Post-Acceptance Performance Period Annual (or Regular Interval) M&V - At least annually, the contractor and the ESPC stakeholders shall verify that the installed equipment/systems have been properly maintained, continue to operate correctly, and continue to have the potential to generate the predicted savings. This ensures that the M&V monitoring and reporting systems are working properly, and it allows fine-tuning of measures throughout the year based on operational feedback.

Post-Installation Measurement and Verification Activities - Post-installation measurement and verification is to ensure that the proper equipment/systems have been installed, are operating correctly and have the potential to generate the predicted savings. Verification methods may include surveys, inspections, and spot or short-term metering. Commissioning of installed equipment and systems is expected. Commissioning assures that the building systems perform interactively in accordance with the design documentation and intent. The contractor generally completes commissioning. In some cases, however, the site contracts it out.

APPENDIX 2.20

Hawaii ESPC FAQ List

ENERGY SAVINGS PEFORMANCE CONTRACTS FREQUENTLY ASKED QUESTIONS (FAQs) AND ANSWERS

(As of December 2012)

What is an Energy Savings Performance Contract?

Q1: How is an energy savings performance contract (ESPC) different from a standard equipment specification and bid project?

A1: An ESPC relies on the technical expertise of an energy service company (ESCO) to design and build a comprehensive and creative technical energy project. Also, with an ESPC you buy a guaranteed performance result, not just new equipment. These contracts contain a guarantee of avoided utility and operating costs, along with guarantees of environmental comfort parameters, such as temperature, humidity, and carbon dioxide levels. Specifically, they provide compliance with applicable American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) and Illuminating Engineering Society (IES) standards.

Q2: Why is a comprehensive project preferable to several single measure projects?

A2: A comprehensive approach maximizes the capture of savings opportunities available from a specific building or set of buildings. It also provides financial leverage to do more expensive individual measures that might otherwise not be economical to do on a stand-alone basis. A comprehensive project allows the measures with shorter payback periods to subsidize those with longer paybacks. A common error is for a facility to do only the shorter payback measures first and postpone more expensive upgrades. The agency has then lost the opportunity to bundle measures to maximize both energy and cost savings.

Q3: Why not just implement these comprehensive efficiency projects with our own technical staff and capital funds?

A3: Many public agencies do not have adequate capital funds appropriated to address many of their capital equipment replacement needs. They also may not have enough staff or the appropriate technical expertise to manage these complex projects in-house. There may be little incentive for in-house staff to accept the risk of project non-performance or financially guarantee the results of the project's performance. Agency staff may not have the expertise to measure and verify savings or commission the equipment. Also, the traditional procurement process for capital projects may require the acceptance of low-bid equipment instead of a best-value project design that minimizes life-cycle costs. The traditional capital budget process may require as long as five years or more to do a project that an ESCO could deliver in less than three years. The savings opportunities that are lost by waiting three extra years or more for capital funds to implement efficiency projects creates a huge cost of delay.

Q4: If our agency has been doing small efficiency projects for many years, haven't we already picked the "low-hanging fruit" of these savings and eliminated the opportunity for a comprehensive energy efficiency project?

A4: While this may be true in some cases, many owners are finding that even though they have spent hundreds of thousands or even millions of dollars over the last 10-15 years on energy efficiency projects, allowing an ESCO to evaluate their facilities comprehensively often results in their finding large untapped savings opportunities. One reason for this is the continual evolution of energy efficiency technologies. Lighting technologies have improved dramatically in the last five years. Also, the technology of direct digital control systems has dramatically improved and the opportunities to save energy, especially in larger buildings with larger equipment loads, may allow these new controls to provide economically feasible savings. It is recommended that all facilities be evaluated against an energy use index (EUI) of British Thermal Units BTUs per square foot in order to determine their relative efficiency compared to similar types of buildings. The costs of utilities (i.e. electricity and water) have increased in the last few years at a dramatic rate. Projects that may not have been economically attractive five years ago may be feasible today due to the higher utility costs.

