Hawaii Energy Efficiency Program

July 1, 2015 through June 30, 2016

Technical Reference Manual (TRM)

PY 2015

Measure Savings Calculations

Table of Contents

1 Introduction

METHODS AND ASSUMPTIONS

This reference manual provides methods, formulas and default assumptions for estimating energy and demand peak impacts from measures and projects that receive cash incentives from the Hawaii Energy Efficiency Program.

This reference manual is organized by program, end-use and measure. Each section provides mathematical equations for determining savings (algorithms), other program Technical Reference Manual (TRM) methodologies as well as default assumptions for all equation parameters that are not based on site-specific information. In addition, any descriptions of calculation methods or baselines are provided, as appropriate.

The parameters for calculating savings are listed in the same order for each measure. Algorithms are provided for estimating annual energy and demand impacts.

Data assumptions are based on Hawaii specific data, where available. Where Hawaii data was not available, data from neighboring regions is used where available and in some cases, engineering judgment is used.

Data sources used, in the general order of preference, included, but were not necessarily limited to the following:

- Energy and Peak Demand Impact Evaluation Report of the 2005-2007 Demand Management Programs – KEMA
- HECO IRP-4: Energy Efficiency Potential Study (HECO DSM Docket)
- 2004-2005 Database for Energy Efficiency Resources (CA DEER database)
- 2007-2008 Database for Energy Efficiency Resources (CA DEER database) Update
- Other EE Program Design Information (e.g. Efficiency Maine, Focus on Energy, etc.)
- SAIC Staff expertise and engineering judgment
- Evergreen TRM Review – 2/23/12
- Evergreen PY12 TRM Review – 1/15/14

2 Gross Customer-to-Net Program Savings Calculation

The algorithms shown with each measure calculate gross customer electric savings without counting the effects of line losses from the generator to the customer or free ridership. The formulae for converting gross customer-level savings to net generation-level savings are as follows:

Net Program kWh = Gross Customer Level ΔkWh $\times$ (1 + SLF) x RR
Net Program kW = Gross Customer Level ΔkW $\times$ (1 + SLF) x RR

Where:
Net kWh = kWh energy savings at generation-level, net of free riders and system losses
Net kW = kWh energy savings at generation-level, net of free riders and system losses
Gross Cust. ΔkWh = Gross customer level annual kWh savings for the measure
Gross Cust. ΔkW = Gross customer level connected load kW savings for the measure
SLF = System Loss Factor
RR = Realization Rate that includes Free Riders and Engineering Verification

SLF – System Loss Factor
The system loss factors were provided by HECO, MECO and HELCO. The do not vary by measure, but by island, and are in the following Table 2.1:

Table 2.1

County Customer to System Loss Factor		
Oahu	Maui	Hawaii
11.17%	9.96%	9.00%

RR - Realization Rate
The Realization Rate used was estimated using the following information from the Evergreen (EM&V) report:

Table 2.2

New Net-to-Gross Factors		
Program		Net-to-Gross
BEEM	Business Energy Efficiency Measures	0.75
CBEEM	Custom Business Energy Efficiency Measures	0.75
BESM	Business Services and Maintenance	0.95
BHTR	Business Hard to Reach	0.99
REEM	Residential Energy Efficiency Measures	0.79
CESH	Custom Energy Solutions for the Home	0.65
RESM	Residential Services and Maintenance	0.92
RHTR	Residential Hard to Reach	1.00
Effective Program Total Based on PY11 Portfolio Performance		0.78

3 Interactive Effects

The TRM provides specific savings algorithms for many prescriptive measures. When a customer installs a prescriptive measure, the savings are determined according to these algorithms. In some cases these algorithms include the effects of interactions with other measures or end.

For "custom" measures, Hawaii Energy performs site-specific customized calculations. In this case, Hawaii Energy takes into account interactions between measures (e.g., individual savings from installation of window film and replacement of a chiller are not additive because the first measure reduces the cooling load met by the second measure).

Hawaii Energy will calculate total savings for the package of custom measures being installed, considering interactive effects, either as a single package or in rank order of measures as described below.

If a project includes both prescriptive and custom measures, the prescriptive measures will be calculated in the normal manner. However, the prescriptive measures will be assumed to be installed prior to determining the impacts for the custom measures.

For commercial lighting measures, the following factors are applied for facilities with air conditioning.

Table 3.1

Building Type	Expected Level of Similarity	Energy Factor	Demand Factor
All Commercial	Low	1.056	1.075
Misc Commercial	Low	1.056	1.075
Cold Storage	Very High	1.423	1.22
Education	Low	1.061	1.039
Grocery	Low	1.043	1.114
Health	High	1.122	1.233
Hotel/Motel	High	1.115	1.236
Industrial	Low	1.043	1.074
Office	Low	1.068	1.102
Restaurant	Low	1.051	1.073
Retail	Low	1.054	1.085
Warehouse	Low	1.019	1.053

4 Persistence

Persistence factors may be used to reduce lifetime measure savings in recognition that initial engineering estimates of annual savings may not persist long term.

This might be because a measure is removed or stops functioning prior to the end of its normal engineering lifetime, because it is not properly maintained, it is overridden, it goes out of calibration (controls only), or for some other reason.

Some of the measure algorithm may contain an entry for persistence factor. The default value if none is indicated is 1.00 (100%). A value lower than 1.00 will result in a downward adjustment of lifetime savings and total resource benefits.

For any measure with a persistence value less than 1.00, the claimed first year savings are reduced, and claimed for each year of the equipment's expected useful life.

5 Glossary

The following glossary provides definitions for necessary assumptions needed to calculate measure savings.

Attribution Factor (AF): The Attribution Factor is the amount of savings attributable to the program impact. It is calculated by subtracting from one the % free ridership.

Baseline Efficiency (η_{base}): The assumed standard efficiency of equipment, absent an Hawaii Energy program.

Coincidence Factor (CF): Coincidence factors represent the fraction of connected load expected to be "on" and using electricity coincident with the system peak period.

Connected Load: The maximum wattage of the equipment,under normal operating conditions, when the equipment is "on".

Freeridership (FR): A program's free ridership rate is the percentage of program participants deemed to be free riders. A free rider refers to a customer who received an incentive through an energy efficiency program who would have installed the same or a smaller quantity of the same high efficiency measure on their own within one year if the program had not been offered.

Full Load Hours (FLH): The equivalent hours that equipment would need to operate at its peak capacity in order to consume its estimated annual kWh consumption (annual kWh/connected kW).

High Efficiency (η_{effic}): The efficiency of the energy-saving equipment installed as a result of an efficiency program.

Incremental Cost: The cost difference between the installed cost of the high efficiency measure and the standard efficiency measure.

Lifetimes: The number of years (or hours) that the new high efficiency equipment is expected to function. These are generally based on engineering lives, but sometimes adjusted based on expectations about frequency of remodeling or demolition.

System Loss Factor (SLF): The marginal electricity losses from the generator to the customer meter – expressed as a percent of meter-level savings. The Energy Line Loss Factors vary by period. The Peak Line Loss Factors reflect losses at the time of system peak, and are shown for two seasons of the year (winter and summer). Line loss factors are the same for all measures.

Load Factor (LF): The fraction of full load (wattage) for which the equipment is typically run.

Operating Hours (HOURS): The annual hours that equipment is expected to operate.

Persistence (PF): The fraction of gross measure savings obtained over the measure life.

Realization Rate (RR): The fraction of gross measure savings realized by the program impact. It includes the gross verification adjustment and free ridership or attribution adjustment.

Spillover (SPL): Spillover refers to energy-efficient equipment installed in any facility in the program service area due to program influences, but without any financial or technical assistance from the Program. It is expressed as a percent or fraction of the gross savings attributable to program participation.

Total Resource Benefits (TRB): The present value of benefits from the program savings resulting from avoided energy and capacity costs for the utility and their ratepayers.

6 Load shapes and Demand Coincidence Factors

Load shapes for different types of equipment or systems were not needed because the savings values estimated in the KEMA 2008 impact evaluation already accounted for these load shapes. The coincidence factors were developed based on the calculated full load demand reduction and the KEMA values for each building type. The resulting coincidence factors were evaluated for reasonableness depending on the system type and the building type.

7 Total Resource Benefits – Avoided Costs and Measure Life

Table 7.1

Hawaii Energy - PY15 - TRB Values Using Modified Current EEPS Utility Avoided Cost									
			Discount Rate	Factored EEPS	Escalation Rate				
			6%	76%	3%				
				Utility Avoided Costs*		NPV for each Year		NPV Cumulative from Final Year	
Program Year	Year	Period	NPV Multiplier	$/kW/yr.	$/kWh/yr.	$/kW/yr.	$/kWh/yr.	$/kW/yr.	$/kWh/yr.
PY15	2016	1	1.00		$ 0.161	$ -	$ 0.1610	$ -	$ 0.1610
PY16	2017	2	0.94		$ 0.166	$ -	$ 0.1564	$ -	$ 0.3174
PY17	2018	3	0.89		$ 0.171	$ -	$ 0.1520	$ -	$ 0.4694
PY18	2019	4	0.84		$ 0.176	$ -	$ 0.1477	$ -	$ 0.6171
PY19	2020	5	0.79	$ 904	$ 0.181	$ 716	$ 0.1435	$ 716	$ 0.7606
PY20	2021	6	0.75	$ 986	$ 0.187	$ 737	$ 0.1395	$ 1,453	$ 0.9001
PY21	2022	7	0.70	$ 856	$ 0.192	$ 603	$ 0.1355	$ 2,056	$ 1.0356
PY22	2023	8	0.67	$ 750	$ 0.198	$ 499	$ 0.1317	$ 2,555	$ 1.1673
PY23	2024	9	0.63	$ 663	$ 0.204	$ 416	$ 0.1280	$ 2,971	$ 1.2953
PY24	2025	10	0.59	$ 590	$ 0.210	$ 349	$ 0.1243	$ 3,320	$ 1.4196
PY25	2026	11	0.56	$ 527	$ 0.216	$ 294	$ 0.1208	$ 3,615	$ 1.5404
PY26	2027	12	0.53	$ 474	$ 0.223	$ 250	$ 0.1174	$ 3,864	$ 1.6578
PY27	2028	13	0.50	$ 1,020	$ 0.230	$ 507	$ 0.1141	$ 4,371	$ 1.7719
PY28	2029	14	0.47	$ 1,066	$ 0.236	$ 500	$ 0.1108	$ 4,871	$ 1.8827
PY29	2030	15	0.44	$ 964	$ 0.244	$ 426	$ 0.1077	$ 5,297	$ 1.9904
PY30	2031	16	0.42	$ 875	$ 0.251	$ 365	$ 0.1047	$ 5,662	$ 2.0951
PY31	2032	17	0.39	$ 795	$ 0.258	$ 313	$ 0.1017	$ 5,975	$ 2.1968
PY32	2033	18	0.37	$ 724	$ 0.266	$ 269	$ 0.0988	$ 6,244	$ 2.2956
PY33	2034	19	0.35		$ 0.274	$ -	$ 0.0960	$ 6,244	$ 2.3916
PY34	2035	20	0.33		$ 0.282	$ -	$ 0.0933	$ 6,244	$ 2.4849
PY35	2036	21	0.31		$ 0.291	$ -	$ 0.0907	$ 6,244	$ 2.5756
PY36	2037	22	0.29		$ 0.300	$ -	$ 0.0881	$ 6,244	$ 2.6637
PY37	2038	23	0.28		$ 0.308	$ -	$ 0.0856	$ 6,244	$ 2.7493
PY38	2039	24	0.26		$ 0.318	$ -	$ 0.0832	$ 6,244	$ 2.8325
PY39	2040	25	0.25		$ 0.327	$ -	$ 0.0808	$ 6,244	$ 2.9133

* EEPS (2013-0056) Avoided Capacity Cost factored by 76% to reflect contribution of kW reductions achieved on Oahu in PY13. $161/MWh Avoided Costs per Guidance Recommendations. This is a conservative estimate based on EEPS 2014 Projections of $192, $225 and $192/MWh for HECO, HELCO and MECO respectively.

8 Effective Useful Life (EUL)

Version Date & Revision History:
Draft date: July 1, 2013
Revision date: July 7, 2015

Referenced Documents:

- Econorthwest TRM Review – 6/23/10
- DEER (The Database for Energy Efficient Resources) – 10/1/08

TRM Review Actions:

- 6/23/10 Rec. – Adopt DEER values in those cases where there is a greater than 20 percent difference between DEER and current TRM. – Adopted

Major Changes:

- Hawaii Energy will adopt DEER EUI values across the board and will follow DEER changes as they are updated unless obvious differences for Hawaii applications are identified.
- 7/7/2015 – Changed Commercial Solar Water Heating effective useful life from 15 to 20 years to be consistent with residential SWH and historical data available through literature review

The measure Effective Useful Life estimated for each measure is shown in the following table:

Table 8.1

Residential (R) Business (B)	Measure Type	Description	DEER Effectve Useful Life (EUL)
REEM	Water Heating	Solar Water Heating	20
R		Heat Pumps	10
R	Lighting	CFL	6
R		LED	15
R	Air Conditioning	VRF Split	15
R		Window AC w/recycling	9
R		Ceiling Fans	5
R		Solar Attic Fans	20
R		Whole House Fans	20
R	Appliances	Refrigerator (<$600)	14
R		Refrigerator w/Recycling	14
R		Garage Refrigerator/Freezer Bounty	14
R		Clothes Washer (Tier II/III)	11
R		Set top box	5
R		Pool VFD Controller Pumps	10
R		Advanced Power Strip	5
R	Control Systems	Room Occupancy Sensors & Timers	8
R		Peer Group Comparison	1
R		Whole House Energy Metering	4
R		Water cooler timer	8
CESH	Custom	Efficiency Project Auction	5
RESM	Design and Audits	Efficiency Inside	15
R	Tune Ups	Solar Water Heater Tune Up	5
R	Tune Ups	Central Air Conditional Retrofit	15
RHTR	Hard to Reach Grants	CFL Exchange	6
R		Refrigerator w/Recycling	14
R		Solar Water Heating	20
R	Direct Install	Energy Saving Kits	6

Residential (R) Business (B)	Measure Type	Description	DEER Effectve Useful Life (EUL)
BEEM	Water Heating	Solar Water Heating - Electric Resistance	20
B		Solar Water Heating - Heat Pump	
B		Heat Pump - conversion - Electric Resistance	10
B		Heat Pump Upgrade	10
B		Single Family Solar Water Heating	20
B	Lighting	Ceramic Metal Halide	14
B		CFL	3
B		Delamp w/Reflector (2', 4', 8')	14
B		Delamp	14
B		ENERGY STAR LED Dimmable A19	15
B		ENERGY STAR LED Dimmable w/Controls	15
B		ENERGY STAR LED Non-Dimmable	15
B		ENERGY STAR LED Non-Dimmable A19	15
B		LED Exit Signs	16
B		LED FIXTURE	15
B		LED Refrigerator Case Lighting	15
B		LED STREET AND PARKING LOT FIXTURE	15
B		Sensors	8
B		Stairwell Bi-Level Dimming Fluorescent	14
B		T12 to T8 Low Wattage	14
B		T12 to T8 Standard (2/3)	14
B		T8 to T8 Low Wattage	14
B	HVAC	Chillers	20
B		Chiller Plant Efficiency kW/Ton Meter	20
B		Garage Active Ventilation Control	8
B		Package Units	15
B		VFR Split System - New Construction	15
B		VFR Split System - Existing	15
B		VFD - AHU	15
B		VFD - Chilled Water/Condenser Water	15

Residential (R) Business (B)	Measure Type	Description	DEER Effectve Useful Life (EUL)
B	Water Pumping	VFD Dom Water Booster Packages	15
B		VFD Pool Pump	15
B	Motors	CEE Tier 1 + Premium Efficiency Motors	15
B		ECM w/Controller - evap fan motors	15
B		ECM - Fan Coil Fans	15
B	Industrial Process	Kitchen Exhaust Hood Demand Ventilation	15
B		Refrigerated Case Night Covers	10
B	Building Envelope	Cool Roof	10 15
B		Window Tinting	10
B	Business Equipment	ENERGY STAR Refrigerator	14
B		Clothes Washer	11
B		Energy Savings Kit	6
B	Control Systems	Hotel Room Occupancy Controls	8
B		Condominium submetering	8
B		Small Business submetering	8
CBEEM	Customized	Custom <= 5 years	5
B		Custom > 5 years	13
B		Efficiency Project Auction	10
BESM	Design and Audits	Benchmarking Metering	1
B		Decision Maker - Real time submeters	1
B		Energy Audit	N/A
B		Energy Study Implementation - 100%	N/A
B		Energy Study Assistance - 50%	N/A
B		Design Assistance - 50%	N/A
B		Water/Wastewater Catalyst	15
BHTR	Direct Install	SBDI	14
B	Grants	Water cooler timer	5
B	Restaurant	SBDI - Kitchen Exhaust Hood Demand Ventilation	15
B		Low flow spray rinse nozzles	12
B		ENERGY STAR Kitchen Equipment	12
B		SBDI - Lighting	14
B	Customized	Customized Retrofit	Custom calculated value

9 Commercial Lighting Factors

Commercial Lighting Factors

Building Type	Annual Hours of Operation[1]	Peak Coincidence Factor[2]
Misc. Commercial	4,325	0.3
Cold Storage	4,160	0.5
Education	2,653	0.2
Grocery	5,824	0.85
Health	6,474	0.65
Hotel/Motel	4,941	0.6
Industrial	4,290	0.5
Office	2,808	0.5
Restaurant	5,278	0.75
Retail	4,210	0.6
Warehouse	4,160	0.45

[1]The Database for Energy Efficient Resources (DEER)

[2]California Commercial End Use Summary (CEUS)

10 Residential Energy Efficiency Measures (REEM)

10.1 High Efficiency Water Heating

10.1.1 Solar Water Heater

Version Date & Revision History:
Draft date: February 24, 2010
Revision date: April 8, 2015

Referenced Documents:
- Energy and Peak Demand Impact Evaluation Report of the 2005-2007 Demand Management Programs – (KEMA 2005-07)
- Econorthwest TRM Review – 6/23/10
- Evergreen TRM Review – 2/23/12
- Evergreen TRM Review – 1/15/14
- DCA Office of Affordable Housing, 2011 Architectural Manual, Expected Useful Life Table

TRM Review Actions:
- 6/23/10 Rec. # 6 – For PY 2010, adjust claimed demand savings based on participant data from all service territories covered. Adjust Demand Savings based on participant data weighted average of KEMA results across all counties. Change from 0.50 to 0.46 kW. non-military – Adopted and incorporated into PY2010-1 TRM.
- 6/23/10 Rec. # 7 - For PY 2010, include a discussion of shell losses in the savings analysis and supporting documentation. Discussion included in PY2010-1 TRM.
- 10/5/11 – Currently Under Review.

Major Changes:
- Demand change to weighted average from KEMA 2008. 0.46 kW
- Changed individual water usage from 13.3035 to 13.3
- 4/8/2015 – Changed performance factor from 0.943816230585148 to 0.94. Resultant reduction in yearly energy savings from 2065 kWh to 2057 kWh.

Measure Description:
Replacement of Electric Resistance Water Heater with a Solar Water Heater designed for a 90% Solar Fraction. The new Solar Water Heating systems most often include an upgrade of the hot water storage tank sized at 80 or 120 gallons.

Systems must comply with Hawaii Energy Solar Standards and Specifications which call out:
- Panel Ratings
- System Sizing
- Installation orientation de-rating factors
- Hardware and mounting systems

Shell Losses:
The increase in size from a 40 or 60 gallon to an 80 or 120 gallon standard electric resistance water heater would in and of itself increase the “shell” losses of the system. These shell losses are the result of a larger surface area exposing the warm water to the cooler environment and thus more heat lost to the environment through conduction through the tank. Engineering calculations by Econorthwest puts this at a 1% increase in losses. This is further reduced by 90% as the solar water system provides that fraction of the annual water heating requirements.