Q5: Is energy savings performance contracting the same as a Power Purchase Agreement (PPA)?

A5: No, this is not the same as a Power Purchase Agreement (PPA). In a PPA, a 3rd party investor owns and operates the equipment (usually for large renewable energy or combined heat and power plant projects). Power purchase contracts require a user to take the output from this 3rd party owned generation asset for their power needs as part of a long term agreement to supply energy at a specified price. A power purchase agreement requires no up-front capital investment by the customer, and the 3rd party handles installation and operation and maintenance on behalf of the customer. The cost of power is based on a long-term rate with a pre-determined annual escalator. In contrast, with an energy savings performance contract, the ESCO would develop and install a turn-key solution, but it does not own or operate the equipment.

Q6: What are pros and cons of including renewable energy in ESPC? Is PPA a better approach than ESPC for implementing renewable energy projects? What about a combined ESPC/PPA project?

A6: In most cases where a renewable energy PPA would be economically viable, it is actually a better financial decision for the agency to acquire the renewable energy system as part of an ESPC. The ESCO can guarantee a level of energy performance output from the renewable energy system without requiring a separate contract which results in giving the agency ownership of the asset. It is possible to execute a separate PPA as one component of a larger ESPC project but it will result in two separate finance agreements. The PPA financing would be held by the ESCO. The ESPC financing would be held by the agency.

Type of Contract	Pros	Cons
ESPC with Renewable Energy	▪ More flexibility with regard to contract term ▪ Agency owns the assets ▪ Agency has flexibility with regard to the level and cost of operations and maintenance services provided ▪ ESCO can guarantee a specified level of energy performance from the installed equipment ▪ May be less expensive on a life cycle cost basis than a PPA	▪ Does not qualify for energy tax credits or depreciation ▪ Owner assumes some performance risk ▪ May have higher procurement costs
PPA for Renewable Energy	▪ It requires no upfront capital investment ▪ Provider bears all performance risk ▪ Provider is eligible for state and federal energy tax credits ▪ Provider can claim accelerated depreciation ▪ Relatively low procurement costs for a PPA	▪ Agency does not own the asset ▪ Agency must agree to take-or-pay for the energy output ▪ Less flexibility with regard to contract term ▪ Generally limited to a single technology ▪ Less attractive for small projects
Combined ESPC/PPA with Renewable Energy	▪ Provider is eligible for state and federal energy tax credits ▪ Provider can claim accelerated depreciation ▪ Agency has flexibility with regard to the level and cost of operations and maintenance services provided under the ESPC	▪ Two separate finance agreements ▪ Greater legal complexity ▪ May take longer to arrange multiple financing agreements ▪ Agency does not own the PPA asset ▪ Agency must agree to take-or-pay for the PPA energy output

Project Planning and Site Selection

Q7: What is the process for planning an ESPC project?

A7: The agency staff should determine whether modernizing facility infrastructure or generating excess utility cost savings is the primary focus. They should also decide what operational and maintenance or avoided equipment replacement cost savings they are willing to count for purposes of measuring the project's economic benefits. They should determine the target indoor environmental comfort standards that they would like the

project to deliver and identify any specific high priority equipment replacements that they would like the ESCO to include in the project.

In general, the following steps should be taken during the planning phase of the ESPC project:

- Determining there is a need for energy efficiency improvements
- Identifying a target list of potential improvements
- Committing to comprehensive building efficiency solutions
- Be willing to partner and share facility data with an ESCO
- Be open to new energy efficiency solutions (e.g., water, renewables)
- Recognizing the value of having a better understanding about how their buildings operate
- Understanding the value of buying best quality equipment
- Committing to use life-cycle costing for evaluating building solutions
- Viewing maintenance investments as insurance that provides reliable building operation
- Compare the selected facility against energy performance benchmarks

Q8: How do I evaluate whether my facility is a good candidate for an energy savings performance contract?

A8: Two indexes that can be used to quickly evaluate the size of an efficiency opportunity are the dollar costs spent for energy per square foot, and the building's energy consumption measured in BTUs per square foot. Many buildings can be benchmarked on the ENERGY STAR scale to see if they are efficient enough to qualify for a label certification. Most ESCOs prefer a minimum project size of at least $1 million. Also, equipment near the end of its useful life, which has very high maintenance and repair costs, indicates the potential for significant operating cost savings. If there are significant problems with the operational control of building comfort, this provides another opportunity to create value by dramatically improving indoor environmental quality. Due to the long-term nature of ESPCs, it is important that the agency have a long-term plan to use the building in the future.

Q9: What are the main obstacles to ESCOs delivering ESPC projects to state agencies?

A9: Lengthy government procurement processes extend the implementation cycle that increases ESCO project delivery costs and the cost of delay for agencies. Multiple agency decision-makers who need to approve projects can delay the process of finalizing the energy services agreement and project financing. The agency needs to establish an in-house team that is focused on selecting a project based on the best value rather than low bid. The agency team should include the facility manager, budget and finance staff, legal advisor, procurement officer, engineering staff and outside technical consultants if applicable. Agency facility and financial managers receive little or no recognition or incentives for championing ESPCs. Rather than combining several agency facilities into a single procurement, many building managers focus projects on either one or just a few

buildings, which makes the project's economics less attractive. Financing energy savings performance contracts over periods of less than 15 years erodes the opportunity to leverage financing for capital projects. Due to staff turnover, long-term relationships with customers are expensive for ESCOs to maintain.

What is an Energy Service Company (ESCO)?

Q10: How is an ESCO different from a standard architectural/engineering firm?

A10: An ESCO must financially guarantee energy and operating cost savings and measure project performance results over time. The ESCO assumes a financial risk that the project will produce the promised savings performance. Also, the ESCO typically provides a broader range of customer services, like measurement and verification of cost savings and commissioning of project equipment and systems. It provides more comprehensive engineering analyses of energy, water, and maintenance cost savings opportunities. It also assists in providing financing for projects. Part of the ESCO's turnkey approach is to provide on-site construction management services, as well as comprehensive post-construction training and maintenance services.

Q11: What are the distinguishing qualities of the most innovative ESCOs?

A11: The most innovative ESCOs typically have very experienced energy engineers on their staff. They excel at providing creative and comprehensive design engineering solutions for projects. They are responsive to their customers and provide high quality customer services. They are committed to long-term, sustainable savings performance for their customers and offer continuous project commissioning as a core competency. They have the technical breadth and depth to earn Leadership in Energy and Environmental Design (LEED) accreditation for their clients and are sophisticated about measuring improvements in indoor environmental quality and accounting for the environmental benefits of reduced air pollution.

Q12: How is an investment grade energy audit (IGA) conducted by an ESCO different from a traditional energy savings analysis?

A12: Since an investment grade audit (IGA) is the technical and economic foundation for a project that must produce guaranteed energy savings, it typically provides more detail on existing consumption levels, operating hours, and utility costs than a traditional energy analysis. It establishes and defines consumption and cost baselines for all operating costs savings. It also provides a description of the analysis methods, data logger measurements, savings calculations, and all of the detailed technical and economic assumptions used to calculate savings. The IGA serves as the technical basis for project development and justifies the economic feasibility of the project to secure financing.

Q13: How large is the annual ESCO market?

A13: Based on a market research study conducted by Lawrence Berkeley National Laboratories, the reported annual market size for ESCOs in 2010 was $6-7 billion. For the last 5 years the annual market growth rate is estimated to be between 15%-20%. The typical minimum size of an ESPC project is $1 million. Energy efficiency now provides at least 42 percent of all new U.S. energy resources as measured by the change in energy use per dollar of the U.S. GDP. Rising wholesale energy prices and technical efficiency innovations continuously expand the amount of economically feasible energy efficiency resources. Over the last 30 years, energy efficiency has been the most important, cheapest, and fastest growing energy resource available to building managers.

Benefits of ESPC

Q14: What are the main benefits of energy savings performance contracting projects?