Baseline Efficiencies:
Baseline usage is a 0.9 COP Electric Resistance Water Heater. The baseline water heater energy consumption is by a single 4.0kW electric resistance element that is controlled thermostatically on/off controller based of tank finish temperature set point. The tank standby loss differences between baseline and high efficiency case are assumed to be negligible.

Demand Baseline has been determined by field measurements by KEMA 2005-07 report. The energy baseline also comes from the KEMA 2005-07 report and is supported by engineering calculations shown in this TRM.

Building Types	Demand Baseline (kW)	Energy Baseline (kWh)
Residential	0.57	2,732

High Efficiency:
Solar Water Heater designed for a 90% Solar Fraction. The Solar Systems use solar thermal energy to heat the water 90% of the time and continue to utilize electricity to operate the circulation pump and provide heating through a 4.0 kW electric resistance element when needed.

Solar Contractors do not favor Photo-Voltaic powered DC circulation pumps as they have proven less reliable in the field than an AC powered circulation pump.

The electric resistance elements in the high efficiency case do not have load control timers on them.

The energy is the design energy of a 90% solar fraction system with circulation pump usage as metered by KEMA 2008.

The on peak demand is the metered demand found by KEMA 2008.

Building Types	Demand High Efficiency (kW)	Energy High Efficiency (kWh)	Circ. Pump %
Residential	0.07	379	28%

Energy Savings:

Solar Water Heater Gross Savings before operational adjustments:

Building Types	Demand Savings (kW)	Energy Savings (kWh)
Residential	0.46	2,354

Operational Factor	Adjustment Factor
Solar Fraction Performance (sfp)	0.94
Persistence Factor (pf)	1.0
Demand Coincidence Factor (cf)	0.93

Solar Water Heater Net Savings after operational adjustments:

Building Types	Energy Savings (kWh/year)	Demand Savings (kW)
Residential	2057	0.46

Savings Algorithms

Solar Water Heater - Non-Military Single Family Home

Energy per Day (BTU) = (Gallons per Day) x (lbs. per Gal.) x (Temp Rise) x (Energy to Raise Water Temp)

Hot Water needed per Person		13.3	Gallons per Day per Person	HE
Average Occupants	x	3.77	Persons	KEMA 2008
Household Hot Water Usage		50.141	Gallons per Day	
Mass of Water Conversion		8.34	lbs/gal	
Finish Temperature of Water		130	deg. F Finish Temp	
Initial Temperature of Water	-	75	deg. F Initial Temp	
Temperature Rise		55	deg. F Temperature Rise	
Energy to Raise Water Temp		1.0	BTU / deg. F / lbs.	
Energy per Day (BTU) Needed in Tank		23,000	BTU/Day	
Energy per Day (BTU) Needed in Tank		23,000	BTU/Day	
BTU to kWh Energy Conversion	÷	3,412	kWh / BTU	
Energy per Day (kWh)		6.7	kWh / Day	
Days per Month	x	30.4	Days per Month	
Energy (kWh) per Month		205	kWh / Month	
Days per Year	x	365	Days per Year	
Energy (kWh) Needed in Tank to Heat Water per Year		2,459	kWh / Year	
Elec. Res. Water Heater Efficiency	÷	0.90	COP	
Base SERWH Energy Usage per Year at the Meter		2,732	kWh / Year	KEMA 2008 - HECO
Design Annual Solar Fraction		90%	Water Heated by Solar System	Program Design
		10%	Water Heated by Remaining Backup Element	
Energy Usage per Year at the Meter		2,732	kWh / Year	
	x	10%	Water Heated by Remaining Backup Element	
Back Up Element Energy Used at Meter		273	kWh / Year	
Circulation Pump Energy		0.082	kW	KEMA 2008
Pump Hours of Operation	x	1,292	Hours per Year	KEMA 2008
Pump Energy used per Year		106	kWh / Year	
Back Up Element Energy Used at Meter		273	kWh / Year	72%
Pump Energy used per Year	+	106	kWh / Year	28%
Design Solar System Energy Usage		379	kWh / Year	
Base SERWH Energy Usage per Year at the Meter		2,732	kWh / Year	
Design Solar System Energy Usage	-	379	kWh / Year	
Design Solar System Energy Savings		2,353	kWh / Year	
Design Solar System Energy Savings		2,353	kWh / Year	
Performance Factor		0.94	pf	HE
Persistance Factor	x	0.93	pf	KEMA 2008
		2,057	kWh / Year	KEMA 2008
Residential Solar Water Heater Energy Savings		**2,057**	**kWh / Year Savings**	
Base SERWH Element Power Consumption		4.0	kW	
Coincidence Factor	x	0.143	cf	8.6 minutes per hour
Base SERWH On Peak Demand		0.57	kW On Peak	KEMA 2008
Base SERWH On Peak Demand	-	0.57	kW On Peak	
Solar System Metered on Peak Demand	-	0.11	kW On Peak	KEMA 2008
		0.46	kW On Peak	
Residential Solar Water Heater Demand Savings		**0.46**	**kW Savings**	

Operating Hours
See Table above.

Loadshape
TBD

Freeridership/Spillover Factors
TBD

Persistence
The persistence factor has been found to be 0.93 based in the KEMA 2005-07 report that found 7% of the systems not operational.

Measure Life
20 years (DCA Office of Affordable Housing, 2011 Architectural Manual, Expected Useful Life Table)

Component Costs and Lifetimes Used in Computing O&M Savings
TBD

Reference Tables
None

10.1.2 Solar Water Heating Loan Interest Buydown (Hot Water Cool Rates)

Version Date & Revision History:
Draft date: May 22, 2011

Referenced Documents:
- Energy and Peak Demand Impact Evaluation Report of the 2005-2007 Demand Management Programs – (KEMA 2005-07)
- Econorthwest TRM Review – 6/23/10
- Evergreen TRM Review – 2/23/12
- Evergreen TRM Review – 1/15/14

TRM Review Actions:
- 6/23/10 Rec. # 6 – For PY 2010, adjust claimed demand savings based on participant data from all service territories covered. Adjust Demand Savings based on participant data weighted average of KEMA results across all counties. Change from 0.50 to 0.46 kW. non-military – Adopted and incorporated into PY2010-1 TRM.
- 6/23/10 Rec. # 7 - For PY 2010, include a discussion of shell losses in the savings analysis and supporting documentation. Discussion included in PY2010-1 TRM.
- 10/5/11 – Currently Under Review.

Major Changes:
- Eliminated Military figure as no foreseeable military retrofit applications will be received.
- Demand change to weighted average from KEMA 2008. 0.46 kW
- Changed individual water usage from 13.3035 to 13.3
- 11/14/13 – Included peak demand savings calculations.

Measure Description:
The Solar Water Heating Loan Interest Buydown Program offers eligible borrowers an interest buy down of $1,000 (with a minimum loan of $5,000) toward the financing of a solar water heating system from a participating lender – see www.hawaiienergy.com for a list of participating lenders.

Replacement of Electric Resistance Water Heater with a Solar Water Heater designed for a 90% Solar Fraction. The new Solar Water Heating systems most often include an upgrade of the hot water storage tank sized at 80 or 120 gallons.

Systems must comply with Hawaii Energy Solar Standards and Specifications which call out:
- Panel Ratings
- System Sizing
- Installation orientation de-rating factors
- Hardware and mounting systems

Shell Losses:
The increase in size from a 40 or 60 gallon to an 80 or 120 gallon standard electric resistance water heater would in and of itself increase the “shell” losses of the system. These shell losses are the result of a larger surface area exposing the warm water to the cooler environment and thus more heat lost to the environment through conduction through the tank. Engineering calculations by Econorthwest puts this at a 1% increase in losses. This is further reduced by 90% as the solar water system provides that fraction of the annual water heating requirements.

Baseline Efficiencies:
Baseline usage is a 0.9 COP Electric Resistance Water Heater. The baseline water heater energy consumption is by a single 4.0 kW electric resistance element that is controlled thermostatically on/off controller based of tank finish temperature set point. The tank standby loss differences between baseline and high efficiency case are assumed to be negligible.

Demand Baseline has been determined by field measurements by KEMA 2005-07 report. The energy baseline also comes from the KEMA 2005-07 report and is supported by engineering calculations shown in this TRM.

Building Types	Demand Baseline(kW)	Energy Baseline (kWh)
Residential	0.57	2,733

High Efficiency:
Solar Water Heater designed for a 90% Solar Fraction. The Solar Systems use solar thermal energy to heat the water 90% of the time and continue to utilize electricity to operate the circulation pump and provide heating through a 4.0 kW electric resistance element when needed.

Solar Contractors do not favor Photo-Voltaic powered DC circulation pumps as they have proven less reliable in the field than an AC powered circulation pump.

The electric resistance elements in the high efficiency case do not have load control timers on them.

The energy is the design energy of a 90% solar fraction system with circulation pump usage as metered by KEMA 2008.

The on peak demand is the metered demand found by KEMA 2008.

Building Types	Demand High Efficiency (kW)	Energy High Efficiency (kWh)	Circ. Pump %
Residential	0.07	379	28%

Energy Savings:
Solar Water Heater Gross Savings before operational adjustments:

Building Types	Demand Savings (kW)	Energy Savings (kWh)
Residential	0.46	2,354

Operational Factor	Adjustment Factor
Solar Fraction Performance (sfp)	0.94
Persistence Factor (pf)	0.93
Demand Coincidence Factor (cf)	1.0

Solar Water Heater Net Savings after operational adjustments:

Building Types	Energy Savings (kWh/year)	Demand Savings (kW)
Residential	2057	0.46

Savings Algorithms
See savings algorithm for for section 9.1.1 Solar Water Heater.

Operating Hours
See savings algorithm for for section 9.1.1 Solar Water Heater.

Loadshape
TBD

Freeridership/Spillover Factors
TBD

Persistence
The persistence factor has been found to be 0.93. Based in the KEMA 2005-07 report that found 7% of the systems not operational.

Lifetime
20 years

10.1.3 Heat Pump Water Heaters

Measure ID:

Version Date & Revision History:
Draft date: March 2, 2011
Revision date: June 23, 2015

Referenced Documents:
- From SalesForce Measures (Impact)
- October 2004 (KEMA Report)
- Evergreen TRM Review – 2/23/12
- Evergreen TRM Review – 1/15/14

TRM Review Actions:
- 10/5/11 – Currently Under Review.
- 11/14/13 – Adjusted savings to be consistent with the most recent product specifications.
- 06/23/15 – Reviewed for PY15. Removed reference to incentive amount ($).

Major Changes:
- Recognizing the growing product availability and sales efforts regarding residential heat pumps, increase educational efforts.
- Changed base SERWH element power consumption from 4.5 kW to 4.0 kW

Measure Description:
Rebate applications for water heaters are provided by the retailers at the time of purchase or a customer can visit our website and download the form. Rebate applications must include an original purchase receipt showing brand and model number.

Baseline Efficiencies:
The base case is a standard electric resistance water heater (SERWH).

Energy Savings:

Measure	Energy Savings (kWh/year)	Demand Savings (kW)
Base Case (SERWH)	2732	0.57
Enhanced Case (HPWH)	1088	0.36
Savings	1644	0.21

Savings Algorithms

Heat Pump Water Heater

Energy per Day (BTU) = (Gallons per Day) x (lbs. per Gal.) x (Temp Rise) x (Energy to Raise Water Temp)

Hot Water needed per Person		13.3	Gallons per Day per Person	HE
Average Occupants	x	3.77	Persons	KEMA 2008
Household Hot Water Usage		50.1	Gallons per Day	
Mass of Water Conversion		8.34	lbs/gal	
Finish Temperature of Water		130	deg. F Finish Temp	
Initial Temperature of Water	-	75	deg. F Initial Temp	
Temperature Rise		55	deg. F Temperature Rise	
Energy to Raise Water Temp		1.0	BTU / deg. F / lbs.	
Energy per Day (BTU) Needed in Tank		23,000	BTU/Day	
Energy per Day (BTU) Needed in Tank		23,000	BTU/Day	
BTU to kWh Energy Conversion	÷	3,412	kWh / BTU	
Energy per Day (kWh)		6.7	kWh / Day	
Days per Month	x	30.4	Days per Month	
Energy (kWh) per Month		205	kWh / Month	
Days per Year	x	365	Days per Year	
Energy (kWh) Needed in Tank to Heat Water per Year		2,459	kWh / Year	
Elec. Res. Water Heater Efficiency	÷	0.90	COP	
Base SERWH Energy Usage per Year at the Meter		2,732	kWh / Year	KEMA 2008 - HECO
Energy (kWh) Needed to Heat Water per Year		2,459	kWh / Year	
Heat Pump Water Heating Efficiency	÷	2.26	COP	
Heat Pump Water Heating Energy Usage		1,088	kWh / Year	
Base SERWH Energy Usage per Year at the Meter		2,732	kWh / Year	
Heat Pump Water Heating Energy Usage	-	1,088	kWh / Year	
Residential Heat Pump Water Heating Energy Savings		**1644**	**kWh / Year**	

Heat Pump Power Consumption		4.5	kW		
Coincidence Factor	x	0.08	cf	4.80	Minutes per hour
		0.36	kW On Peak		
Base SERWH Element Power Consumption		4.0	kW		
Coincidence Factor	x	0.143	cf	8.6	Minutes per hour
Base SERWH On Peak Demand		0.57	kW On Peak	KEMA 2008	
Base SERWH On Peak Demand	-	0.57	kW On Peak		
Heat Pump Water Heater Demand	-	0.36	kW On Peak	KEMA 2008	
		0.21	kW On Peak		
Residential Heat Pump Water Heating Demand Savings		**0.21**	**kW Savings**		

Operating Hours
See Table above.

Loadshape
TBD

Freeridership/Spillover Factors
TBD

Persistence Factor

Coincidence Factor
0.143 (based on 8.6 minutes per hour for 4 hours)

Lifetime
10 years (DEER)

10.2 High Efficiency Lighting

10.2.1 Compact Fluorescent Lamp (CFL)

Version Date & Revision History:
Draft date: February 24, 2010
Revision date: April 17, 2015

Referenced Documents:
- Energy and Peak Demand Impact Evaluation Report of the 2005-2007
- Demand Management Programs – KEMA (KEMA 2005-07)
- Econorthwest TRM Review – 6/23/10
- Evergreen TRM Review – 2/23/12
- Evergreen TRM Review – 1/15/14

TRM Review Actions:
- 6/23/10 Rec. # 8 – Starting with PY2010, adjust the hours used per day for CFLs from 4.98 to 2.3 in order to be consistent with other literature. Conduct additional research to verify the most appropriate hours of operation for the Hawaii customer base, which can be incorporated into future years. – Adopted.
- 6/23/10 Rec. # 9 - Starting with PY 2010, adjust the peak coincidence factor from 0.334 to 0.12 to be consistent with the literature. Conduct additional research to verify the most appropriate coincidence factor for the Hawaii customer base, which can be incorporated into future years.- Adopted.
- 10/5/11 – Currently Under Review.
- 4/17/12 – Updated persistence factor to 0.96 and removed adjustment for mix of CFL sizes found in CA study as per EMV report February 23, 2012. Updated energy and demand savings accordingly.
- 11/14/13 – Adjust delta watts from 45W to 38.25W.

Major Changes:
- Hours used per day for CFLs from 4.98 to 2.3 hrs.
- Peak coincidence factor from 0.334 to 0.12
- Persistence factor changed from 0.80 to 0.96 as per EMV
- Adjustment for mix of CFL sized found in CA study removed as per EMV
- 4/17/15 – Baseline efficiency for CFL and for LED shall be the same.
- 4/17/15 – Adjust baseline to be a mixture of incandescents and CFLs.
- 4/17/15 – Adjust baseline percentages based on Program statistics of CFLs and incandescents and a burn-out ratio of 4.5:1 (incandescents:CFL).
- 4/17/15 – Adjust enhanced case to be a mixture of CFLs based on actual Program statistics.

Measure Description:
The replacement of incandescent screw-in lamps to standard spiral compact fluorescent lamps in Residential Single Family and Multi-family homes. Lamps must comply with Energy Star and UL.

Baseline Efficiencies:
Breakdown of CFL vs incandescent is based on a burn-out ratio of 9000 hours to 2000 hours. In 9000 hours, 4.5 incandescents will burn out and 1 CFL will burn out, for a total of 5.5 burnt-out bulbs. This equates to a replacement rate of 81.8% incandescents and 18.2% CFLs. Within each category of incandescents or CFLs, the breakdown of wattages is based on actual Hawaii Energy Program statistics.

Baseline Efficiency					
Lamp Types	Demand Baseline (kW)	Hours per Day	Energy Baseline (kWh/year)	%	Totals
Incandescent	0.072	2.3	60.4	2.4%	1.45
Incandescent	0.053	2.3	44.5	26.5%	11.79
Incandescent	0.043	2.3	36.1	24.7%	8.92
Incandescent	0.029	2.3	24.3	28.2%	6.87
CFL	0.026	2.3	21.8	0.5%	0.12
CFL	0.023	2.3	19.0	5.9%	1.12
CFL	0.014	2.3	11.9	5.5%	0.65
CFL	0.013	2.3	10.6	6.3%	0.67
				Total Baseline Energy (kWh)	31.58
				Total Average Demand (kW)	0.0376

High Efficiency:
The high efficiency case is a mixture of 26 W, 23 W, 14, W, and 13W CFL bulbs. These wattages, as well as the percentage breakdown of wattages, is based on actual Hawaii Energy Program statistics.

Enhanced Efficiency					
Lamp Types	Demand Baseline (kW)	Hours per Day	Energy Baseline (kWh/year)	%	Totals
CFL	0.026	2.3	21.8	2%	0.35
CFL	0.023	2.3	19.0	33%	6.28
CFL	0.014	2.3	11.9	24%	2.81
CFL	0.013	2.3	10.6	42%	4.42
				Total Baseline Energy (kWh)	13.86
				Total Average Demand (kW)	0.0165

Operational Factors:

Operational Factor	Adjustment Factor
Persistence Factor (pf)	0.96
Demand Coincidence Factor (cf)	0.12

Energy Savings:
CFL Net Savings after operational adjustments:

Wattage Delta (kW)	0.0211
Annual Operating hours	839.5
Total Baseline Energy (kWh/year)	31.58
Total High Efficiency Energy (kWh/year)	13.86
Energy Delta (kWh/year)	17.72
Persistence Factor (pf)	0.96
Annual Energy Savings (kWh/year)	**17.0**
Persistence Factor (pf)	0.96
Peak Coincidence Factor	0.12
Peak Demand Savings (kW)	**0.0024**

Operating Hours
2.3 hours per day, 839.5 hours per year

Loadshape
TBD

Freeridership/Spillover Factors
TBD

Demand Coincidence Factor
Estimated coincidence factor of 0.12 cf assumes that 12% of the lamps purchased would be operating during the winter 5 p.m. to 9 p.m. weekday peak period.

Persistence
Estimated persistence factor of 0.96 pf which assumes 4% of the lamps purchased not installed or returned back to incandescent.

Lifetime
6 years

Component Costs and Lifetimes Used in Computing O&M Savings
TBD

Reference Tables
None

Military savings
Based on EM&V review 1/15/14, military homes have 50 percent more operating hours than non-military homes, or 1,259.3 hours per year instead of 839.5 hours per year.