A14: The most obvious economic benefits are utility and maintenance cost savings. The modernization and replacement of aging capital equipment, however, is probably an even more important project driver. Significant improvement in the indoor environmental quality resulting from better control of temperature, humidity, and ventilation is another benefit. Preserving scarce capital funds for priority projects that do not produce significant operating cost savings is an additional and important financial benefit.

Q15: What are the primary procurement benefits of using the ESCO project delivery model to implement energy efficiency projects?

A15: Using the design-build approach creates a mini-design competition between proposers, which results in more creativity in generating technical solutions. Ready access to project financing dramatically speeds up project implementation. The ability to select equipment and services based upon their quality and long term value rather than lowest first cost is a significant advantage. Having an ESCO design a comprehensive and creative technical solution provides single point accountability for project performance and reduces administrative costs compared to piecemeal implementation of project components.

Q16: Can an energy savings performance contract help my buildings earn an ENERGY STAR or LEED certification?

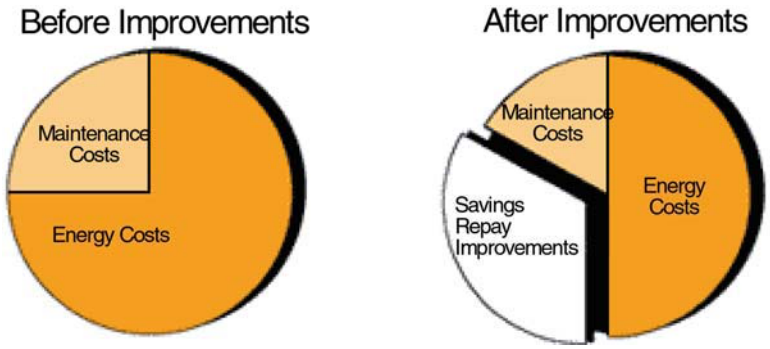
A16: Many ESCOs have staff members that are LEED certified and are familiar with the EPA's ENERGY STAR label program. They welcome the opportunity to create additional benefits for building owners. The economic benefits for human health and productivity from better thermal, visual, and acoustic comfort and better indoor air quality can provide significant project value. Properly measuring these benefits could lead to larger investments in energy efficiency projects. By reducing utility consumption of electricity and water, energy savings performance contracting projects significantly reduce air pollution.

Financial Benefits of ESPC

Q17: If energy savings performance contracting is such an effective way to fund comprehensive energy efficiency projects in state agencies, why don't states require agencies do what they can with ESPCs before spending capital appropriations on energy efficiency projects?

A17: Some states do require the use of energy savings performance contracting to implement feasible energy efficiency projects before spending appropriated funds on these capital projects (e.g., Texas, Georgia and Colorado). In other states, ESPC provides the primary basis for funding energy efficiency projects in state agencies (e.g., Kansas, Pennsylvania, Illinois and Missouri). If state comptrollers understood the favorable financial impact of using energy performance contracts to finance capital improvements from the cost savings produced by the improvements over time, perhaps more of them would require the use of ESPC as the preferred method for funding energy projects.

How ESPC Impacts Building Operating Costs



Q18: What are the primary reasons offered for not using ESPC to fund energy efficiency projects?

A18: Some people prefer low-bid and unbundled energy conservation measure (ECM) procurement as a strategy to keep their first costs low; unfortunately, this approach seldom minimizes life-cycle costs. Some believe that savings may be too difficult or too expensive to measure. Innovations in field data logger technology and refinements in the trend logging capabilities of control systems have decreased the costs and increased the accuracy of savings measurement. Some building operators believe that they will lose operating control of their facilities with an ESPC. Building operators retain the right and responsibility to maintain operational control of their facilities, but they should be accountable for the consequences of their operational decisions. ESPCs are specifically designed to recognize the partnership of the building owner and the ESCO in achieving mutual goals for reduced operating costs and improved indoor environmental quality.

Some managers believe that appropriated capital improvement funds are preferable to low-cost tax-exempt lease financing of projects. Whether capital funds are available

from taxes or bonds, they still create an obligation to collect tax revenues to pay project costs. One significant benefit of energy savings performance contracting is that it uses saved budget funds that would have been used to pay for operating costs (e.g. utilities, maintenance contracts, equipment replacement) to pay for the costs of capital improvement projects. Many building managers recognize the benefits of ESPC, but have trouble finding the time to implement a project at their facility. A number of states have created dedicated in-house technical assistance resources for ESPC or used program consultants to help agencies implement programs.

Q19: In addition to utility cost savings what other economic value is produced by an energy savings performance contract over a 20-year contract term?

A19: If we let X = average annual utility cost savings, then over 20 years the cumulative value of utility savings would be worth 20X. There are a a variety of non-energy benefits that will be produced from these projects over the 20 year term. For example improved employee health and productivity benefits are at least 2.2X (based on studies from Carnegie Mellon University). The economic development benefits from the purchase of local materials and services could be as large as 5X. Avoiding the cost of project delay could be worth 3X. Avoiding incremental utility systems line losses and capacity costs could be worth 6X. Operation and maintenance savings could conservatively be worth 1.5X. The value of air emissions reductions alone could be worth 1.5X. Utility rebates could total 0.3X for the project. The total energy and non-energy economic benefits produced from an ESPC over 20 years could be as much as 40 times the average annual utility cost savings.

Q20: What are the disadvantages of using appropriated capital improvement funds for energy efficiency projects?

A20: Capital funds are usually limited so energy efficiency projects face stiff competition from other budget priorities. The approval process for requesting new capital appropriations can be time consuming and expensive. Failure to obtain all the required capital funds for a comprehensive energy efficiency project leads to piecemeal project implementation which is more expensive. The crucial advantage of ESPCs is that they use operating cost savings from existing budgets to pay for the cost of capital projects.

Savings Guarantees

Q21: What does guaranteed energy savings mean? What happens if the ESCO does not meet the savings goal?

A21: A key aspect of this approach is that the ESCO provides a corporate guarantee that the project savings, which must be measured and verified at specific intervals, will cover all project costs. The ESCO guarantees a reduction in utility consumption which results in avoiding future utility costs. The ESCO does not guarantee lower future utility bills. Higher utility bills may result from increases in utility rates even if utility consumption levels have been significantly decreased from the implementation of the ESPC project. The ESCO does not guarantee the project financing payments which are an obligation of

the agency. ESPC project cash flows are designed so that guaranteed avoided utility costs are sufficient to repay the annual project financing costs. If the savings guarantee is not met, the ESCO is obligated to pay the difference to the agency. The use of savings measurement and verification and continuous commissioning help the agency and the ESCO ensure that the savings guarantee and equipment performance levels are achieved. In the event that the actual annual verified savings are less than the annual amount guaranteed, the ESCO is contractually obligated to pay the agency the difference between the guaranteed amount and the actual verified amount, based on an annual reconciliation. With an energy savings performance contract you buy a guaranteed performance result, not just new equipment.

Q22: What is the risk to my agency that the ESCO will miss their savings guarantee?

A22: Experience in the industry, especially in the last 10 years, shows that most ESCO projects achieve 110% percent of their total savings guarantees. They also have a substantial internal reserve fund to cover any savings guarantee shortfalls. On an industry-wide basis the percentage of missed savings guarantees is less than 1%. For the rare project that misses its savings guarantee, ESCOs promptly reimburse their customers for the savings shortfall and correct any issues that may have caused or contributed to the shortfall. Sound project design, installation, functional performance testing of installed equipment (e.g. commissioning), and performance monitoring are the most cost-effective methods to deliver promised project performance.

How to Competitively Plan and Procure an ESPC

Q23: Why use a Request for Qualifications (RFQ) to create a qualified list of proposers?