Type	Demand Savings (kW)	Energy Savings (kWh/yr)
Non-Military	0.0028	17.0
Military	0.0028	25.5

Savings Algorithm:

CFL - Single and Multi Family Residential Home				
Lamp Average Demand		0.0376	kW	
		2.30	Hours per Day	
	x	365	Days	839.50 Hours per Year
Baseline Energy Usage		31.57	kWh per Year	
Enhanced LED Lamp Average Demand		0.0165	kW	
		2.30	Hours per Day	
	x	365	Days	839.50 Hours per Year
Enhanced LED Lamp Energy Usage		13.85	kWh per Year	
Baseline Energy Usage		31.57	kWh per Year	
Enhanced LED Lamp Energy Usage	-	13.85	kWh per Year	
LED Savings Before Adjustments		17.71	kWh per Year	
		17.71	kWh per Year	
Persistance Factor	x	0.960	pf	4.0% Lamps not installed or replaced back
		17.00	kWh per Year	
CFL Energy Savings		**17.0**	**kWh / Year Savings**	
Baseline Lamp Demand		0.0376	kW	
Enhanced LED Lamp Demand	-	0.0165	kW	
LED Demand Reduction Before Adjustments		0.0211	kW	
LED Demand Reduction Before Adjustments		0.021	kW	
Coincidence Factor		0.120	cf	12.0% Lamps on between 5 and 9 p.m.
Persistance Factor	x	0.960	pf	4.0% Lamps not installed or replaced back
		0.0024	kW	
CFL Demand Savings		**0.0024**	**kW Savings**	

10.2.2 Light Emitting Diode (LED)

Version Date & Revision History:
Draft date: February 24, 2010
Revision date: May 19, 2016

Referenced Documents:
- Evergreen TRM Review – 2/23/12
- Evergreen TRM Review – 1/15/14

TRM Review Actions:
- 10/5/11 – Currently Under Review.
- 4/8/15 – Revised LED savings values per PY12 TRM Review

Major Changes:
- 11/21/11 – Updated tables and text in the following headings:
  - Measure description
  - Baseline efficiencies
  - High efficiency
  - Energy savings
  - Savings algorithm
- Updates made to capture a broader range of lamp types (two wattages per lamp type) and obtain more accurate savings calculations.
- 11/21/11 – Changed the following text under *Energy Savings* heading: 1) "LED Gross Savings before operational adjustments" was changed to "LED Savings before…" and 2) "CFL Net Savings after operational adjustments" was changed to "LED Savings after…"
- 11/21/11 – Under *Energy Savings* heading changed table to only one building type because savings are calculated the same between single and multi-family housing.
- Removed the 1.08 size adjustment factor.
- 4/8/15 – Changed persistence factor from 0.8 to 0.96 to be consistent with CFL bulbs.
- 4/17/15 – Baseline efficiency for CFL and for LED shall be the same.
- 4/17/15 – Adjust baseline to be a mixture of incandescents and CFLs.
- 4/17/15 – Adjust baseline percentages based on Program statistics of CFLs and incandescents and a burn-out ratio of 4.5:1 (incandescents:CFL). Burn-out ratio from 2014 DEER data.
- 4/17/15 – Adjust enhanced case to be a mixture of LEDs based on actual Program statistics.
- 5/19/2016 – Added measure life.

Measure Description:
The replacement of a standard incandescent lamp or spiral compact fluorescent lamp with a light emitting diode in both Residential Single Family and Multi-family homes. Lamps must comply with Energy Star and UL.

Baseline Efficiencies:

Breakdown of CFL vs incandescent is based on a burn-out ratio of 9000 hours to 2000 hours. In 9000 hours, 4.5 incandescents will burn out and 1 CFL will burn out, for a total of 5.5 burnt-out bulbs. This equates to a replacement rate of 81.8% incandescents and 18.2% CFLs. Within each category of incandescents or CFLs, the breakdown of wattages is based on actual Hawaii Energy Program statistics.

Baseline Efficiency					
Lamp Types	Demand Baseline (kW)	Hours per Day	Energy Baseline (kWh/year)	%	Totals
Incandescent	0.072	2.3	60.4	2.4%	1.45
Incandescent	0.053	2.3	44.5	26.5%	11.79
Incandescent	0.043	2.3	36.1	24.7%	8.92
Incandescent	0.029	2.3	24.3	28.2%	6.87
CFL	0.026	2.3	21.8	0.5%	0.12
CFL	0.023	2.3	19.0	5.9%	1.12
CFL	0.014	2.3	11.9	5.5%	0.65
CFL	0.013	2.3	10.6	6.3%	0.67
				Total Baseline Energy (kWh)	**31.58**
				Total Average Demand (kW)	**0.0376**

High Efficiency:

The high efficiency case is a mixture of 5.5 W, 7.6 W, 12.6 W, and 17.1 W LED bulbs. These wattages, as well as the percentage breakdown of wattages, is based on actual Hawaii Energy Program statistics.

Enhanced Efficiency					
Lamp Types	Demand Baseline (kW)	Hours per Day	Energy Baseline (kWh/year)	%	Totals
LED	0.0171	2.3	14.4	8%	1.20
LED	0.0126	2.3	10.6	29%	3.09
LED	0.0076	2.3	6.4	57%	3.62
LED	0.0055	2.3	4.6	6%	0.26
				Total Baseline Energy (kWh)	**8.17**
				Total Average Demand (kW)	**0.0097**

Operational Adjustments

Operational Factor	Adjustment Factor
Persistence Factor (pf)	0.96
Demand Coincidence Factor (cf)	0.12

Energy Savings:
LED Savings:

Wattage Delta (kW)	0.0279
Annual Operating hours	839.5
Total Baseline Energy (kWh/year)	31.58
Total High Efficiency Energy (kWh/year)	8.17
Energy Delta (kWh/year)	23.41
Persistence Factor (pf)	0.96
Annual Energy Savings (kWh/year)	**22.5**
Persistence Factor (pf)	0.96
Peak Coincidence Factor	0.12
Peak Demand Savings (kW)	**0.0032**

Military savings
Based on EM&V review 1/15/14, military homes have 50 percent more operating hours than non-military homes, or 1,259.3 hours per year instead of 839.5 hours per year.

Type	Demand Savings (kW)	Energy Savings (kWh/yr)
Non-Military	0.0032	22.5
Military	0.0032	33.8

Measure Life
15 years

Savings Algorithms

LED - Single and Multi Family Residential Home					
Lamp Average Demand		0.0376	kW		
		2.30	Hours per Day		
	x	365	Days	839.50	Hours per Year
Baseline Energy Usage		31.58	kWh per Year		
Enhanced LED Lamp Average Demand		0.0097	kW		
		2.30	Hours per Day		
	x	365	Days	839.50	Hours per Year
Enhanced LED Lamp Energy Usage		8.14	kWh per Year		
Baseline Energy Usage		31.58	kWh per Year		
Enhanced LED Lamp Energy Usage	-	8.14	kWh per Year		
LED Savings Before Adjustments		23.43	kWh per Year		
		23.4	kWh per Year		
Persistance Factor	x	0.960	pf	4.0%	Lamps not installed or replaced back
		22.5	kWh per Year		
LED Energy Savings		**22.5**	**kWh / Year Savings**		
Baseline Lamp Demand		0.038	kW		
Enhanced LED Lamp Demand	-	0.010	kW		
LED Demand Reduction Before Adjustments		0.028	kW		
LED Demand Reduction Before Adjustments		0.028	kW		
Coincidence Factor		0.120	cf	12.0%	Lamps on between 5 and 9 p.m.
Persistance Factor	x	0.960	pf	4.0%	Lamps not installed or replaced back
		0.0032	kW		
LED Demand Savings		**0.0032**	**kW Savings**		

10.3 High Efficiency Air Conditioning

10.3.1 VRF Split System AC

Version Date & Revision History:
Draft date: February 24, 2011
Revision date: April 17, 2015

Referenced Documents:
- Evergreen TRM Review – 2/23/12
- Evergreen TRM Review – 1/15/14

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- 4/17/2015 – Updated values for single-family vs multi-family to 68% and 32% based on Evergreen Baseline Report to PUC. Resultant change was energy savings of 583 kWh/year to 689 kWh/year and 0.30 kW to 0.32 kW.
- 12/18/2015 – Changed coincidence factor from 1.0 to 0.5 to match other residential AC measures.
- 12/18/2015 – Removed SF/MF use factor and weighted average method and changed equivalent full-load operating hours from 5016 to 1825 to capture average usage for all types of homes.
- 3/9/2016 – Added standard sizes for "small" and "large" units and corresponding energy and demand savings values for respective sizes.

Description: Inverter driven variable refrigerant flow (VRF) air conditioning systems are direct expansion AC systems that utilize variable speed evaporator/condenser fans, and a combination of fixed and variable speed compressors along with most often multiple individual zone evaporators to provide the ability to more closely match the AC system's output with the building's cooling requirements.
Savings comes from:
- *Part Load Efficiencies*: Increased part-load efficiency operation
- *High Efficiency Motors*: Many systems use ECM motors
- *Higher Room Temperatures*: The capacity matching allows for better humidity control through longer cooling operation.
- *Reduction of Distribution Losses*: Duct losses are reduced with DX systems. This may be offset by dedicated outside air distribution systems when needed.

Energy and Demand Savings: VRF systems have demonstrated a 20-30% reduction in energy consumption as compared to standard DX equipment.

Base Efficiency
Base case efficiency is 10.9 SEER.

High Efficiency
The high efficiency case is 16 SEER.

Energy Savings
Savings of 640 kWh/year (see algorithm below) is based on per 1 ton (12,000 Btu/hr) cooling capacity. Energy savings may be multiplied for VRF systems larger than 1 ton. From a review of PY2015 rebates processed, the average size of a small unit (2 tons and less) was 1.28 tons. The average size of a large unit (greater than 2 tons) was 2.58 tons. Therefore, a small VRF unit savings is equal to 819 kWh/year and a large VRF unit is 1651 kWh/year.

Demand Savings

Peak demand savings of 0.18 kW (see algorithm below) is based on per 1 ton (12,000 Btu/hr) cooling capacity. Demand savings may be multiplied for VRF systems larger than 1 ton. From a review of PY2015 rebates processed, the average size of a small unit (2 tons and less) was 1.28 tons. The average size of a large unit (greater than 2 tons) was 2.58 tons. Therefore, a small VRF unit demand savings is equal to 0.23 kW and a large VRF unit demand savings is 0.46 kW.

Savings Algorithms

VRF Split System AC - Single and Multi Family Residential Home				
Base Case				
Conventional Room AC Built After 1994				
Average Unit Cooling Capacity		12,000	BTU / Hr	(Equals 1 Ton Cooling Capacity)
Energy Efficiency Ratio	÷	10.9	EER	Federal minimum standard (June 1, 2014)
Full Load Demand		1,101	Watts	
Conversion	÷	1,000	Watts / kW	
Full Load Demand		1.1	kW	
Conventional Room AC Full Load Demand		1.1	kW	
Honolulu Full Load Equivalent Cooling Hours	x	1,825	Hours per Year	Hawaii Energy estimate full-load equivalent hours
Conventional Room AC Annual Energy Consumption		2,009	kWh per Year	
VRF Split System AC				
Average Unit Cooling Capacity		12,000	BTU / Hr	(Equals 1 Ton Cooling Capacity)
Energy Efficiency Ratio	÷	16.0	EER	HE minimum requirement for incentive
Full Load Demand		750.0	Watts	
Conversion	÷	1,000.0	Watts / kW	
Full Load Demand		0.75	kW	
VRFSplit AC Full Load Demand		0.75	kW	
Honolulu Full Load Equivalent Cooling Hours	x	1,825	Hours per Year	
VRF Split Annual Energy Consumption		1,369	kWh per Year	
Conventional Room AC Annual Energy Consumption		2,009	kWh per Year	
VRF Split Annual Energy Consumption	-	1,369	kWh per Year	
VRF Split Annual Energy Savings		640	kWh per Year	
		640	kWh per Year	
Persistance Factor	x	1	pf	100.0%
		640	kWh per Year	
VRF Split AC Energy Savings		**640**	**kWh / Year Savings per ton of capacity**	
Conventional Room AC Full Load Demand		1.1	kW	
VRF Split AC Full Load Demand	-	0.75	kW	
VRF AC Demand Reduction Before Adjustments		0.35	kW	
VRF AC Demand Reduction Before Adjustments		0.35	kW	
Coincidence Factor	x	0.5	pf	50.0% VRFs operational between 5-9 PM
Persistance Factor	x	1.0	pf	100.0% VRFs installed and operational at EER Efficiency
VRF AC Demand Reduction After Adjustments		0.18	kW	
Single & Multi Family VRF Split AC Demand Savings		**0.18**	**kW Savings per ton of capacity**	

Measure Life

The measure life is assumed to be 15 years.

10.3.2 Window AC with Recycling

Version Date & Revision History:
Draft date: December 23, 2014
Revision date: June 23, 2015

Referenced Documents:
- http://www1.eere.energy.gov/buildings/appliance_standards/product.aspx/productid/41)

TRM Review Actions:

Major Changes:
- Base-case efficiency = 9.8 EER (Energy conservation standard for 8500 Btuh capacity with louvered sides and without reverse cycle, per US DOE, until 5/31/2014. Enhanced-case efficiency = 11.2 EER (Minimum Energy Star qualifying for < 19,999 Btuh capacity with louvered sides and without reverse cycle)
- Measure life = 9 years (DEER)
- Coincidence Factor = 0.50
- 6/23/15 – Changed run time from 1824 to 1825 hours for simplicity (Hawaii Energy estimation based on Hawaii climate, 5 hrs per day)

Measure Description
This measure involves the early removal of an existing inefficient room window air conditioning unit from service and replacement with a new ENERGY STAR qualifying unit.

Baseline Condition
The baseline condition is the existing inefficient room air conditioning unit 8,500 Btuh at 9.8 EER.

Definition of Efficient Condition
The efficient condition is a new replacement room air conditioning unit 8,500 Btuh meeting the ENERGY STAR efficiency standard at 11.2 EER.

Annual Energy Savings Algorithm
Savings for remaining life of existing unit:

$$\Delta kWh = (Hours * BtuH * (1/EERexist - 1/EERee))/1,000$$

Where:
- Hours = Run hours of Window AC unit = 1,825 hr/yr
- Btuh = Capacity of replaced unit = Actual or 8,500 if unknown
- EERexist = Efficiency of existing unit in Btus per Watt-hour = 9.8
- EERee = Efficiency of ENERGY STAR unit in Btus per Watt-hour = 11.2

Annual Energy Savings = 197.8 kWh/year

Peak Demand Savings Algorithm

Peak Demand Savings = Annual Energy Savings divided by Hours of Operation multiplied by Coincidence Factor

Peak Demand Savings = 0.054 kW

Algorithm Savings

Window AC w/Recycling				
Average Unit Cooling Capacity		8500	BTU/Hr	Average size of Window AC's incentivized by Hawaii Energy in PY14
Energy Efficiency Ratio	÷	9.8	EER	DOE Federal Test Procedure 10CFR 430, Appendix F
Full Load Demand		867.3	Watts	
Conversion	÷	1000	Watts/kW	
Full Load Demand		0.87	kW	
Conventional Full Load Demand		0.87	kW	
Honolulu Full Load Equivalent Cooling Hour	x	1825	Hours per Year	Hawaii Energy estimate, based on 5 hr/day, 365 day/year
Conventional AC Annual Energy Consumption		1582.9	kWh per Year	
Energy Star Window AC		8500	BTU/hr	Average size of Window AC's incentivized by Hawaii Energy in PY14
Energy Efficiency Ratio	÷	11.2	EER	Minimum Energy Star Rated Window AC
Full Load Demand		758.9	Watts	
Conversion	÷	1000	Watts/kW	
Full Load Demand		0.76	kW	
ENERGY STAR Full Load Demand		0.76	kW	
Cooling Hours	x	1825	Hours per Year	Hawaii Energy estimate, based on 5 hr/day, 365 day/year
ENERGY STAR AC Annual Energy Consumption		1385.0	kWh per Year	
Annual Energy Savings		198	kWh per Year	
Coincidence Factor		0.5		Hawaii Energy estimate for AC use during peak demand period
Demand Peak Savings		0.054	kW	

Incremental Cost

The incremental cost for this measure should be the actual implementation cost for recycling the existing units, plus $129.

Measure Life

The measure life is assumed to be 9 years.

10.3.3 Ceiling Fans

Version Date & Revision History:
Draft date: March 2, 2011
Review date: June 23, 2015

Referenced Documents:

- ENERGY STAR Ceiling Fan Savings Calculator

TRM Review Actions:

Major Changes:

- Reduced fan lighting hours of operation from 3.5 hours to 2.3 hours per day to be consistent with the other lighting measures – EM&V Review November 14, 2013

Measure Description:
This measure describes the instillation of an ENERGY STAR ceiling fan that uses a high efficiency motor and contains compact fluorescent bulbs in place of a standard fan with integral incandescent bulbs.

Baseline Efficiencies:
The baseline equipment is assumed to be a standard fan with integral incandescent bulbs.

High Efficiency:
The efficient equipment must be an ENERGY STAR certified ceiling fan with integral CFL bulbs.

Energy Savings:

	Average Annual kWh savings per unit	Average Coincident Peak kW savings per unit
2010 - 2013	110	0.019
2014 on	65	0.012

$\Delta kWh = ((\%_{low} * (LowKW_{base} - LowKW_{ee}) + \%_{med} * (MedKW_{base} - MedKW_{ee}) + \%_{high} * (HighKW_{base} - HighKW_{ee})) * HOURS_{fan}) + ((IncKW – CFLKW) * HOURS_{light} * WHFe)$

Where:

$\%_{low}$	= Percent of time on Low Speed	= 40%
$\%_{med}$	= Percent of time on Medium Speed	= 40%
$\%_{high}$	= Percent of time on High Speed	= 20%
$LowWatt_{base}$	= Low speed baseline ceiling fan wattage	= 0.0152 kW
$LowWatt_{ee}$	= Low speed ENERGY STAR ceiling fan wattage	= 0.0117 kW
$MedWatt_{base}$	= Medium speed baseline ceiling fan wattage	= 0.0348 kW
$MedWatt_{ee}$	= Medium speed ENERGY STAR ceiling fan wattage	= 0.0314 kW
$HighWatt_{base}$	= High speed baseline ceiling fan wattage	= 0.0725 kW
$HighWatt_{ee}$	= High speed ENERGY STAR ceiling fan wattage	= 0.0715 kW
$HOURS_{fan}$	= Typical fan operating hours (2.8/day, 365 days per year)	= 1022 hours
IncWatt	= Incandescent bulb kW (assumes 3 * 60W bulb)	= 0.180kW
CFLWatt	= CFL bulb kW (assumes 3 * 20W bulb)	= 0.060kW
$HOURS_{light}$	= Typical lighting operating hours (2.3/day, 365 days per year)	= 839.5 hours
WHFe	= Waste Heat Factor for Energy to account for cooling savings from Efficient lighting.	= 1.07

ΔkWh = ((0.4 * (0.0152 – 0.0117) + 0.4 * (0.0348 – 0.0314) + 0.2 * (0.0725 – 0.0715)) * 1022) + ((0.18 – 0.06) * 839.5 * 1.07)

= **110 kWh**

Baseline Adjustment

Federal legislation stemming from the Energy Independence and Security Act of 2007 will require all general-purpose light bulbs between 40 and 100W to be approximately 30% more energy efficient than current incandescent bulbs, in essence beginning the phase out of standard incandescent bulbs. In 2012 100W incandescents will no longer be manufactured, followed by restrictions on 75W in 2013 and 60W in 2014. The baseline for this measure will therefore become bulbs (improved incandescent or halogen) that meet the new standard. To account for these new standards, first year annual savings for this measure must be reduced beginning in 2014. This measure assumes 60W baseline bulbs, which in 2014 will become 43W and so the annual savings beginning in 2014 should therefore be:

ΔkWh = ((0.4 * (0.0152 – 0.0117) + 0.4 * (0.0348 – 0.0314) + 0.2 * (0.0725 – 0.0715)) * 1022) + ((0.129 – 0.06) * 839.5 * 1.07)

= **65 kWh**

In addition, since during the lifetime of a CFL, the baseline incandescent bulb will be replaced multiple times, the annual savings claim must be reduced within the life of the measure. Therefore, for bulbs installed in 2010, the full savings (110 kWh) should be claimed for the first four years, but the reduced annual savings (65 kWh) claimed for the remainder of the measure life. The savings adjustment is therefore equal to 65/110 = 59%.

Coincident Peak Demand Savings

ΔkW = (%low * (LowKWbase - LowKWee) + %med * (MedKWbase - MedKWee) + %high * (HighKWbase - HighKWee)) + ((IncKW – CFLKW) * WHFd) * CF

Where:

WHFd = Waste Heat Factor for Demand to account for cooling savings from efficient lighting = 1.21

CF = Peak Coincidence Factor for measure = 0.11

ΔkW = ((0.4 * (0.0152 – 0.0117) + 0.4 * (0.0348 – 0.0314) + 0.2 * (0.0725 – 0.0715)) + ((0.18 – 0.06) * 1.21) * 0.11

ΔkW = **0.019kW**

After 2014, this will be reduced to:

ΔkW = ((0.4 * (0.0152 – 0.0117) + 0.4 * (0.0348 – 0.0314) + 0.2 * (0.0725 – 0.0715)) + ((0.129 – 0.06) * 1.21) * 0.11

ΔkW = **0.012kW**

Operating Hours
See Table above.

Loadshape
TBD

Freeridership/Spillover Factors
TBD

Lifetime
5 years (DEER)

Component Costs and Lifetimes Used in Computing O&M Savings
TBD

10.3.4 Solar Attic Fans

Version Date & Revision History:
Draft date: March 2, 2011
Revision date: April 29, 2016

Referenced Documents:
- n/a

TRM Review Actions:
- November 14, 2013 – Conduct additional research to ensure the 10% air conditioning savings estimate is reasonable. This could include some metering or bill history analysis of customers who participated in this measure. This is a low priority research task as participation for this measure was small during the last program year.

Major Changes:
- 4/17/2015 – PY14 TRM was assuming 5016 full load operating hours of a room air conditioner. This value was revised to 1825 hours to be consistent with the Window AC with Recycling measure.
- 4/17/2015 – PY14 TRM was assuming an average size of 1.0 kW room air conditioner. To be consistent with the Window AC with Recyling measure, size was revised to 0.87 kW, which is based on actual Hawaii Energy program statistics from PY14.
- 4/17/2015 – Resultant change in net energy savings was 158 kWh/year instead of 502 kWh/yr.
- 4/29/2016 – Measure life corrected to 20 years

Measure Description: Solar attic fan is assumed to reduce 10% of existing air conditioning load energy usage and no demand reduction from 5PM – 9PM.

Baseline Efficiencies: The baseline case is no solar attic fan.

Base Case	Demand Baseline (kW)	Energy Baseline (kWh/year)
No Solar Attic Fan	0.87	1583

High Efficiency: The enhanced case is a solar attic fan in conjunction with a AC unit.

High Efficiency Case	Efficient Case (kW)	Efficient Case (kWh/year)
Solar Attic Fan	0.87	1425

Operational Factors:

Operational Factor	Adjustment Factor
Persistence Factor (pf)	1.00
Demand Coincidence Factor (cf)	0.00

Energy Savings:

Savings Type	Net Customer Savings (kW)	Net Customer Savings (kWh/year)
Net Savings	0.000	158

Savings Algorithms

Solar Attic Fan - Single Family Residential Home				
Average Unit Cooling Capacity		8500	BTU/Hr	Average size of Window AC's incentivized by Hawaii Energy in PY14
Energy Efficiency Ratio	÷	9.8	EER	DOE Federal Test Procedure 10CFR 430, Appendix F
Full Load Demand		0.87	kW	
Energy Star Room AC Full Load Demand		0.87	kW	
Honolulu Full Load Equivalent Cooling Hours	x	1,825	Hours per Year	Hawaii Energy estimate for window AC based on local climate
Energy Star Room AC Annual Energy Consumption		1,583	kWh per Year	
Energy Reduction Percentage with Solar Attic Fan		10.0%		
Energy Usage with Solar Attic Fan		1,425	kWh / Year Savings	
Energy Star Room AC Annual Energy Consumption		1,583	kWh / Year Savings	
Energy Usage with Solar Attic Fan	-	1,425	kWh / Year Savings	
Solar Attic Fan Annual Energy Savings		158	kWh / Year Savings	
Solar Attic Fan Annual Energy Savings		158	kWh / Year Savings	
Persistance Factor	x	1.0		
Net Customer Level Savings		158	kWh / Year Savings	
Solar Attic Fan Energy Savings		158	kWh / Year Savings	
Energy Star Room AC Full Load Demand		0.87	kW	
Peak Demand Reduction		0%		
AC Demand with Solar Attic Fan		0.87	kW	
Energy Star Room AC Full Load Demand		0.87	kW	
AC Demand with Solar Attic Fan	-	0.87	kW	
Gross Customer Demand Savings		-	kW	
Solar Attic Fan Demand Savings		0.000	kW Savings	

Operating Hours
See Table above.

Loadshape
TBD

Freeridership/Spillover Factors
TBD

Persistence
1.0

Lifetime
20 years

10.3.5 Whole House Fans

Version Date & Revision History
Draft date: March 2, 2011
Revision date: April 17, 2015

Referenced Documents:
- KEMA for the Sate of California Low-Income Energy Efficiency Program; calmac.org/publications/2001_LIEE_Impact_Evaluation.pdf
- Evergreen TRM Review – 2/23/12

TRM Review Actions:
- 10/5/11 – Currently Under Review.
- 4/9/12 – Energy reduction percentage changed from .25 to .2 as per the EM&V report dated 23 Feb 2012. Added reference document from EM&V report.

Major Changes:
- 4/17/2015 – PY14 TRM was assuming 5016 full load operating hours of a room air conditioner. This value was revised to 1825 hours to be consistent with the Window AC with Recycling measure.
- 4/17/2015 – PY14 TRM was assuming an average size of 1.0 kW room air conditioner. To be consistent with the Window AC with Recyling measure, size was revised to 0.87 kW, which is based on actual Hawaii Energy program statistics from PY14.
- 4/17/2015 – Resultant change in net energy savings was 365 kWh/year instead of 1,254 kWh/yr.

Measure Description: A whole house fan is a ventilation system, usually placed centrally within a home, that pulls air from the living space into an attic for purposes of increased circulation. In warm climates such as Hawaii, this serves to cool the home, by pulling in cooler outside air and evacuating warmer air that has been built up or trapped within the house. Whole house fan is assumed to reduce 20% of existing air conditioning load energy usage.

Baseline Efficiencies:

Base Case	Demand Baseline (kW)	Energy Baseline (kWh/year)
No Whole House Fan	1.00	1,825

High Efficiency:

High Efficiency Case	Efficient Case (kW)	Efficient Case (kWh/year)
Whole House Fan	0.15	1,460

Energy Savings:

Savings Type	Gross Customer Savings (kW)	Gross Customer Savings (kWh/year)
Gross Savings	0.85	365
Operational Factor	**Adjustment Factor**	
Persistence Factor (pf)	1.00	
Demand Coincidence Factor (cf)	0.59	
Savings Type	**Net Customer Savings (kW)**	**Net Customer Savings (kWh/year)**
Net Savings	0.50	365

Savings Algorithms

Whole House Fan - Single Family Residential Home				
Energy Star Room AC Full Load Demand		1.0	kW	
Honolulu Full Load Equivalent Cooling Hours	x	1,825	Hours per Year	Hawaii Energy estimate (5 hrs/day)
Energy Star Room AC Annual Energy Consumption		1,825	kWh per Year	
Energy Reduction Percentage with Whole House Fan		20.0%		Per Evergreen review dated 1/23/2012
Energy Usage with Whole House Fan		1,460	kWh / Year Savings	
Energy Star Room AC Annual Energy Consumption		1,825	kWh / Year Savings	EPA, 2002 Report
Energy Usage with Whole House Fan	-	1,460	kWh / Year Savings	
Whole House Fan Annual Energy Savings		365	kWh / Year Savings	
Whole House Fan Annual Energy Savings		365	kWh / Year Savings	
Persistance Factor	x	1.0		
Net Customer Level Savings		365	kWh / Year Savings	
Whole House Fan Energy Savings		365	kWh / Year Savings	
Energy Star Room AC Full Load Demand		1.00	kW	
Whole House Fan Demand	-	0.15	kW	
Gross Customer Demand Reduction		0.85	kW	
Gross Customer Demand Reduction		0.850	kW	
Gross Customer Demand Reduction		0.850	kW	
Persistence Factor		1.000		
Coincidence Factor	x	0.590		
Net Whole House Fan Demand Savings		0.50	kW Savings	

Operating Hours
See Table above.

Lifetime
20 years

10.4 High Efficiency Appliances

10.4.1 ENERGY STAR Refrigerator and Clothes Washer

Version Date & Revision History:
Draft date: February 24, 2010
Revision date: November 14, 2013
Review date: June 23, 2015

Referenced Documents:
- HECO DSM Docket – Backup Worksheets - Global Energy (07-14-06)
- Econorthwest TRM Review – 6/23/10
- Department of Energy Refrigerator Profile – Updated December 2009
- Evergreen TRM Review – 1/15/14

TRM Review Actions:
- 6/23/10 Rec. # 11 – Revise savings to be consistent with ENERGY STAR estimates. – Adopted with modifications on refrigerator figures based on DOE Refrigerator profile and the addition of bounty, recycle with new figures.
- 6/23/10 Rec. # 12 – Split the claimed savings by appliance. – Adopted.
- 6/23/10 Rec. # 13 – Incorporate solar hot water heating into appliance savings values – Adopted.
- 6/23/10 Rec. # 14 – Revise demand savings values for ENERGY STAR appliances – Adopted.
- 10/4/11 – Removed dishwashers from appliance list.
- 4/9/12 – Baseline efficiency for non-ES Refrigerator changed from 537 to 540. Number changed to match ES data.
- 11/14/13 – Updated Energy Star clothes washer to be consistent with the most recent Energy Star standards and calculations.
- 11/14/13 – New standards will take effect beginning September 15, 2014.

Major Changes:
- Split between ESH appliances
- Incorporation of three refrigerator categories (new, new with turn in, and bounty (turn in only))
- All ESH 313 kWh and 0.12 kW changed to:
  - New ES Refrigerator Only – 105 kWh, .017 kW
  - New ES Refrigerator with Turn-In – 822 kWh, .034 kW
  - Bounty (Turn in only) – 859 kWh, .034 kW
  - Washing Machine – 328 kWh, .042 kW

Measure Description:
The replacement of standard Clothes Washers and Refrigerators in Residential Single Family and Multi-family homes.

Appliances must comply with:
- Energy Star

Refrigerators – ENERGY STAR refrigerators utilize improvements in insulation and compressors.

Clothes Washers – Clothes washers that meet ENERGY STAR criteria use next generation technology to cut energy and water consumption by over 40% compared to conventional washers. Clothes washers come in either front-load or redesigned top-load designs. Both configurations include technical innovations that help save substantial amounts of energy and water.
- **No Central Agitator** Front-loaders tumble clothes through a small amount of water instead of rubbing clothes against an agitator in a full tub. Advanced top loaders use sophisticated wash

systems to flip or spin clothes through a reduced stream of water. Both designs dramatically reduce the amount of hot water used in the wash cycle, and the energy used to heat it.

- **High Spin Speeds** Efficient motors spin clothes two to three times faster during the spin cycle to extract more water. Less moisture in the clothes means less time and energy in the dryer.

Baseline Efficiencies:
Baseline energy usage based on 2009 Energy Star Information for the appliances are as follows:

	Demand Baseline (kW)	Energy Baseline (kWh)	Notes
Non ES Qualifying Refrigerator		540	19.0-21.4 Top Freezer
Non ES Qualifying Clothes Washer		966	392 Loads per Year

High Efficiency:
The high efficiency case Energy Star energy usage based on 2009 Energy Star Calculator Information and DOE Refrigerator Market Profile for the appliances is as follows:

	Demand High Efficiency (kW)	Energy High Efficiency (kWh)	Notes
ES Qualifying Refrigerator		435	19.0-21.4 Top Freezer
ES Qualifying Clothes Washer		609	392 Loads per Year

Energy Savings:

Energy Star Appliance Gross Savings before operational adjustments:

	Demand Savings (kW)	Energy Savings (kWh)
ES Refrigerator	0.017	105
ES Refrigerator with Turn-In	0.034	822
Bounty (Turn in only)	0.034	859
ES Washing Machine	0.042	328

Energy Star Appliance Net Savings operational adjustments:

Operational Factor	Adjustment Factor
Persistence Factor (pf)	1.0
Demand Coincidence Factor (cf)	1.0

Savings Algorithms

Energy Star Clothes Washer

Standard (kWh)	Energy Star (kWh)	Savings (kWh/yr)	SHW PF	Claimed Energy Savings (kWh)
966	609	357	92%	328

Energy Star Refrigerator and Turn In Refrigerator - Single and Multi Family Residential Home

Opportunity		Energy Usage		
New Non-ENERGY STAR		540		Table 2
New ENERGY STAR Refrigerator	-	435		Table 2
		105	kWh/Year	Table 1
#1 - Purchase of ENERGY STAR Refrigerator		105		Table 1
#2 - Removal of Old Unit from Service (off the grid)	+	717		Table 1
#1 + #2 = Purchase ES and Recycle old unit		822	kWh/Year	

	Energy Usage	Ratio	Contribution		
Post-1993 Refrigerator	640	55%	354.54		Table 3
Pre-1993 Refrigerator	1,131	45%	504.46		Table 3
			859	kWh/Year	

Table 1

Energy Savings Opportunities for Program Sponsors

Opportunity	Annual Savings			
	Per Unit		Aggregate U.S. Potential	
	kWh	$	MWh	$ million
1. Increase the number of buyers that purchase ENERGY STAR qualified refrigerators. • 9.3 million units were sold in 2008. • 70 percent were not ENERGY STAR. • 6.5 million potential units per year could be upgraded.	105	11.64	675,928	75
2. Decrease the number of units kept on the grid when new units are purchased. • 8.7 million primary units were replaced in 2008. • 44 percent remained in use, whether they were converted to second units, sold, or given away. • 3.8 million units are candidates for retirement every year.	717	79.53	2,746,062	305
3. Decrease the number of second units. • 26 percent of households had a second refrigerator in 2008. • 29.6 million units are candidates for retirement.	859	95.28	25,442,156	2,822
4. Replace pre-1993 units with new ENERGY STAR qualified models. • 19 percent of all units in use in 2008 were manufactured before 1993. • 27.3 million total potential units are candidates for targeted replacement.	730	81	19,946,440	2,212

Sources: See endnote 10.

Table 2

Energy and Cost Comparison for Upgrading to ENERGY STAR

Purchase Decision	New Non-ENERGY STAR Qualified Refrigerator	New ENERGY STAR Qualified Refrigerator
Annual Consumption	540 kWh	435 kWh
	$60	$48
Annual Savings	–	105 kWh
	–	$12
Average Lifetime	12 years	12 years
Lifetime Savings	–	1,260 kWh
	–	$140
Price Premium	–	$30 - $100
Simple Payback Period	–	3-9 years

Note: Calculations based on shipment-weighted average annual energy consumption of 2008 models. An ENERGY STAR qualified model uses 20 percent less energy than a new non-qualified refrigerator of the same size and configuration.

Source: See endnote 10.

Table 3

Energy and Cost Comparison for Removing a Second Refrigerator from the Grid

Fate of Unit	Post-1993 Unit		Pre-1993 Unit	
	Remains on the Grid	Removed from the Grid	Remains on the Grid	Removed from the Grid
Annual Consumption	640 kWh	–	1,131 kWh	–
	$71	–	$125	–
Annual Savings	–	640 kWh	–	1,131 kWh
	–	$71	–	$125
Average Lifetime*	6	–	6	–
Lifetime Savings*	–	3,840 kWh	–	6,788 kWh
	–	$426	–	$753
Removal Cost	–	$50 - $100	–	$50 - $100
Simple Payback Period	–	1-2 years	–	<1 year

*Assumes unit has six years of functionality remaining.

Sources: See endnote 10.

Operating Hours
Refrigerators = 8,760 hours per year
Clothes Washers = 392 Loads per Year

Loadshape
TBD

Freeridership/Spillover Factors
TBD

Demand Coincidence Factor
NA

Persistence
NA

Lifetime
(DEER) 11 years for clothes washer
(DEER) 14 years for refrigerator

Measure Costs and Incentive Levels

Residential Measure Costs and Incentive Levels

Description	Unit Incentive	Incremental Cost HECO DSM Docket 2006	Incremental Cost Energy Star 2009
ES Refrigerator	$50	$ 60.36	$ 65
ES Clothes Washer	$50	$ 398.36	$ 258

Component Costs and Lifetimes Used in Computing O&M Savings
TBD

Water Descriptions

	Base Water Usage (Gallons)	High Efficiency Water Usage (Gallons)	Water Savings (Gallons)	Notes
Refrigerator	n/a	n/a		19.0-21.4 Top Freezer
Clothes Washer	12,179	5,637	6,542	392 Loads per Year

10.4.2 Pool Pump VFD

Version Date & Revision History:
Draft date: February 24, 2010

Referenced Documents:

- Davis Energy Group (2008). Proposal Information Template for Residential Pool Pump Measure Revisions. Prepared for Pacific Gas and Electric Company; Page 2.
- Residential Retrofit High Impact Measure Evaluation Report. The Cadmus Group. February 8, 2010.

TRM Review Actions:

- 4/9/12 – Measure updated per EMV report February 23, 2012. Coincidence Factor of .0862 added. Added algorithm for Evergreen with 4.25 hours in place of 6 hours per day. Added Cadmus Group reference.
- 10/5/11 – Currently Under Review.
- 11/14/13 – No changes are recommended.

Major Changes:

- n/a

Measure Description
A variable speed residential pool pump motor in place of a standard single speed motor of equivalent horsepower.

Definition of Efficient Equipment
The high efficiency equipment is a variable speed residential pool pump.

Definition of Baseline Equipment
The baseline efficiency equipment is assumed to be a single speed residential pool pump.

$$\Delta kWh = (kWBASE \times Hours) \times 55\%\ BASE$$

Where:

Unit = variable speed pool pump
ΔkWh = Average annual kWh reduction
Hours = Average annual operating hours of pump
kWBASE = connected kW of baseline pump
55% = average percent energy reduction *(Davis Energy Group, 2008)*

Baseline Efficiency
The baseline efficiency case is a single speed pump.

Based Demand	0.70 kW
Base Energy Usage per day	2.97 kWh/day
Base Energy Usage per year	1085 kWh/year

High Efficiency

The high efficiency case is variable speed pump.

Demand Reduction	10%
High Efficiency Demand	0.63 kW
Energy Savings	55%
High Efficiency Energy Usage	488 kWh/year

Energy and Demand Savings

Demand Savings	1.278 kW
Coincidence Factor	0.0862 kW

Energy Savings per year	597 kWh/year
Peak Demand Reduction	0.006 kW

Savings Algorithm

Average Pool Pump Horesepower	0.75 HP
Efficiency	0.8
Hours of operation per day	4.25 hours
Number of days pool in use	365 days per year
1 HP Equals	0.746 kW

Based Demand	0.70 kW
Base Energy Usage per day	2.97 kWh/day
Base Energy Usage per year	1085 kWh/year

Demand Reduction	10%
High Efficiency Demand	0.63 kW
Energy Savings	55%
High Efficiency Energy Usage	488 kWh/year

Demand Savings	1.278 kW
Coincidence Factor	0.0862 kW

Energy Savings per year	597 kWh/year
Peak Demand Reduction	0.006 kW

Lifetime of Efficient Equipment

The estimated useful life for a variable speed pool pump is 10 years.