A23: An RFQ lets you comprehensively survey and quickly evaluate ESCO capabilities and experience. It is less risky and less costly for ESCOs to respond to an RFQ because there is no requirement for them to spend time on-site. It is helpful to disclose in the RFQ the economic potential of projects for which the agency intends to issue an RFP so that ESCOs have an incentive to respond to the RFQ.

Q24: What key elements should be included in a Request for Proposals (RFP) or Invitation for Proposals (IFP) for an energy savings performance contract?

A24: Well-defined evaluation criteria are the essence of a best-value RFP. A clear description of the procurement process and schedule is critical to creating credibility for a project. Providing reasonable technical building profile data on the energy characteristics of your project facility assists ESCOs in evaluating the economic feasibility of your project. Specific goals you would like to achieve for this project should be identified in the RFP. The RFP should also describe an evaluation process that is objective, clear, fair, efficient, and effective. If ESCOs know that proposals will be evaluated on their merits, they will be highly motivated to provide high quality proposals.

Q25: What are the benefits of the best-value approach to evaluating ESPC project proposals?

A25: Focusing on the quality of the proposals increases the likelihood of selecting the best long-run solution. It also provides greater flexibility in comparing the strong and weak points of competing proposals. It takes advantage of the technical knowledge of the selection committee to evaluate the best approach from a wide range of proposed solutions.

Q26: What can I do to improve the ESPC process and outcome for my agency project?

A26: Develop a partnership ethic that emphasizes cooperation and clear understanding of each party's roles and responsibilities. Full and timely communication between all relevant agency and ESCO staff is crucial to project success. Keep good records of revisions to the project scope as the project evolves so no one is surprised at the final project scope. It is important to budget realistically for project commissioning, training, maintenance, and measurement and verification services. Making quality decisions at every step of the process will produce high quality project results. Create a clear and detailed plan for measuring project performance, including the role of agency staff in providing notice of building changes and utility data to the ESCO. Consistently apply realistic standards and fairness as you negotiate the allocation of project responsibilities between the agency and the ESCO.

Q27: What can the state do to help individual agencies with the ESPC process?

A27: The state can develop standardized procurement, evaluation, and contracting procedures and documents (e.g., RFQ, RFP, audit contract, energy services agreement, evaluation forms, etc.). They can offer technical assistance and training to agency staff for the evaluation and negotiation of energy savings performance contracting projects. They can centralize and streamline the project review and approval process. The state should provide the maximum flexibility in project financing by allowing the use of appropriated capital funds, federal grants, tax-exempt leases, etc., to permit larger ESPC projects to be completed as a single transaction. For example, the Hawaii Department of Accounting and General Services (DAGS) Phase I Project combined capital funds, federal grant funds and a tax-exempt lease to finance the project.

Managing and Measuring Project Performance

Q28: What are the benefits of measuring and verifying project operating cost savings?

A28: Ongoing measurement of cost savings gives ESCOs real feedback on the performance of their design, installation, and operation strategies. Monitoring savings over the contract term improves both the persistence and reliability of savings achieved. Savings measurement and verification helps agencies document the economic benefits of their projects.

Q29: How is project commissioning relevant to ESPC projects?

A29: Formal building commissioning is a systematic, interactive, and documented quality control process. Commissioning functionally tests and verifies the performance of a building system's design, installation, operation, and maintenance procedures against the customer's requirements specified in the project commissioning plan. The initial commissioning report should certify that all newly installed equipment is operating and performing in accordance with the design parameters contained in the commissioning plan. Proper training of building operators and adequate documentation of the building's systems are also essential components of effective commissioning. The goal, which formal building commissioning shares with energy savings performance contracting, is to deliver verifiable building performance results. The plan should also address a continuous commissioning process to assure the performance of the energy conservation measures (ECMs) over the life of the project.

Q30: Why has project commissioning for energy savings performance contracts become more important in recent years?

A30: Building equipment has become more technically sophisticated and for major systems, may have specialized and packaged controls (e.g., chillers). Building automation systems have become much more complex and require effective calibration and programming. Building heating and cooling systems are being designed with less excess capacity which requires the systems to perform as designed. Building and safety codes are becoming more stringent. The economic value of health and productivity benefits from properly operating buildings has become a more urgent concern for building owners.

Q31: What are the main benefits of commissioning ESPC projects?

A31: Project commissioning provides the knowledge to optimize building equipment system efficiency. During project construction, commissioning provides more complete communication between the ESCO and the agency. This results in shorter punch lists and fewer callbacks, as well as a faster and smoother equipment startup process. Commissioning extends the life of the equipment due to the verification of proper design and installation. It also prevents future equipment performance problems over time. Another valuable benefit from commissioning comes from better building control, which improves thermal comfort and indoor air quality.

Q32: What is the difference in Measurement & Verification (M&V) options? Where do we find information on them?

A32: The International Performance Measurement and Verification Protocol (IPMVP) offers four options for measuring and verifying performance and energy and water savings. These options, titled A, B, C, and D, are the cornerstones of the standardized set of procedures contained in the IPMVP. In brief, Options A and B focus on the performance of specific ECMs. Option C assesses the energy savings at the whole-facility level by metering and analyzing utility costs before and after the implementation of ECMs.

Option D is based on computer models of the energy performance of equipment or the whole facility, calibrated against historical utility consumption data to verify the accuracy of the simulation model.

Further information regarding measurement and verification can be found in the *M&V Guidelines* document published by the Federal Energy Management Agency (FEMP) and accessed at *http://www1.eere.energy.gov/femp/pdfs/mv_guidelines.pdf*.

IPMVP Public Library of Documents*: http://www.evo-world.org/*

Q33: What are allowable avoided costs in ESPC?

A33: Utility savings from energy and water and fuel savings from propane and diesel fuel are allowable avoided costs. In addition, avoided operations and maintenance costs and avoided equipment replacement costs are also allowed.

Q34: If operations & maintenance (O&M) services are included in the ESPC contract, in addition to the O&M for contractor-installed equipment, what happens to existing maintenance contracts?

A34: As part of the ESPC project, ESCOs often propose repairs to existing systems, such as re-installation of damaged or missing controls or repairs of leaks in chilled water or landscape irrigation piping. Generally, the ESCO assumes some responsibility for preventive maintenance and repairs to new equipment installed. Existing maintenance contracts can often be renegotiated to revise the scope of services or, in some cases, be eliminated due to the installation of new equipment or maintenance services provided by the ESCO.

Q35: How can Direct Digital Control (DDC) systems be used to manage ESPC project performance?

A35: The following are recommended strategies for using DDC systems to effectively manage project performance:

- Select a system that has energy information data management capabilities.
- Use trend log data to verify equipment operating compliance with energy saving schedules and operating parameters.
- Store trend log data in a data warehouse so that it can be analyzed to refine equipment control strategies.
- Design the trend log data to provide actionable information to building operators and maintenance contractors to optimize equipment performance.
- Use the DDC system effectively for remote equipment operation fault detection and diagnostics.

- Design equipment control alarms so that they are prioritized to provide valuable information.

- Be sure that ESCO staff or building maintenance staff is trained to properly use the information provided by the DDC system.

- Establish clear lines of responsibility for who is accountable for taking corrective action based on the data provided by the DDC system.

Q36: What are the major technical risks of ESPC projects to owners and how can they be mitigated?

A36: It is important to effectively manage the long term contractual relationship with the ESCO. This requires full and timely project communication and adequate documentation of problem resolution. The following are examples of common technical risks and mitigation strategies:

Making incorrect design decisions

- Pay careful attention to sizing equipment properly
- Evaluate interactions between equipment to maximize system performance and efficiency

Having inadequate detail in the definition of the project performance specifications

- Clearly define the scope of work in sufficient detail
- Base designs on accurate existing conditions data
- Spot-check installation to catch quality issues

Basing decisions on lowest first-cost

- Design projects to minimize life cycle costs

Failing to adequately budget for operations and maintenance to support long term project performance

- Budget sufficient maintenance funds to prevent customer operation and maintenance performance problems
- Be realistic about what customer maintenance staff can be trained to do and what maintenance support will have to be provided by the ESCO or its subcontractors
- Standardize design choices to reduce maintenance costs by simplifying equipment and materials inventory
- Review long-term operations and maintenance of every ECM

- Coordinate early planning with other construction projects to avoid confusion and delays
- Keep records of agreements regarding various contractual items.