Measure Cost

The incremental cost is estimated to be $750 for a variable speed motor

10.4.3 Smart Strips

Version Date & Revision History:
Draft date: February 24, 2010
Revision date: December 11, 2015

Referenced Documents:

- 11/22/11 – Akamai Power Strip kWh savings updated based on NYSERDA Measure Characterization for Advanced Power Strips.

TRM Review Actions:

- Evergreen TRM Review – 1/15/14

Major Changes:

- 6/23/2015 – Removed power strip cost data.
- 12/11/2015 – Added persistence factor of 0.80 (estimate) to account for some smart strips that are never installed or uninstalled.

Measure Description

Load sensing advanced power strips. This measure involves the purchase and installation of a new load sensing advanced power strips in place of a code-compliant or standard efficiency power strip. Savings is based on the average savings per plug of a 5-plug strip and a 7-plug strip.

Definition of Efficient Equipment

The high efficiency equipment is an advanced power strip. If the exact number of plugs in the strip is unknown, savings is based on a 6-plug strip, as shown below. If the exact number of plugs in the strip is known, such as part of the Hawaii Energy online kit promotions, then the respective savings value may be used based on the actual size of the advanced power strip.

Definition of Baseline Equipment

The baseline efficiency equipment is a code-compliant or standard efficiency power strip.

Measure Life

5 years

Savings Algorithm

Akamai Power Strips					
Savings per Unit		56.5 kWh		102.8 kWh	*NYSERDA Measure Characterization for*
Plugs per Unit		x 5 plugs		x 7 plugs	Advanced Power Strips
Savings per Plug		11.3 kWh/plug		14.7 kWh/plug	
Average Savings per Plug			13.0	kWh	
	x		6	plugs/unit	
	x		0.8	pf	
Akamai Power Strip Energy Savings			**62.4**	**kWh per Unit first year**	
Hours of Operation			8760	hours/year	
Demand Savings			**0.0071**	**kW**	
First Year Savings			62.4	kWh first year	
Measure Life	x		5	year measure life	
Lifetime Savings			312	kWh lifetime	

10.5 Energy Awareness, Measurement and Control Systems

10.5.1 Room Occupancy Sensors

Version Date & Revision History:
Draft date: March 2, 2011

Referenced Documents:
Flex your Power – "Occupancy sensors can reduce lighting costs by up to 50% in rooms where lights are frequently left on when on one is around."

According to the Federal Energy Management Program (FEMP) of the US Department of Energy, in a small, private office, an occupancy sensor can reduce energy use by almost 30% shaving 100kWh off the annual energy use. In a large open office area, energy use can be reduced by approximately 10%.

TRM Review Actions:

- 10/5/11 – Currently Under Review.
- 11/14/13 – It is recommended that further research be conducted in order to determine if the savings assumptions used in this measure is appropriate.

Major Changes:

- n/a

Measure Description:
This measure is for wall switch sensors that controls the use of lighting in areas around the home with variable use such as laundry, storage, garage, bedrooms or spare areas.

Occupancy sensors must comply with:

- Energy Star
- UL Listing

Baseline Efficiencies:
The base case is an even split between two (2) 60W A-Shaped incandescent lamp and 15W Compact Fluorescent Lamp with the energy consumption as follows:

Lamp Types	Demand Baseline (kW)	Hours per Day	Energy Baseline (kWh/year)	%	Totals
Incandescent	0.060	2.30	50.4	50%	25.2 kWh
CFL	0.015	2.30	12.6	50%	6.3 kWh
				Watts per Lamp	31.5 W
				Lamps	2
				Total Baseline Energy (kWh)	63.0 kWh

High Efficiency:
The high efficiency case is 33% run time reduced.

Lamp Types	Demand Baseline (kW)	Hours per Day	Energy Baseline (kWh/year)	%	Totals
Incandescent	0.060	1.54	33.7	50%	16.9 kWh
CFL	0.015	1.54	8.4	50%	4.2 kWh
				Watts per Lamp	21.1 W
				Lamps	2
				Total High Efficiency Energy (kWh)	42.2 kWh

Energy Savings:

Total Baseline Energy (kWh)	63.0 kWh
Total High Efficiency Energy (kWh)	42.2 kWh
	20.8 kWh

<u>Savings Algorithms</u>

Room Occupancy Sensors - Single and Multi Family Residential Home

Two (2) - Lamp Demand		0.075	kW	Even split between 60W Incand. and 15W CFL
		2.30	Hours per Day	
	x	365	Days	839.5 Hours per Year
Baseline Energy Usage		63.0	kWh per Year	
Run Time Reduced (RTR)		0.76	Hours per Day	33%
		63.0	kWh per Year	
	x	0.330		33% Run Time Reduced
		20.8	kWh per Year	
Energy Savings		**20.8**	**kWh / Year Savings**	
Two Lamp Demand Reduction Before Adjustments		0.075	kW	
Demand Reduction Before Adjustments		0.038	kW	
Coincidence Factor		0.120	cf	12.0% Lamps on between 5 and 9 p.m.
Persistance Factor	x	1.000	pf	100.0%
		0.0046	kW	
Demand Savings		**0.0046**	**kW Savings**	

Operating Hours
2.3 hours per day

Loadshape
TBD

Freeridership/Spillover Factors
TBD

Coincidence
CF = 0.12 (12% lamps on between 5PM – 9PM)

Persistence
PF =1.0

Lifetime
8 years (DEER)

Component Costs and Lifetimes Used in Computing O&M Savings
TBD

Reference Tables
None

10.5.2 Peer Group Comparison

Version Date & Revision History:
Draft date: September 18, 2011

Referenced Documents:

TRM Review Actions:
- Continue to monitor participant vs control group energy usage comparison.
- 10/5/11 – Currently Under Review.

Major Changes:
- New PBFA 100% funded program.
- 11/22/11 – Removed detailed table from *Energy Savings* heading – not pertinent information.
- 11/14/13 – Change savings from 1.73% to 0.89% per EM&V review.

Measure Description:
The Behavior/Feedback programs send monthly energy use reports to participating electric customers in order to change customers' energy-use behavior. These reports rank the customers within a group of 100 similar sized homes in their neighborhood. Customers are also directed to a website with energy efficient tips and recommendations on energy conservation.

Energy Savings
The unit energy savings of 0.89% is based on EM&V recommendation.

Example Algorithm Calculating Customer Level Impact

ΔkWh = (Total Monthly Base Energy Usage)(# of Participating Months)(%Savings)
ΔkW = Annual ΔkWh per Unit/ 3000 hours

(Note: 3000 hours assumes 8.22 hours per day of active behavioral usage)

Where:
Unit = One participant household
%Savings = Energy savings percent per program participant

Baseline Efficiency
The baseline efficiency case is the control group that does not receive behavior and feedback program reports.

High Efficiency
The high efficiency case is test group receiving home energy reports.

Persistence
1 year

Measure Life
1 year

10.5.3 Whole House Energy Metering

Version Date & Revision History:
Draft date: March 2, 2011

Referenced Documents:
- Hawaii Energy Historic Utility Billing Research – Residential Review 2010
- Evergreen TRM Review – 2/23/12

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- Changed energy savings from 2% to 3.8% based on EM&V Review.

Measure Description:
Whole house metering systems allow the occupant to see in real time the energy usage in their home. This "dashboard" allows them to see what actions and equipment drive their energy usage and the associated costs of running them. These devices collect energy data for the whole house at the panel and transmit the information to a display unit "dashboard" which can be located anywhere in the house.

Baseline Efficiencies:

Building Types	Demand Baseline (kW)	Energy Baseline (kWh/year)
No Metering	1.50	12,000

High Efficiency:

Building Types	Efficient Case (kW)	Efficient Case (kWh/year)
Whole House Meter	1.47	11,544

Energy Savings:

Building Types	Efficient Case (kW)	Efficient Case (kWh/year)
Whole House Meter	1.47	11,544

Building Types	Gross Customer Savings (kW)	Gross Customer Savings (kWh/year)
Gross Customer Savings	0.026	456

Operational Factor	Adjustment Factor
Persistence Factor (pf)	0.90
Demand Coincidence Factor (cf)	0.30

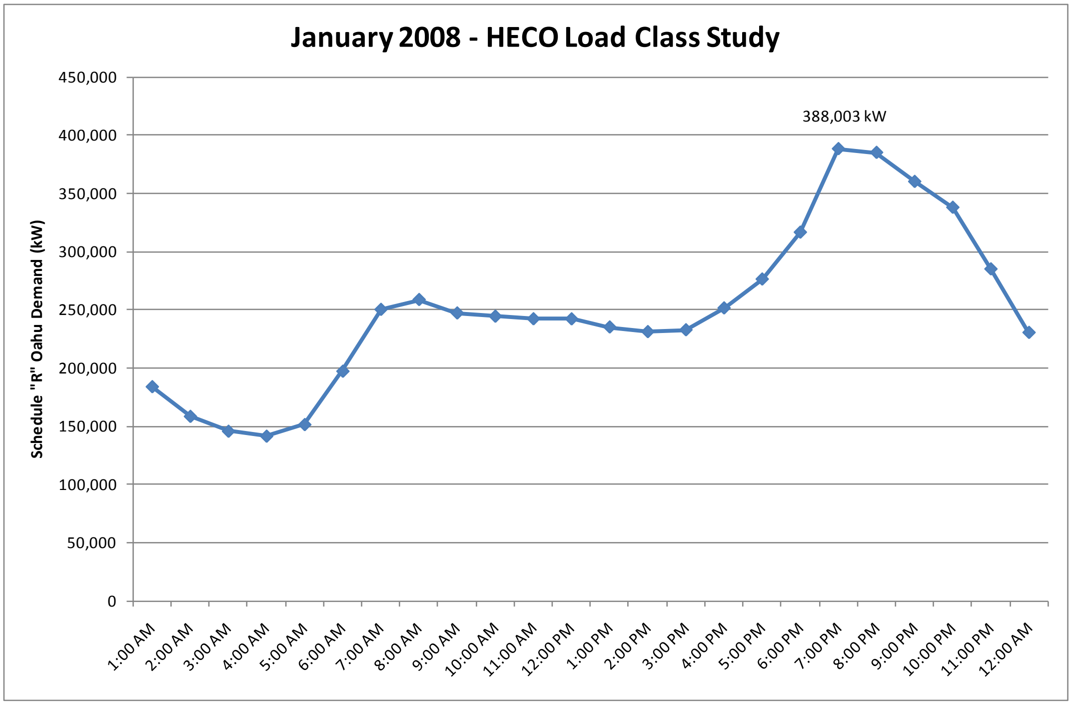
Building Types	Net Customer Savings (kW)	Net Customer Savings (kWh/year)
Net Customer Savings	0.007	410

Savings Algorithms

Whole House Metering - Single Multi Family Residential Home				
High Energy Usage Home (85th percentile)		1,000	kWh per home per month	Hawaii Energy review - HECO 2010 Data
	x	12		
Baseline Household Energy Usage		12,000	kWh per Year	
Energy Reduction		3.8%		
Actively Informed Household Energy Usage		11,544	kWh per Year	
Baseline Household Energy Usage		12,000	kWh per Year	
Actively Informed Household Energy Usage	-	11,544	kWh per Year	
Gross Customer Level Energy Savings		456	kwh per Year	
	x	1,000	Watts per kW	
	÷	8,760	Hours per Year	
Average 24/7 Demand Reduction		52	Watts	
Gross Customer Level Energy Savings		456	kwh per Year	
Persistance Factor	x	0.9		
Net Customer Level Savings		410	kwh per Year	
Whole House Metering Energy Savings		410	kWh / Year Savings	
Baseline Household Demand		1.50	kW	HECO 2008 Load Study
Peak Demand Reduction		1.75%		
Actively Informed Household Demand		1.47	kW	
Baseline Household Demand		1.50	kW	
Actively Informed Household Demand	-	1.47	kW	
Gross Customer Demand Savings		0.026	kW	
Gross Customer Demand Savings		0.026	kW	
Persistance Factor	x	0.90		
Coincidence Factor	x	0.30		
		0.007	kW	
Whole House Metering Demand Savings		0.007	kW Savings	

Operating Hours
8,760 hours per year

Loadshape
TBD



Freeridership/Spillover Factors
0.73

Persistence Factor
PF = 0.9

Coincedence Factor
CF= 0.3

Lifetime
4 years

Measure Costs and Incentive Levels

		Low	High
Measure Cost		$100	$450
Incremental Cost		$100	$450

Incentive Level 50% up to $100

10.6 Energy Efficiency Equipment Grants

10.6.1 Home Energy Savings Kits

Measure ID:

Version Date & Revision History:
Draft date: 12-15-2015

Referenced Documents:

-

TRM Review Actions:

- 12/15/2015 – Pending review by EM&V

Major Changes:

- New measure

Measure Description:
Customized kits can be built using different energy saving devices of varying quantities. Savings for each kit will be calculated based on energy savings list below This online kit promotion may contain various combinations of the following components:

- A19 LED (60 watt equivalent)
- BR30 LED (65 watt equivalent)
- 1 CFL
- Advanced power strip
- Low-flow showerhead*
- Faucet aerator*

*The savings claim for each household for water measures depends on the type of water heating for each home, as well as the occupancy for each home (this data was collected by the team).

Baseline Efficiencies:
Baseline lighting = blend of incandescent/CFL = 37.6 watts (see 9.2.1)
Showerhead = 2.5 gpm
Faucet = 2.2 gpm

Enhanced Efficiencies:
CFL = 13 watts
LED = 10 watts
Advanced power strip (7 plugs) for home entertainment system or home office
Low-flow showerheads = 1.5 gpm (40% reduction)
Low-flow faucet aerators = 1.5 gpm (32% reduction)

Persistence Factor:
For LED lightbulbs: 0.96
For CFL lightbulbs: 0.96
For advanced power strip: 0.80
For showerheads: 0.59
For faucet aearators: 0.51

Peak Demand Coincidence Factor:
For LED lightbulbs: 0.12
For CFL lightbulbs: 0.12
For advanced power strip: 1.00

For showerheads: N/A (no demand savings claimed, too small)
For faucet aerators: N/A (no demand savings claimed, too small)

Measure Lives:
For LED lightbulbs: 15 years
For CFL lightbulbs: 6 years
For advanced power strip: 5 years
For showerheads and faucet aearators: 5 years

Energy Savings Algorithm:
For A19 LED and BR30 LED:
Use TRM value of 22.5 kWh per year (see Section 9.2.2 Light Emitting Diode (LED))

For CFL:
Use TRM value of 17.0 kWh per year (see Section 9.2.1 Compact Fluorescent Lamp (CFL))

For advanced power strip
Using TRM value of 102.8 kWh/year savings for 7-plug power strip (see Section 9.4.3 Smart Strips) and applying persistance factor of 0.80 = 102.8 kWh * 0.80 = 82.2 kWh per year

For water saving measures (low-flow showerheads and faucet aerators), the energy and demand savings calculation depend on a number of factors:

- type of water heating (standard electric-resistance, heat pump, electric tankless, solar)
- number of occupants (1, 2, 3, 4, 5, 6, 7, 8+)
- number of faucets in the home (it was calculated that the average SF/MF home has 2.8 faucets)
- number of showers in the home (It was calculated that the average SF/MF home has 1.8 showerheads)

See separate docuement for detailed energy savings calculations.

For low-flow showerhead:

Water Heater Type	1	2	3	4	5	6	7	8
electric resistance	51.1	68.0	102.0	136.0	170.0	204.0	238.0	272.0
heat pump	17.5	23.3	35.0	46.6	58.3	70.0	81.6	93.3
electric tankless/on-demand	39.4	52.4	78.7	104.9	131.1	157.3	183.5	209.7
solar water heating	6.6	13.1	19.7	26.3	32.9	39.4	46.0	52.6

For faucet aerator:

Water Heater Type	1	2	3	4	5	6	7	8
electric resistance - MF+SF average	11.5	23.0	34.4	45.9	57.4	68.9	80.4	91.8
heat pump - MF+SF average	4.9	9.8	14.6	19.5	24.4	29.3	34.1	39.0
on demand	8.5	16.9	25.4	33.8	42.3	50.7	59.2	67.7
SWH	6.5	13.0	19.5	26.0	32.5	39.0	45.5	52.0

Demand Savings Algorithm
For A19 LED and BR30 LED:
Use TRM value of 0.0032 kW (see Section 9.2.2 Light Emitting Diode (LED))

For CFL:
Use TRM value of 0.0024 kW (see Section 9.2.1 Compact Fluorescent Lamp (CFL))

For advanced power strip
Using TRM value of 102.8 kWh/year savings for 7-plug power strip (see Section 9.4.3 Smart Strips) and operating hours of 8760 hours per year and applying persistence factor = 102.8 kWh * 0.80 ÷ 8760 = 0.0094 kW

For low-flow showerhead:
Peak demand savings is difficult to quantify and almost neglible. Therefore, demand savings= 0.
For faucet aerator:
Peak demand savings is difficult to quantify and almost neglible. Therefore, demand savings= 0.

	Energy Savings (kWh/year)	Demand Savings (kW)
A19 LED	22.5	0.0032
BR30 LED	22.5	0.0032
CFL	17.0	0.0024
Advanced power strip	82.2	0.0094
Low-flow showerhead	See table above	0
Faucet Aerator	See table above	0

11 Custom Energy Solutions for the Home (CESH)

11.1 Target Cost Request for Proposals

11.1.1 Efficiency Project Auction

Version Date & Revision History:
Draft date: October 4, 2011

Referenced Documents:
- n/a

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- n/a

Measure Description:
Hawaii Energy will issue a call for projects to solicit innovative, cost-effective projects that focus on energy efficiency in high-consumption and hard-to-reach homes. Projects must meet a total dollar per kWh savings target.

Implementation
Eligible projects in this auction will be any new technology, marketing approach or offering not currently served by existing Hawaii Energy programs. This initiative should increase customer satisfaction and participation in the energy efficiency program by allowing the market to be creative in the actions and measures that achieve the targeted cost per kWh energy savings. The projects will use utility metered data and submeters if required, to insure savings performance.

11.2 Residential Design

11.2.1 Solar Water Heating Tune-up

Version Date & Revision History:
Draft date: February 21, 2011

Referenced Documents:
- KEMA "Impact Evaluation Report of the 2001-2003 Demand Side Management Programs" October 2004. Page 2-36 "Inoperable systems are those that use more than an average of 5 kWh per day, and problem systems use between 2-5 kWh per day.

TRM Review Actions:
- none

Major Changes:
- New

Eligibility:

- Systems never received tune-up must be > 3 years old
- Systems that received a tune-up incentive cannot be eligible more than once every 5 years

Measure Description:

- Demonstrate the benefits of tune-ups
- Educate customer of potential savings and system longevity
- Utilize the participating contractors to contact the customers and have them arrange for the service work
- Participating contractors will use the Hawaii Energy Checklist to inspect and record the pre and post conditions
- Participating contractor's invoice must show that checklist requirements have been met and signed by the servicing technician

Baseline Efficiencies:

	Energy (kWh)	Demand (kW)
Baseline	577	0.079

High Efficiency:

	Energy (kWh)	Demand (kW)
High Efficiency	328	0.05

Energy/Demand Savings:

	Energy (kWh)	Demand (kW)
Energy Savings	249	0.029

KEMA 2005-2007 Energy and Peak Demand Impact Evaluation Report

Samples	Group	kWh per Unit	On Peak Demand	Total kWh	On Peak Demand
260	All	577	0.079	150,020	20.5
18	Failed	3,925	0.469	70,644	8.4
242	Operating	328	0.050	79,376	12.1

Measure Life
5 years

Operating Hours
10 hours

Loadshape
TBD

Freeridership/Spillover Factors
TBD

Demand Coincidence Factor

Persistence

Measure Costs and Incentive Levels
Incentive is available once per system per year.

Component Costs and Lifetimes Used in Computing O&M Savings
TBD

Reference Tables
None

11.2.2 Central Air Conditioning Retrofit

Version Date & Revision History:
Draft date: June 20, 2014

Measure Description
This measure involves the early removal of an existing inefficient central air conditioning unit from service, prior to its measure and natural end of life, and replacement with a higher efficient unit.