Q37: What kind of equipment warranties should be expected in ESPC?

A37: Typically the ESCO will provide a comprehensive equipment and labor warranty for one year from the date of beneficial use of major equipment systems installed as part of an ESPC. Due to the fact that construction on large projects can range between 18 and 24 months, it is possible that some warranties could expire prior to completed project construction. It is often possible to negotiate to arrange for the ESCO warranty period to run for one year from the date of project completion and acceptance. Specific equipment manufacturer's warranties do vary significantly based on the type of equipment selected. For example, electronic ballasts for fluorescent lighting generally has a 5-year warranty, LED and induction lighting may offer 15 year warranties. In contrast, most HVAC equipment manufacturers only offer one year warranties although extended warranties may be purchased. Agencies need to do a careful evaluation of the expected value gained from purchasing extended warranties.

Q38: What does the "cost of delay" mean and how can it be mitigated?

A38: By deferring the implementation date of a project for years at a time, the savings that would have occurred had that project been implemented earlier represents the cost of delay. The quick access to cost-effective tax-exempt financing allows agencies to pay for energy projects without waiting for capital appropriations. Savings from comprehensive energy efficiency projects occur over time, irrespective of how the agency pays for the project.

Q39: How should repairs to equipment not being replaced, but being made to operate more efficiently, be treated in the ESPC process?

A39: Recognize that buildings function as a set of interdependent systems. Equipment that is not being replaced must still function properly as part of the system. Sometimes ESCOs establish a repair and replacement fund for large buildings to spend at the owner's discretion to make sure that all the small components in large buildings can respond properly to control signals from a new DDC system or other equipment. It is not practical to identify every single component which may require repair even with a detailed investment grade audit. Usually these component repairs will be selected during installation based on their contribution to improving the energy savings performance of the new equipment being installed. For large projects with major deferred maintenance, the repair fund could be as much as 5% of total project cost.

Q40: What is the most common method for financing ESPC projects?

A40: The tax-exempt status granted to a public agency enables it to access lower-cost financing than is available to an ESCO. Tax exempt lease purchase agreements (TELPs)

are the most common method of project financing. Project financing can be readily obtained and financing agreements can be executed quickly after receipt of project technical approvals. Third-party tax-exempt financing transactions offer customized structures to maximize the agency's flexibility (e.g. non-levelized repayment schedules). It is standard to fund the project costs into an escrow account and permit progress payments to an ESCO during construction. Combining available capital funds with TELP financing including incentives and rebates allows a more comprehensive project to be implemented more rapidly, avoiding excessive costs caused by piecemeal project implementation. A TELP agreement typically does not require legislative or voter approval. This type of financing also allows the agency to receive title to the equipment with an equipment security interest held by the lender.

Q41: What are the most important factors to evaluate when reviewing the projected cash flow for an ESCO project?

A41: The accuracy, reasonableness, and documentation of utility and other operational savings amounts, are critical to a proper economic analysis. The interest rate and utility escalation rates have a significant effect on the project cash flow due to the length of these contracts (i.e. 20 years). It is important to be realistic, since choosing rates which are too high or low can skew the economic analysis of project feasibility. Also it is important to evaluate the difference between the level of savings being guaranteed and what is projected. If guaranteed savings are less than 90% of projected savings, it may raise concerns about the accuracy of savings calculations. If guaranteed savings are 100% of projected savings, there should be a significant amount of excess net savings in the cash flow to hedge project performance risk.

Acknowledgment

This material is based upon work supported by the U.S. Department of Energy under Award Number DE-EE0000216 through State of Hawai‘i Contract Number 59499, Supplement No. 1.

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