Baseline Condition
The baseline condition is the existing inefficient central air conditioning unit with an EER of 9.8.

Definition of Efficient Condition
The efficient condition is a new replacement central air conditioning with a higher EER of 13.0.

Annual Energy Savings Algorithm
Savings for remaining life of existing unit:

$$\Delta kWh = (Hours * BtuH * (1/EERexist - 1/EERee))/1,000$$

Where:

- Hours = Run hours of AC unit
- Btuh = Capacity of replaced unit
- EERexist = Efficiency of existing unit in Btus per Watt-hour = 9.8
- EERee = Efficiency of new higher efficient = 13.0

Savings Algorithm

Central AC Replacement				
Average Unit Cooling Capacity		12000	BTU/Hr	Equals 1 Ton Cooling Capacity
Energy Efficiency Ratio	÷	9.8	EER	DOE Federal Test Procedure 10CFR 430, Appendix F
Full Load Demand		1224.5	Watts	
Conversion	÷	1000	Watts/kW	
Full Load Demand		1.22	kW	
Conventional Full Load Demand		1.22	kW	
Honolulu Full Load Equivalent Cooling Hours	x	2920	Hours per Year	Based on 8 hr/day, 365 day/year
Conventional AC Annual Energy Consumption		3575.5	kWh per Year	
High Efficiency Central AC		12000	BTU/hr	Equals 1 Ton Cooling Capacity
Energy Efficiency Ratio	÷	13	EER	Minimum Energy Star Rated Window AC
Full Load Demand		923.1	Watts	
Conversion	÷	1000	Watts/kW	
Full Load Demand		0.92	kW	
High Efficiency Demand		0.92	kW	
Cooling Hours	x	2920	Hours per Year	
High Efficiency Energy Usage		2695.4	kWh per Year	
Annual Energy Savings		880.1	kWh per Year (PER TON)	
Coincidence Factor		0.75		
Demand Peak Savings		0.226	kW/TON	

12 Residential Hard to Reach (RHTR)

12.1 Energy Efficiency Equipment Grants

12.1.1 Residential Water Cooler Timer

Measure ID:

Version Date & Revision History:
Draft date:

Referenced Documents:

- LBNL 2007 - http://enduse.lbl.gov/info/LBNL-56380%282007%29.pdf
- EPA2012 - http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=WA#specs

TRM Review Actions:

- Currently Under Review.

Major Changes:

- New measure

Measure Description:
Many homes have water coolers, often equipped with both cold and hot water spigots. Unbeknownst to many, however, is how much energy is used to continuously keep that water hot and cold.

Similar to the timers you might use to control lights in your home, water cooler timers are programmed to turn off during periods when family members are away or sleeping.

Baseline Efficiencies:
No timer

	Energy Usage	
Type of Water Cooler	Cold Only (kWh/day)	Hot/Cold (kWh/day)
ENERGY STAR	0.16	1.20
Conventional	0.29	2.19

Hours per Day	24
Days per year	365

Base Case Usage	Cold Only	Hot/Cold
ENERGY STAR USAGE (kWh/year)	58	438
Conventional (kWh/year)	106	799

High Efficiency:
Timer installed.

Enhanced Case Usage	Cold Only	Hot + Cold
ENERGY STAR (kWh/year)	41	311
Conventional (kWh/year)	75	567

Energy Savings:

Energy Savings	Cold Only	Hot + Cold
ENERGY STAR (kWh/year)	17	127
Conventional (kWh/year)	31	233
Average Savings (kWh/yr)	24	180
Ave Savings Combined (kWh/yr)	102	
Persistence Factor	50%	
Energy Savings (kWh/yr)	**51.0**	

Energy Savings Assumptions:

It is assumed that half of all water coolers are Energy Star and half are not:

- 50% Energy Star
- 50% Conventional

It is assumed that half of all water coolers are cold only and half are hot + cold dispenser:

- 50% Cold Only
- 50% Hot + Cold

The energy savings figure will be based on the average of the above-mentioned percentages.

Operating Hours: Timer Off from 10PM-5AM everyday.

Persistence Factor = 50% (half will not use for intended purpose)

Demand Savings:
No Demand savings since cooler is off from 10PM – 5AM.

Savings Algorithms

Type of Water Cooler	Cold Only (kWh/day)	Hot + Cold (kWh/day)
ENERGY STAR	0.16	1.2
Conventional	0.29	2.19

Hours per day	24
Days per year	365

Base Case Usage	Cold Only	Hot + Cold
ENERGY STAR (kWh/year)	58	438
Conventional (kWh/year)	106	799

Weekday OFF (hr/day)	7	(10PM-5AM)
Weekend OFF (hr/day)	7	(10PM-5AM)
Weekday (days/week)	5	
Weekend (days/week)	2	
Weekday (weeks/yr)	52	
Weekend (weeks/yr)	52	

Hours OFF	2548
Hours per year	8760
Hours Off (%)	29%
Hours On (%)	71%

Enhanced Case Usage	Cold Only	Hot + Cold
ENERGY STAR (kWh/year)	41	311
Conventional (kWh/year)	75	567

Energy Savings	Cold Only	Hot + Cold
ENERGY STAR (kWh/year)	17	127
Conventional (kWh/year)	31	233
Average Savings (kWh/yr)	24	180
Ave Savings Combined (kWh/yr)	102	
Persistence Factor	75%	
Energy Savings (kWh/yr)	**76.4**	

Lifetime

8 years

12.1.2 Multifamily Direct-Install Kits

Measure ID:

Version Date & Revision History:
Draft date: July 1, 2015

Referenced Documents:
-

TRM Review Actions:
- 7/1/2015 – Pending review by EM&V

Major Changes:
- New measure

Measure Description:
The Hawaii Energy/Honeywell team went in to multifamily residential buildings and offered free installation of energy efficiency devices, including light bulbs, low flow showerheads and faucet aeartors, and an advanced power strip. The savings claim for each household depends on the type of water heating for each home, as well as the occupancy for each home (this data was collected by the team).

Baseline Efficiencies:
100 W incandescent (replaced with 23 W CFL)
75 W incandescent (replaced with 20 W CFL)
60 W incandescent (replaced with 13 W CFL)
Showerhead = 2.5 gpm
Faucet = 2.2 gpm

Enhanced Efficiencies:
23 W CFL to replace the 100 W incandescent
20 W CFL to replace the 75 W incandescent
13 W CFL to replace the 60 W incandescent
Advanced power strip (7 plugs) for home entertainment system or home office
Low-flow showerheads = 1.5 gpm (40% reduction)
Low-flow faucet aerators = 1.5 gpm (32% reduction)

Persistence Factor:
Given that this measure was directly installed by the Hawaii Energy/Honeywell team, persistence factors are:
For CFL lightbulbs: 0.96
For advanced power strip: 0.96
For showerheads and faucet aearators: 1.00

Peak Demand Coincidence Factor:
For CFL lightbulbs: 0.12
For advanced power strip: 1.00
For showerheads and faucet aearators: 0.2

Measure Lives:
For CFL lightbulbs: 6 years
For advanced power strip: 5 years
For showerheads and faucet aearators: 5 years

Energy Savings Algorithm:

For advanced power strip: See 9.4.3, Smart Strips

- Savings = 102.8 kWh per year * 0.96 pf = 98.7 kWh per year, first-year
- Given that this device was a 7-plug strip, the 7-plug strip value was used, rather than the TRM assumption of an average 6-plug unit.

For light bulbs:

- For each bulb replaced, the reduced wattage was calculated. Run time was assumed to be 2.3 hours per day per bulb, 365 days per year. Persistence factor is 0.96 and measure life = 6 years.
- 100 W replacement = 23 W CFL = 62.1 kWh per year savings
- 75 W replacement = 20 W CFL = 44.3 kWh per year savings
- 60 W replacement = 13 W CFL = 37.9 kWh per year savings

For low-flow showerheads:

- Given standard electric resistance water heating: PY14 TRM value of 306 kWh for an average family size of 3.77 people. This value was normalized on a per person basis of 81.2 kWh. Then the value was multiplied by the actualy occupancy of the household. These values were assumed to be the same regardless of individual electric resistance water heating in the residential unit or system level electric resistance water heating in the building. Also, these values were assumed to be the same regardless of individually metered electrical billing at the apartment or master-metered electrical billing at the building.

Water Heater Type	1	2	3	4	5	6	7	8
Indiv Meter - Indiv WH - Elect	81.2	162.3	243.5	324.7	405.8	487.0	568.2	649.3
Indiv Meter - Sys WH - Elect	81.2	162.3	243.5	324.7	405.8	487.0	568.2	649.3
Master Meter - Indiv WH - Elect	81.2	162.3	243.5	324.7	405.8	487.0	568.2	649.3
Master Meter - Sys WH - Elect	81.2	162.3	243.5	324.7	405.8	487.0	568.2	649.3

- Given heat pump water heating: Starting with the PY14 TRM value of 2460 kWh per year required for heating all water for an average family size of 3.77 people, this value was divided by an average COP of 2.26 for heat pump water heaters, for 1088 kWh per year. Then the value was plussed up given 6% tank and pipe losses, for 1157 kWh per year. Given the assumption that showers account for 28% of all hot water use, heat pump water heating consumption for an average family is 324 kWh per year. By reducing shower water consumption by 40% with the low-flow showerhead, heat pump water heading consumption is reduced to 195 kWh per year per family, for a savings of 130 kWh per year per family. Per person energy savings is 34.5 kWh per person per year. Finally, the value was multiplied by the actualy occupancy of the household. Savings is assumed to be the same regardless of individual heat pump, central heat pump, individually metered billing, or master-metered billing.

Water Heater Type	1	2	3	4	5	6	7	8
Indiv Meter - Indiv WH - HP	34.5	69.0	103.5	137.9	172.4	206.9	241.4	275.9
Indiv Meter - Sys WH - Cent HP	34.5	69.0	103.5	137.9	172.4	206.9	241.4	275.9
Master Meter - Indiv WH - HP	34.5	69.0	103.5	137.9	172.4	206.9	241.4	275.9
Master Meter - Sys WH - HP	34.5	69.0	103.5	137.9	172.4	206.9	241.4	275.9

- Given on-demand electric water heating: Starting with the PY14 TRM value of 2460 kWh per year required for heating all water for an average family size of 3.77 people, this value was divided by an average efficiency of 0.98 for on-demand/instantaneous water heaters, for 2510 kWh per year. Then the value was plussed up given 2% tank and pipe losses, for 2561 kWh per year. Given the assumption that showers account for 28% of all hot water use, heat pump water heating consumption for an average family is 717 kWh per year. By reducing shower water consumption by 40% with the low-flow showerhead, on-demand water heading consumption is reduced to 430 kWh per year per family, for a savings of 287 kWh per year per family. Per person energy savings is 76.1 kWh per person per year. Finally, the value was multiplied by the actualy occupancy of the household. Savings is assumed to be the same regardless of individually metered billing or master-metered billing. There are no central on-demand water heating systems, only individual systems.

Water Heater Type	1	2	3	4	5	6	7	8
Indiv Meter - Indiv WH - OD	76.1	152.2	228.3	304.4	380.5	456.6	532.7	608.8
Master Meter - Indiv WH - OD	76.1	152.2	228.3	304.4	380.5	456.6	532.7	608.8

- Given boiler water heating: Savings were assumed to be the same for boiler water heating as for standard electric resistance water heating because gas-fired boilers were not in the scope of this measure. An electric-fired boiler is essentially the same as a standard electric resistance water heater. Savings are assumed to be the same regardless of individually metered billing or master-metered billing. There are no individual boiler water heaters in apartments, only central boilers.

Water Heater Type	1	2	3	4	5	6	7	8
Indiv Meter - Sys WH - Boiler	81.2	162.3	243.5	324.7	405.8	487.0	568.2	649.3
Master Meter - Sys WH - Boiler	81.2	162.3	243.5	324.7	405.8	487.0	568.2	649.3

For faucet aerators:

- Given standard electric-resistance water heating: PY14 TRM value for savings per year for an average family size of 3.77 people for faucet aerators is 65 kWh (assuming 90% efficiency). This value was normalized on a per person basis of 17.2 kWh. Then the value was multiplied by the actualy occupancy of the household. These values were assumed to be the same regardless of individual electric resistance water heating in the residential unit or system level electric resistance water heating in the building. Also, these values were assumed to be the same regardless of individually metered electrical billing at the apartment or master-metered electrical billing at the building.

Water Heater Type	1	2	3	4	5	6	7	8
Indiv Meter - Indiv WH - Elect	17.2	34.5	51.7	69.0	86.2	103.4	120.7	137.9
Indiv Meter - Sys WH - Elect	17.2	34.5	51.7	69.0	86.2	103.4	120.7	137.9
Master Meter - Indiv WH - Elect	17.2	34.5	51.7	69.0	86.2	103.4	120.7	137.9
Master Meter - Sys WH - Elect	17.2	34.5	51.7	69.0	86.2	103.4	120.7	137.9

- Given heat pump water heating: Starting with the PY14 TRM value of 58.44 kWh savings per year for a family of 3.77 for faucet aerators (assuming 100% efficiency), this value was divided by an average COP of 2.26 for heat pump water heaters, for 25.9 kWh per year. Then the value was plussed up given 6% tank and pipe losses, for 27.6 kWh per year per family, or 7.3 kWh per year per person. Finally, the value was multiplied by the actualy occupancy of the household. Savings is assumed to be the same regardless of individual heat pump, central heat pump, individually metered billing, or master-metered billing.

Water Heater Type	1	2	3	4	5	6	7	8
Indiv Meter - Indiv WH - HP	7.3	14.6	21.9	29.3	36.6	43.9	51.2	58.5
Indiv Meter - Sys WH - Cent HP	7.3	14.6	21.9	29.3	36.6	43.9	51.2	58.5
Master Meter - Indiv WH - HP	7.3	14.6	21.9	29.3	36.6	43.9	51.2	58.5
Master Meter - Sys WH - HP	7.3	14.6	21.9	29.3	36.6	43.9	51.2	58.5

- Given on-demand electric water heating: Starting with the PY14 TRM value of 58.44 kWh savings per year for a family of 3.77 for faucet aerators (assuming 100% efficiency), this value was divided by an average efficiency of 98% for on-demand/instantaneous water heaters, for 59.6 kWh per year. Then the value was plussed up given 2% tank and pipe losses, for 60.8 kWh per year per family, or 16.1 kWh per year per person. Finally, the value was multiplied by the actualy occupancy of the household. Savings is assumed to be the same regardless of individually metered billing, or master-metered billing. There is only individual on-demand water heating, no central systems.

Water Heater Type	1	2	3	4	5	6	7	8
Indiv Meter - Indiv WH - OD	16.1	32.3	48.4	64.6	80.7	96.8	113.0	129.1
Master Meter - Indiv WH - OD	16.1	32.3	48.4	64.6	80.7	96.8	113.0	129.1

- Given boiler water heating: Savings were assumed to be the same for boiler water heating as for standard electric resistance water heating because gas-fired boilers were not in the scope of this measure. An electric-fired boiler is essentially the same as a standard electric resistance water heater. Savings are assumed to be the same regardless of individually metered billing or master-metered billing. There are no individual boiler water heaters in apartments, only central boilers.

Water Heater Type	1	2	3	4	5	6	7	8
Indiv Meter - Sys WH - Boiler	17.2	34.5	51.7	69.0	86.2	103.4	120.7	137.9
Master Meter - Sys WH - Boiler	17.2	34.5	51.7	69.0	86.2	103.4	120.7	137.9

Demand Savings Algorithm

For lightbulbs:

- Peak coincidence demand factor is 0.12.
- 100 W replacement = 77 watt reduction * 0.96 pf * 0.12 cf = 0.0089 kW
- 75 W replacement = 55 watt reduction * 0.96 pf * 0.12 cf = 0.0063 kW
- 60 W replacement = 47 watt reduction * 0.96 pf * 0.12 cf = 0.0054 kW

For advanced power strip:

- 98.7 kWh savings per year/8760 hours per year = 0.0113 kW peak demand reduction

For low-flow showerheads:

- Electric-resistance = PY14 TRM value = 0.1144 kW (see PY14 TRM Section **Error! Reference source not found.**)
- Heat pump = 0.1008 kW
- On-demand = assumed the same as electric-resistance (conservative value)

For faucet aerators:

- Electric-resistance = TRM value = 0.017 kW (see PY14 TRM Section **Error! Reference source not found.**)
- Heat pump = TRM value = 0.0936 kW
- On-demand = assumed the same as electric-resistance (conservative value)

13 Business Energy Efficiency Measures (BEEM)

13.1 High Efficiency Lighting

13.1.1 T12 to T8 with Electronic Ballast

Version Date & Revision History:
Draft date: February 24, 2011
Revision date: May 16, 2016

Referenced Documents:
- Energy and Peak Demand Impact Evaluation Report of the 2005-2007
- Demand Management Programs – KEMA (KEMA 2005-07).
- Econorthwest TRM Review – 6/23/10
- DEER - The Database for Energy Efficient Resources
- The California Energy Commission California Commercial End Use Summary http://www.energy.ca.gov/ceus/
- Evergreen TRM Review – 2/23/12

TRM Review Actions:
- 6/23/10 Rec. #18 – Break down T8 savings by lamp length – Adopted
- 10/5/11 – Currently Under Review.

Major Changes:
- Wholesale replacement of prior TRM using DEER operational data and CEUS Commercial Data
- Added interactive effect factors for energy and demand Table 3.
- 5-19-2016 – Added measure life

Description: This measure involves the replacement of an existing T12 lamp with a new high efficiency T8 lamp, and savings are calculated assuming standard T12 lamps and magnetic ballasts. The average watt savings per lamp for replacing 2', 3', 4', and 8' lamps is calculated by weighting the average toward those replacements that most likely to occur; largely 4' 2 lamp and 4' 4 lamp fixtures. Based on the assumed fixture distribution, the average savings per lamp is 18.6W.

Base Efficiency
The base case efficiency is either an existing T12 lamp with magnetic ballast.

High Efficiency
The high efficiency case is a T8 lamp with electronic ballast.

Measure Life:
14 years

Demand Savings: Using the CEUS coincidence factors the demand savings are (see Section 3 Interactive Effects):

	Demand Savings (kW)			
Building Type	**2' Lamp**	**3' Lamp**	**4' Lamp**	**8' Lamp**
Misc. Commercial	0.0020	0.0040	0.0060	0.0120
Cold Storage	0.0040	0.0070	0.0100	0.0200
Education	0.0020	0.0030	0.0040	0.0080
Grocery	0.0070	0.0110	0.0160	0.0340
Health	0.0050	0.0080	0.0130	0.0260
Hotel/Motel	0.0050	0.0080	0.0120	0.0240
Industrial	0.0040	0.0070	0.0100	0.0200
Office	0.0040	0.0070	0.0100	0.0200
Restaurant	0.0060	0.0100	0.0140	0.0300
Retail	0.0050	0.0080	0.0120	0.0240
Warehouse	0.0040	0.0060	0.0090	0.0180

Energy Savings: Using the DEER operational hours the energy savings are (see Section 3 Interactive Effects):

	Energy Savings (kWh/year)			
Building Type	**2' Lamp**	**3' Lamp**	**4' Lamp**	**8' Lamp**
Misc. Commercial	35.9	56.4	83.2	170.8
Cold Storage	34.5	54.3	80.0	164.3
Education	22.0	34.6	51.0	104.8
Grocery	48.3	76.0	112.0	230
Health	53.7	84.5	124.5	255.7
Hotel/Motel	41.0	64.5	95.0	195.2
Industrial	35.6	56.0	82.5	169.5
Office	23.3	36.6	54.0	110.9
Restaurant	43.8	68.9	101.5	208.5
Retail	34.9	54.9	81.0	166.3
Warehouse	34.5	54.3	80.0	164.3

13.1.2 T12 to T8 Low Wattage

Version Date & Revision History:
Draft date: February 24, 2011
Revision date: May 19, 2016

Referenced Documents:
- Energy and Peak Demand Impact Evaluation Report of the 2005-2007
- Demand Management Programs – (KEMA 2005-07).
- Econorthwest TRM Review – 6/23/10
- DEER-The Database for Energy Efficient Resources
- The California Energy Commission California Commercial End Use Summary http://www.energy.ca.gov/ceus/
- Evergreen TRM Review – 2/23/12

TRM Review Actions:
- 6/23/10 Rec. #no number– Adjust with DEER/CEUS usage characteristics – Adopted
- 10/5/11 – Currently Under Review.

Major Changes:
- Adjustment of hours and coincidence factors of prior TRM using DEER operational data and CEUS Commercial Data
- Added interactive effect factors for energy and demand Table 3.
- 5/19/2016 – Added measure life

Description:
This measure involves the replacement of 4' standard T12 with low wattage T8 fixtures and electronic ballasts.

Base Efficiency
The baseline fixtures are assumed to be standard magnetic ballasts with T12 lamps.

High Efficiency
The high efficiency case is super T8 low wattage lamps with high performance electronic ballasts.

Energy and Demand Savings:
The savings for this measure were calculated assuming an even distribution of 1, 2, 3, and 4 lamp fixtures.

Measure Life:
14 years

Energy and Demand Savings and Incentive Levels: Using the DEER operational hours (Energy) and the CEUS coincidence factors (Demand) the savings are the following (see Section 3 Interactive Effects):

Building Type	Demand Savings (kW)	Energy Savings (kWh/year)
Misc. Commercial	0.005	78.1
Cold Storage	0.009	75.1
Education	0.004	47.9
Grocery	0.015	105.1
Health	0.012	116.9
Hotel/Motel	0.011	89.2
Industrial	0.009	77.4
Office	0.009	50.7
Restaurant	0.014	95.3
Retail	0.011	76.0
Warehouse	0.008	75.1

13.1.3 T8 to T8 Low Wattage

Version Date & Revision History:
Draft date: February 24, 2011
Revision date: May 19, 2016

Referenced Documents:
- Energy and Peak Demand Impact Evaluation Report of the 2005-2007
- Demand Management Programs – (KEMA 2005-07).
- Econorthwest TRM Review – 6/23/10
- DEER-The Database for Energy Efficient Resources
- The California Energy Commission California Commercial End Use Summary http://www.energy.ca.gov/ceus/
- Evergreen TRM Review – 2/23/12

TRM Review Actions:
- 6/23/10 Rec. #no number– Adjust with DEER/CEUS usage characteristics – Adopted
- 10/5/11 – Currently Under Review.
- 11/14/13 – Remove all forms of T12 lamps from the energy savings calculations in time for PY16.

Major Changes:
- Adjustment of hours and coincidence factors of prior TRM using DEER operational data and CEUS Commercial Data
- Added interactive effect factors for energy and demand Table 3.
- 5/19/2016 – Added measure life.

Description:
This measure involves the replacement of 4' standard T8 with low wattage T8 fixtures and electronic ballasts.

Base Efficiency
The baseline T8 fixtures are assumed to be standard T8 (32W) lamps with standard magnetic ballasts.

High Efficiency
The high efficiency case is super T8 low wattage (25W/28W) lamps with high performance electronic ballasts.

Energy and Demand Savings:
The Base Watts and New Watts values are taken from Appendix B of the KEMA Report Table B-2. Appendix G of the KEMA report gives the same value for all Building Types. The following table shows the savings for low wattage T8 lamps and ballast compared to standard T8 lamps.

Measure Life:
14 years

Energy and Demand Savings and Incentive Levels: Using the DEER operational hours (Energy) and the CEUS coincidence factors (Demand) the savings are the following (see Section 3 Interactive Effects):

Building Type	Demand Savings (kW)	Energy Savings (kWh/yr)
Misc. Commercial	0.005	21.6
Cold Storage	0.009	37.4
Education	0.004	10.6
Grocery	0.015	87.4
Health	0.012	77.7
Hotel/Motel	0.011	54.4
Industrial	0.009	38.6
Office	0.009	25.3
Restaurant	0.014	73.9
Retail	0.011	46.3
Warehouse	0.008	33.3

13.1.4 Delamping

Version Date & Revision History:
Draft date: February 24, 2011
Revision date: May 19, 2016

Referenced Documents:
- Energy and Peak Demand Impact Evaluation Report of the 2005-2007
- Demand Management Programs – KEMA (KEMA 2005-07).
- Econorthwest TRM Review – 6/23/10
- DEER-The Database for Energy Efficient Resources
- The California Energy Commission California Commercial End Use Summary http://www.energy.ca.gov/ceus/
- Evergreen TRM Review – 2/23/12

TRM Review Actions:
- 6/23/10 Rec. #20 – Break down the savings by lamp size. – Adopted
- 10/5/11 – Currently Under Review.

Major Changes:
- Adjustment of hours and coincidence factors of prior TRM using DEER operational data and CEUS Commercial Data
- Added interactive effect factors for energy and demand Table 3.
- 5/19/2016 – Added measure life

Description: The ballasts are re-wired for de-lamping.

Base Efficiency
The base case is no delamping

High Efficiency
The savings for this measure are determined by calculating the average watt reduction by removing either a 32 W T8, or a standard 40 W or reduced wattage 34 W T12 lamp from a standard ballast fixture, magnetic energy saving ballast fixture, or electric ballast fixture. This measure covers 2’, 4’ and 8’ fixtures.

Incremental Cost
$7.50 per lamp

Measure Life:
14 years

Energy and Demand Savings – see Section 3 Interactive Effects**.**

	Delamping Avg. Wattage Reduction			
	2' Lamp	3' Lamp	4' Lamp	8' Lamp
Average	18.5	27.5	34.5	77.0

	Demand Savings (kW)			
Building Type	2' Lamp	3' Lamp	4' Lamp	8' Lamp
Misc. Commercial	0.0060	0.0080	0.0100	0.0230
Cold Storage	0.0090	0.0140	0.0170	0.0390
Education	0.0040	0.0060	0.0070	0.0150
Grocery	0.0160	0.0230	0.0290	0.0650
Health	0.0120	0.0180	0.0220	0.0500
Hotel/Motel	0.0110	0.0170	0.0210	0.0460
Industrial	0.0090	0.0140	0.0170	0.0390
Office	0.0090	0.0140	0.0170	0.0390
Restaurant	0.0140	0.0210	0.0260	0.0580
Retail	0.0110	0.0170	0.0210	0.0460
Warehouse	0.0080	0.0120	0.0160	0.0350

	Energy Savings (kWh/year)			
Building Type	2' Lamp	3' Lamp	4' Lamp	8' Lamp
Misc. Commercial	80.0	118.9	149.2	333
Cold Storage	77.0	114.4	143.5	320.3
Education	49.1	73.0	91.5	204.3
Grocery	107.7	160.2	200.9	448.4
Health	119.8	178.0	223.4	498.5
Hotel/Motel	91.4	135.9	170.5	380.5
Industrial	79.4	118.0	148.0	330.3
Office	51.9	77.2	96.9	216.2
Restaurant	97.6	145.1	182.1	406.4
Retail	77.9	115.8	145.2	324.2
Warehouse	77.0	114.4	143.5	320.3

13.1.5 Delamping with Reflectors

Version Date & Revision History:
Draft date: February 24, 2011
Revision date: May 19, 2016

Referenced Documents:

- New Buildings Institute, Advanced Lighting Guidelines, 2003
- Energy and Peak Demand Impact Evaluation Report of the 2005-2007
- Demand Management Programs – KEMA (KEMA 2005-07).
- Econorthwest TRM Review – 6/23/10
- DEER-The Database for Energy Efficient Resources
- The California Energy Commission California Commercial End Use Summary http://www.energy.ca.gov/ceus/
- Evergreen TRM Review – 2/23/12

TRM Review Actions:

- 6/23/10 Rec. #20 – Break down the savings by lamp size**.** – Adopted
- 10/5/11 – Currently Under Review.

Major Changes:

- Adjustment of hours and coincidence factors of prior TRM using DEER operational data and CEUS Commercial Data
- Added interactive effect factors for energy and demand Table 3.
- 5/19/2016 – Added measure life

Description: Putting reflectors on the ballasts allows for more light, with less lamps. The ballasts are re-wired for de-lamping.

Base Case

The base efficiency case is no delamping with reflectors.

High Efficiency

The savings for this measure are determined by calculating the average watt reduction by removing either a 32 W T8, or a standard 40 W or reduced wattage 34 W T12 lamp from a standard ballast fixture, magnetic energy saving ballast fixture, or electric ballast fixture.

Measure Life:
14 years

Energy and Demand Savings:
The wattage per lamp varies greatly depending on the size of the lamp. See Section 3 Interactive Effects.

	Demand Savings (kW)			
Building Type	**2' Lamp**	**3' Lamp**	**4' Lamp**	**8' Lamp**
All Commercial	0.0090	0.0140	0.0170	0.0390
Misc. Commercial	0.0060	0.0080	0.0100	0.0230
Cold Storage	0.0090	0.0140	0.0170	0.0390
Education	0.0040	0.0060	0.0070	0.0150
Grocery	0.0160	0.0230	0.0290	0.0650
Health	0.0120	0.0180	0.0220	0.0500
Hotel/Motel	0.0110	0.0170	0.0210	0.0460
Misc. Industrial	0.0090	0.0140	0.0170	0.0390
Office	0.0090	0.0140	0.0170	0.0390
Restaurant	0.0140	0.0210	0.0260	0.0580
Retail	0.0110	0.0170	0.0210	0.0460
Warehouse	0.0080	0.0120	0.0160	0.0350

	Energy Savings (kWh/year)			
Building Type	**2' Lamp**	**3' Lamp**	**4' Lamp**	**8' Lamp**
All Commercial	80.0	118.9	149.2	333
Misc. Commercial	80.0	118.9	149.2	333
Cold Storage	77.0	114.4	143.5	320.3
Education	49.1	73.0	91.5	204.3
Grocery	107.7	160.2	200.9	448.4
Health	119.8	178.0	223.4	498.5
Hotel/Motel	91.4	135.9	170.5	380.5
Misc. Industrial	79.4	118.0	148.0	330.3
Office	51.9	77.2	96.9	216.2
Restaurant	97.6	145.1	182.1	406.4
Retail	77.9	115.8	145.2	324.2
Warehouse	77.0	114.4	143.5	320.3

13.1.6 LED Refrigerated Case Lighting

Version Date & Revision History:
Draft date: October 3, 2011
Revision date: May 19, 2016

Referenced Documents:
- n/a

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- 8/13/12 – Measure updated as per EM&V report. The kWh calculations were updated to use new COP and hours per year numbers, and kW numbers were updated respectively.
- 11/14/13 – Correct the calculation of the refrigeration interactive effect to divide by the COP instead of multiply.
- 5/19/2016 – Added measure life.

Measure Description:
This measure involves the replacement of a 40W T8 fluorescent lamp with a 23W LED linear lamp fixtures.

Baseline Efficiencies:
40W F40 T8 Linear Fluorescent Lamp

High Efficiency:
23W LED Linear Lamp

Energy Savings:
199.7 kWh

Demand Savings:
0.032 kW

Measure Life:
15 years

Savings Algorithms

LED Refrigerated Case Lighting Retrofit				
40W F40 T12 Linear Fluorescent Fixture Demand		40 W	40%	
Base Demand		0.040	kW	
		17	Hours per Day	
	x	365	Days	6,205 Hours per Year
4 foot Linear Fluorescent Lamp Blended Energy Usage		248.2	kWh per Year	
23 W LED Linear Fixture Demand		0.0230	kW	
		17	Hours per Day	
	x	365	Days	6,205 Hours per Year
Energy Usage		142.7	kWh per Year	
4 foot Linear Fluorescent Lamp Blended Energy Usage		248.2	kWh per Year	
Energy Usage	-	142.7	kWh per Year	
LED Savings Before Adjustments		105.5	kWh per Year	
Lighting Wattage Reduction		105.5	kWh per Year	
% of Lighting Savings reduced from Compressor Load	x	100%		
Cooling Energy Reduced from System		105	kWh per Year	
Lighting Contribution to Cooling Energy Reduced from System		105.5	kWh per Year	
Refrigerator Compressor Efficency	÷	1.12	COP	
Compressor Energy Reduced		94.2	kWh per Year	
LED Savings Before Adjustments		105.5	kWh per Year	
Compressor Energy Reduced	+	94.2	kWh per Year	
		199.7	kWh per Year	
		199.7	kWh per Year	
Persistance Factor	x	1.000	pf	0.0% Lamps not installed or replaced back
Fixture Savings per Year		199.7	kWh per Year	
LED Case Lighting Energy Savings		**199.7**	**kWh / Year Savings**	
Annual Energy Savings		199.7		
Hours of Operation	÷	6205		
Total kW savings		**0.032**	**Demand Savings (kW)**	

13.1.7 LED Street and Exterior Lighting

Version Date & Revision History:
- Draft date: July 1, 2015

Referenced Documents:
- PG&E Work Paper PGECOLTG151 (8/29/12)

TRM Review Actions:
- 8/1/14 – Currently Under Review.

Major Changes:
- New Measure

Measure Description:
Replacement of exterior HID fixtures with LED luminaires in outdoor street and exterior area applications.

Light emitting diode (LED) technology has proven to be an effective lighting source that can offer substantial savings over typical high intensity discharge (HID) lighting technologies.

The light is easily controllable and can be turned on and off instantly or dimmed for added energy savings at dawn and dusk.

LED streetlights are available from a variety of vendors and offer many advantages over traditional streetlight technologies.

- No mercury or other hazardous chemical and gasses in the LEDs
- Long lifetimes and highly reliable service, greatly reducing maintenance costs
- White light available in color temperatures from "warm" to "cool" with high CRI providing high-quality white light.

Baseline & High Efficiency:

Measure Name	Building Type	Base Case Wattage (W)	Measure Case Wattage (W)	Delta Watts (kW)	Annual Operating Hours	Energy Savings (kWh/yr)	Demand Reduction (kW)	Unit Definition	EUL	Base Case Cost ($/unit)	Measure Cost ($/unit)	Incremental Measure Cost (IMC)
LED Street/Exterior Lighting - Replace up to a 70 W Lamp with LED	ANY	85	50	0.035	4100	144	0.0350	Fixture	12	$217	$700	$483
LED Street/Exterior Lighting - Replace 71 to 100 W Lamp with LED	ANY	120	70	0.050	4100	205	0.0500	Fixture	12	$251	$800	$549
LED Street/Exterior Lighting - Replace 101 to 150 W Lamp with LED	ANY	176	110	0.066	4100	271	0.0660	Fixture	12	$296	$995	$699
LED Street/Exterior Lighting - Replace 151 to 200 W Lamp with LED	ANY	234	150	0.084	4100	344	0.0840	Fixture	12	$495	$1,200	$705
LED Street/Exterior Lighting - Replace 201 to 250 W Lamp with LED	ANY	293	192	0.101	4100	414	0.1010	Fixture	12	$535	$1,400	$865
LED Street/Exterior Lighting - Replace 251 to 310 W Lamp with LED	ANY	363	225	0.138	4100	566	0.1380	Fixture	12	$535	$1,600	$1,065
LED Street/Exterior Lighting - Replace 311 to 400 W Lamp with LED	ANY	468	265	0.203	4100	832	0.2030	Fixture	12	$555	$1,750	$1,195
Average Energy and Demand Savings						**397**	**0.097**					
Coincidence Factor (CF)	0.75											
Average Delta kW	0.097											
Peak Demand Savings	**0.073**											

Energy Savings:
Energy savings is based on the average kW reduction multiplied by hours of operation. Hours of operation is based on 4100 hours/year. **Average energy savings = 397 kWh/year**

Demand Savings:
Demand savings is based on the average kW reduction = 0.097 kW

- Coincidence Factor = 0.75

- Coincidence factor is based on lights being on during 6PM-9PM which is 3 out of the 4 peak demand hour period.

Peak Demand Savings = CF x 0.097 = 0.073 kW

Program Restrictions and Guidelines

To qualify for an incentive, the following requirements must be met:

- The LEDs must replace high intensity discharge, low pressure sodium, or incandescent lighting.
- Proposed fixture must be ENERGY STAR, Design Lights Consortium (DLC) listed or Lighting Facts.
- The pole/arm-mounted area and roadway luminaires must meet a minimum efficacy of 60 lumens per watt.
- Luminaire/enclosure type must be certified by NEMA/IEC as wet location for exterior parking, roadway, area, or wall-mounted luminaires and damp (or wet) location for parking garage luminaires.
- Not to exceed the power supply manufacturer's maximum recommended case temperature or TMP when measured during in-situ operation. Note: This performance characteristic is separate and distinct from thermal requirements established by UL, which governs safety rather than longevity of the power supply.
- Luminaires must possess a power factor greater than 0.9.
- The LEDs must possess less than 20% of total harmonic distortion.
- A written warranty must be issued to the customer guaranteeing repair or replacement of defective electrical parts (including light source and power supplies) for a minimum of three (3) years from the date of purchase.
- A product cut sheet and installation instructions must be provided.

Measure Life = 12 years (source: PG&E white paper).

Hours of Operation = 4100 hours/year (based on HECO Schedule F).

Incentives:

LED Street/Exterior Area Lighting

Existing Fixture Wattage	Incentive
Replace 311–400 watt lamp with LED	$115/fixture
Replace 251–310 watt lamp with LED	$90/fixture
Replace 201–250 watt lamp with LED	$70/fixture
Replace 151–200 watt lamp with LED	$60/fixture
Replace 101–150 watt lamp with LED	$50/fixture
Replace 71–100 watt lamp with LED	$40/fixture
Replace up to 70 watt lamp with LED	$30/fixture

13.1.8 LED

Version Date & Revision History:
Draft date: November 30, 2011

Referenced Documents:

- The Database for Energy Efficient Resources (DEER)
- California Commercial End Use Summary (CEUS)
- Evergreen TRM Review – 2/23/12
- Evergreen TRM Review – 1/15/14

TRM Review Actions:

- 10/5/11 – Currently Under Review.

Major Changes:

- 11/30/11 – Moved *LED Product Customized Process* measure to addendum (section 16.2.1) and created new prescriptive *LED* measure.
- Added interactive effect factors for energy and demand Table 3.

Measure Description: Light Emitting Diodes (LED) are a lighting technology that utilizes solid-state technology to produce light, opposed to fluorescent or incandescent lighting sources. In general, LED technology will provide energy levels 15% of a comparable incandescent lamp (15W to a 100W equivalent).

Baseline & High Efficiency:

25% *Dimmable Demand Reduction*

Lamp	Base Case Incandescent Demand (kW)	Percent Incandescent Base	Base Case CFL Demand (kW)	Percent CFL Base	Base Mix Demand (kW)	Enhanced Case LED Demand (kW)	*LED* Demand Savings (kW)	*Dimmable LED* Demand Savings (kW)
MR16	0.0500	100%	n/a	0%	0.0500	0.0065	0.0435	0.0326
PAR20 8 deg.	0.0600	80%	0.0150	20%	0.0510	0.0086	0.0424	0.0318
PAR20 25 deg.	0.0550	80%	0.0130	20%	0.0466	0.0090	0.0376	0.0282
PAR30 Short Neck	0.0750	80%	0.0200	20%	0.0640	0.0163	0.0477	0.0358
PAR30 Long Neck	0.0750	80%	0.0200	20%	0.0640	0.0163	0.0477	0.0358
PAR38 25 deg.	0.0750	80%	0.0200	20%	0.0640	0.0203	0.0437	0.0328
A-19	0.0600	20%	0.0150	80%	0.0240	0.0078	0.0162	0.0122

Energy Savings by Building/Usage Type (see Section 3 Interactive Effects):

			Dimmable Commercial Lighting											
			MR16		PAR20 8 deg.		PAR20 25 deg.		PAR30 Short Neck/Long Neck		PAR38 25 deg.		A-19	
Building Type	Hours of Operation[1]	Peak Coincidence Factor[2]	Energy Savings (kWh/year)	Demand Savings (kW)	Energy Savings (kWh/year)	Demand Savings (kW)	Energy Savings (kWh/year)	Demand Savings (kW)	Energy Savings (kWh/year)	Demand Savings (kW)	Energy Savings (kWh/year)	Demand Savings (kW)	Energy Savings (kWh/year)	Demand Savings (kW)
Misc. Commercial	4,325	0.30	188.1	0.0131	183.4	0.0127	162.6	0.0113	206.3	0.0143	189.0	0.0131	70.1	0.0049
Cold Storage	4,160	0.50	181.0	0.0218	176.4	0.0212	156.4	0.0188	198.4	0.0239	181.8	0.0219	67.4	0.0081
Education	2,653	0.20	115.4	0.0087	112.5	0.0085	99.8	0.0075	126.5	0.0095	115.9	0.0087	43.0	0.0032
Grocery	5,824	0.85	253.3	0.0370	246.9	0.0360	219.0	0.0320	277.8	0.0405	254.5	0.0371	94.3	0.0138
Health	6,474	0.65	281.6	0.0283	274.5	0.0276	243.4	0.0244	308.8	0.0310	282.9	0.0284	104.9	0.0105
Hotel/Motel	4,941	0.60	214.9	0.0261	209.5	0.0254	185.8	0.0226	235.7	0.0286	215.9	0.0262	80.0	0.0097
Industrial	4,290	0.50	186.6	0.0218	181.9	0.0212	161.3	0.0188	204.6	0.0239	187.5	0.0219	69.5	0.0081
Office	2,808	0.50	122.1	0.0218	119.1	0.0212	105.6	0.0188	133.9	0.0239	122.7	0.0219	45.5	0.0081
Restaurant	5,278	0.75	229.6	0.0326	223.8	0.0318	198.5	0.0282	251.8	0.0358	230.6	0.0328	85.5	0.0122
Retail	4,210	0.60	183.1	0.0261	178.5	0.0254	158.3	0.0226	200.8	0.0286	184.0	0.0262	68.2	0.0097
Warehouse	4,160	0.45	181.0	0.0196	176.4	0.0191	156.4	0.0169	198.4	0.0215	181.8	0.0197	67.4	0.0073

[1] The Database for Energy Efficient Resources (DEER)
[2] California Commercial End Use Summary (CEUS)

			Non-Dimmable Commercial Lighting											
			MR16		PAR20 8 deg.		PAR20 25 deg.		PAR30 Short Neck/Long Neck		PAR38 25 deg.		A-19	
Building Type	Hours of Operation[1]	Peak Coincidence Factor[2]	Energy Savings (kWh/year)	Demand Savings (kW)	Energy Savings (kWh/year)	Demand Savings (kW)	Energy Savings (kWh/year)	Demand Savings (kW)	Energy Savings (kWh/year)	Demand Savings (kW)	Energy Savings (kWh/year)	Demand Savings (kW)	Energy Savings (kWh/year)	Demand Savings (kW)
All Commercial	4,325	0.50	141.1	0.0163	137.5	0.0159	122.0	0.0141	154.7	0.0179	141.8	0.0164	52.5	0.0061
Misc. Commercial	4,325	0.30	141.1	0.0098	137.5	0.0095	122.0	0.0085	154.7	0.0107	141.8	0.0098	52.5	0.0036
Cold Storage	4,160	0.50	135.7	0.0163	132.3	0.0159	117.3	0.0141	148.8	0.0179	136.3	0.0164	50.5	0.0061
Education	2,653	0.20	86.6	0.0065	84.4	0.0064	74.8	0.0056	94.9	0.0072	87.0	0.0066	32.2	0.0024
Grocery	5,824	0.85	190.0	0.0277	185.2	0.0270	164.2	0.0240	208.4	0.0304	190.9	0.0279	70.8	0.0103
Health	6,474	0.65	211.2	0.0212	205.9	0.0207	182.6	0.0183	231.6	0.0233	212.2	0.0213	78.7	0.0079
Hotel/Motel	4,941	0.60	161.2	0.0196	157.1	0.0191	139.3	0.0169	176.8	0.0215	161.9	0.0197	60.0	0.0073
Misc. Industrial	4,290	0.50	140.0	0.0163	136.4	0.0159	121.0	0.0141	153.5	0.0179	140.6	0.0164	52.1	0.0061
Office	2,808	0.50	91.6	0.0163	89.3	0.0159	79.2	0.0141	100.5	0.0179	92.0	0.0164	34.1	0.0061
Restaurant	5,278	0.75	172.2	0.0245	167.8	0.0239	148.8	0.0212	188.8	0.0268	173.0	0.0246	64.1	0.0091
Retail	4,210	0.60	137.4	0.0196	133.9	0.0191	118.7	0.0169	150.6	0.0215	138.0	0.0197	51.2	0.0073
Warehouse	4,160	0.45	135.7	0.0147	132.3	0.0143	117.3	0.0127	148.8	0.0161	136.3	0.0147	50.5	0.0055

[1] The Database for Energy Efficient Resources (DEER)

[2] California Commercial End Use Summary (CEUS)

Equipment Qualifications: Incentivized LED lamps must be Energy Star labeled or Design Lights Consortium (DLC).

13.1.9 LED Exit Signs

Version Date & Revision History:
Draft date: January, 2010
Revision date: May 19, 2016

Referenced Documents:
- Energy and Peak Demand Impact Evaluation Report of the 2005-2007 Demand Management Programs – KEMA (KEMA 2005-07).
http://www.energystar.gov/ia/business/small_business/led_exitsigns_techsheet.pdf
- Econorthwest TRM Review – 6/23/10

TRM Review Actions:
- 6/23/10 No Changes
- 10/5/11 – Currently Under Review.

Major Changes:
- 5/19/2016 – Added measure life

Measure Description:
Replacement of Incandescent Exit Signs with LED Exit Signs. Savings are equal across all building use types.

Baseline Efficiencies:
Demand Baseline has been determined by technical specifications of an incandescent exit sign, which typically holds two 20 W bulbs (40 W). The Energy Baseline is based on 24/7 operation of the sign (8,760 hours).

Building Types	Demand Baseline(kW)	Energy Baseline (kWh)
All Types	0.040	351

High Efficiency:
The typical technical specification on an LED Exit Sign (through energystar.gov) claims "less than 5W" of Demand. The Energy High Efficiency figure is based on 24/7 operation (8,760 hours).

Building Types	Demand High Efficiency (kW)	Energy High Efficiency (kWh)
All Types	0.005	44

Final Savings:
The Impact Evaluation Report by KEMA states that LED exit signs are expected to have high realization ratios and that measured savings were typically 100% of claimed savings. These figures match the suggested savings by the KEMA report.

Building Types	Demand Savings (kW)	Energy Savings (kWh)
All Types	0.035	307

Measure Life:
16 years

Saving Algorithm:

Exit Signs - Businesses				
Incandescent Exit Sign		0.040	kW	
		24.00	Hours per Day	
	x	365	Days	8,760 Hours per Year
Incandescent Exit Sign		350.4	kWh per Year	
LED Exit Sign		0.005	kW	
		24.00	Hours per Day	
	x	365	Days	8,760 Hours per Year
LED Exit Sign		43.8	kWh per Year	
Incandescent Exit Sign		350.4	kWh per Year	
LED Exit Sign	-	43.8	kWh per Year	
Savings Before Adjustments		306.6	kWh per Year	
		306.6	kWh per Year	
Persistance Factor	x	1.000	pf	0.0% Lamps not installed or replaced back
		307	kWh per Year	
CFL Energy Savings		**307**	**kWh / Year Savings**	
Incandescent Exit Sign		0.040	kW	
LED Exit Sign	-	0.005	kW	
Demand Reduction Before Adjustments		0.035	kW	
Demand Reduction Before Adjustments		0.035	kW	
Coincidence Factor		1.000	cf	100.0% Lamps on between 5 and 9 p.m.
Persistance Factor	x	1.000	pf	0.0% Lamps not installed or replaced back
		0.035	kW	
CFL Demand Savings		**0.035**	**kW Savings**	

13.1.10 HID Pulse Start Metal Halide

Version Date & Revision History:
Draft date: February 24, 2011

Referenced Documents:

- Energy and Peak Demand Impact Evaluation Report of the 2005-2007
- Demand Management Programs – KEMA (KEMA 2005-07).
- Econorthwest TRM Review – 6/23/10
- DEER-The Database for Energy Efficient Resources
- The California Energy Commission California Commercial End Use Summary http://www.energy.ca.gov/ceus/
- Evergreen TRM Review – 2/23/12

TRM Review Actions:

- 6/23/10 Rec. #17 – Break down savings by wattage ranges pulse start metal halides- Adopted
- 10/5/11 – Currently Under Review.

Major Changes:

- Wholesale replacement of prior TRM using DEER operational data and CEUS Commercial Data
- Added interactive effect factors for energy and demand Table 3.
- Updated document regarding persistence and coincident factors based on EM&V review.

Referenced Documents:

Description: Traditional probe-start metal halide lamps do not use an igniter and require three electrical contacts to ignite the gas and remain lit. Recently developed pulse-start metal halide lamps use only two contacts and use an igniter located inside the ballast pod. Pulse-start lamps offer higher light output per unit of electric power. Multiple Wattages of Pulse-Start Metal Halides are installed. The most common have rated wattages between 100 and 250, with the majority of installations being 250 W.

Incremental Cost
$150 (320W PS Replacing 400W HID)

Measure Life
14 years?

Base Case
Probe start metal halide

High Efficiency
Lower wattage pulse start metal halide

Energy Savings

The savings for pulse start metal halide fixtures are calculated based on a wattage savings for the replacement of a metal halide fixture with a smaller wattage pulse start metal halide fixture. Based on the wattages provided, it appears that it was assumed that a 175W metal halide fixture would be replaced with a 100W pulse start metal halide fixture, 250W metal halide fixture would be replaced with either a 150W or 175W pulse start metal halide fixture, and a 400W metal halide would be replaced with a 250W pulse start metal halide fixture. Based on the expected fixture wattages and breakdown of fixture installations, an average savings of 123W per fixture was assumed.

Measure	Metal Halide (W)	Pulse Start Metal Halide (W)
Equivalent Replacement	175	100
	250	150 or 175
	400	250

Savings

	Pulse Start Wattage Reduction		
	<=100W	101-200W	201-350W
Average	48	70	109

Energy Savings: Using the DEER operational hours the energy savings are (see Section 3 Interactive Effects):

	Pulse Start Energy Reduction		
Building Type	**<=100W**	**101-200W**	**201-350W**
Misc. Commercial	209.0	302.0	471.4
Cold Storage	201.1	290.4	453.4
Education	128.2	185.2	289.2
Grocery	281.5	406.6	634.8
Health	312.9	452.0	705.7
Hotel/Motel	238.8	345.0	538.6
Industrial	207.4	299.5	467.6
Office	135.7	196.0	306.1
Restaurant	255.1	368.5	575.3
Retail	203.5	293.9	458.9
Warehouse	201.1	290.4	453.4

Demand Savings: Using the CEUS coincidence factors the demand savings are (see Section 3 Interactive Effects):

	Pulse Start Demand Reduction		
Building Type	**<=100W**	**101-200W**	**201-350W**
Misc. Commercial	0.015	0.021	0.033
Cold Storage	0.024	0.035	0.055
Education	0.010	0.014	0.022
Grocery	0.041	0.059	0.093
Health	0.031	0.045	0.071
Hotel/Motel	0.029	0.042	0.065
Industrial	0.024	0.035	0.055
Office	0.024	0.035	0.055
Restaurant	0.036	0.052	0.082
Retail	0.029	0.042	0.065
Warehouse	0.022	0.031	0.049

Pulse Start Operational Hours and Peak Coincidence Factors:

Commercial Lighting Factors

Building Type	Hours of Operation[1]	Peak Coincidence Factor[2]
Misc. Commercial	4,325	0.30
Cold Storage	4,160	0.50
Education	2,653	0.20
Grocery	5,824	0.85
Health	6,474	0.65
Hotel/Motel	4,941	0.60
Industrial	4,290	0.50
Office	2,808	0.50
Restaurant	5,278	0.75
Retail	4,210	0.60
Warehouse	4,160	0.45

[1] The Database for Energy Efficient Resources (DEER)

[2]California Commercial End Use Summary (CEUS)

13.1.11 Sensors

Version Date & Revision History:
Draft date: March 2, 2011

Referenced Documents:
Occupancy sensors can reduce lighting costs by up to 50% in rooms where lights are frequently left on when on one is around."

According to the Federal Energy Management Program (FEMP) of the US Department of Energy, in a small, private office, an occupancy sensor can reduce energy use by almost 30% shaving 100kWh off the annual energy use. In a large open office area, energy use can be reduced by approximately 10%.

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- TRM measure previously discussed using smart-strips with occupancy sensors. Changed to occupancy sensors for lighting as intended in the annual plan. Updated energy conservations numbers accordingly.

Measure Description:
This measure is for wall switch sensors that controls the use of lighting in areas around the home with variable use such as laundry, storage, garage, bedrooms or spare areas.

Occupancy sensors must comply with:
- Energy Star
- UL Listing

Baseline Efficiencies:
The base case is two (2) 32W T8 fluorescent lamp.

High Efficiency:
The high efficiency case is 33% reduced run time from the base case.

Energy Savings:
Energy savings is calculated at 67.8 kWh per year per sensor.

Savings Algorithms

Room Occupancy Sensors - Commercial				
4' T8 Lamp	0.032	kW		
Two (2) - Lamp	2.0			
	0.064			
Ballast Factor	0.880			
	0.056	kW		
	10.00	Hours per Day		
	x 365	Days	839.5	Hours per Year
Baseline Energy Usage	205.6	kWh per Year		
Run Time Reduced (RTR)	3.30	Hours per Day	33%	
	205.6	kWh per Year		
	x 0.33		33%	Run Time Reduced
	67.8	kWh per Year		
Energy Savings	**67.8**	**kWh / Year Savings**		
Two Lamp Demand Reduction Before Adjustments	0.056	kW		
Coincidence Factor	0.120	cf	12.0%	Lamps on between 5 and 9 p.m.
Persistance Factor	x 1.000	pf	100.0%	
	0.0068	kW		
Demand Savings	**0.0068**	**kW Savings**		

Operating Hours
10 hours per day

Loadshape
TBD

Freeridership/Spillover Factors
TBD

Coincidence
CF = 0.12 (12% lamps on between 5PM – 9PM)

Persistence
PF =1.0

Lifetime
8 years (DEER)

Component Costs and Lifetimes Used in Computing O&M Savings
TBD

13.1.12 Stairwell Bi-Level Dimming Lights

Version Date & Revision History:
Draft date: March 30, 2014

Referenced Documents:
Seattle City Light Energy Smart Services – ***"Funding Calculation Worksheets for Lighting"***

TRM Review Actions:

- Currently Under Review.

Major Changes:

- TRM measure previously discussed using smart-strips with occupancy sensors. Changed to occupancy sensors for lighting as intended in the annual plan. Updated energy conservations numbers accordingly.

Measure Description:
Stairwell lighting typically operates continuously at full output despite very low, intermittent use. Bi-level stairwell dimming lights utilizes either an ultra-sonic or infrared motion sensor to detect motion in stairwells. Solid state controls are used to dim fixtures to lower light levels when a space is unoccupied. This technology is ideal for areas where codes user preferences, safety, or security requirements call for minimal light levels during unoccupied periods and full light output during occupied periods. Fixtures must be UL compliant. If the enhanced case is LED, it must meet program requirements which is 3 year warranty, one of the following: Energy Star/DLC/LED Lighting Facts, UL compliant.

Baseline Efficiencies:
The base case is no bi-level dimming lights with occupancy sensors.

High Efficiency:
The high efficiency case is bi-level dimming lights with occupancy sensors.

Energy Savings:
Energy savings is calculated based on the modified customized lighting worksheet which accounts for the following:

- Watts (Base)
- Watts (Enhanced)
- Hours of operation (including peak period of 5PM-9PM)
- % on High/Low Level (based on the following table from Seattle City Light Energy Smart Services):

Seattle City Light Energy Smart Services

Funding Calculation Worksheets for Lighting

- Occupancy Reference Table 1. Occupancy Type Codes -

Use this table to find the Occupancy Type Code inputs for the Bi-Level Stairway Lighting worksheet.

Occupancy Types		Occupancy Code	Occupied Fraction
High Rise >10 floors	Free Access	FH	10%
	Limited Access (Exit only)	LH	5%
Low Rise <10 floors	Free Access	FL	20%
	Limited Access (Exit only)	LL	10%

1) Occupancy Percentage. This column is included for information only. The Occupancy Percentage is automatically transferred to the Funding Calculation Worksheets when you

Sample Worksheet

CUSTOMIZED LIGHTING INCENTIVE WORKSHEET

Project:	
Application No.:	
Date:	
Done By:	

The yellow columns should correspond with the customized incentive worksheet.

Existing and Base Case

Location	Fixture Type	Fixture Qty	System Wattage	Total Wattage	M - F Hours of Operation	Sat Hours of Operation	Sun Hours of Operation	(E3) Annual Operating Hours	On-Peak Demand Hours (Weekday 5 to 9 pm.)	(E7) Off Peak Demand	(E8) On Peak Demand	(E9) Annual Energy Use (kWh / Yr.)
Stairwell	32WT-8's	205	34	6970	24	24	24	8760.00	4	6.97	6.97	61057.20
				0				0.00		0.00	0.00	0.00
				0				0.00		0.00	0.00	0.00
				0				0.00		0.00	0.00	0.00
				0				0.00		0.00	0.00	0.00
								8760.00	**4.00**	**6.97**	**6.97**	**61057.20**

Notes:

*Please delete all unused rows.

Operational Cost

(E24) Annual Maintenance Cost	

Project Cost

(F27) Equipment Cost	$ 1,000.00
(F26) Total Project Cost	$ 2,000.00

Installation Info

(E30) Installation year	
(E31) Measure of Life	

Enhanced Case: Retrofit

Location	Fixture Type	Fixture Qty	System Wattage	Total Wattage	M - F Hours of Operation	Sat Hours of Operation	Sun Hours of Operation	(G3) Annual Operating Hours	On-Peak Demand Hours (Weekday 5 to 9 pm.)	(G7) Off Peak Demand	(G8) On Peak Demand	(G9) Annual Energy Use (kWh / Yr.)
Stairwell	Fluorescent Bi-level Lighting	205	6	1230	23	23	23	8395.00	4	1.23	1.23	10325.85
Stairwell	Fluorescent Bi-level Lighting	205	60	12300	1	1	1	365.00	1	12.30	3.08	4489.50
				0				0.00		0.00	0.00	0.00
				0				0.00		0.00	0.00	0.00
				0				0.00		0.00	0.00	0.00
								4380.00	**2.50**	**13.53**	**4.31**	**14815.35**

Notes:

*Please delete all unused rows.

Operational Cost

(G24) Annual Maintenance Cost	

Project Cost

(G27) Equipment Cost	$ 34,628.72
(G26) Total Project Cost	$ 49,330.13

Installation Info

(G30) Installation year	2012
(G31) Measure of Life	13.00 years
(G32) New / Retrofit Project	Retrofit

Project Summary			**Estimated Incentive Amount**
Average Energy Savings Per Year	**46241.85 kWh/Year**	**$ 0.10 kWh/Year**	$ 4,624.19
On-Peak Demand Savings	**2.67 kW**	**$ 125 /kW**	$ 333.13
Total Demand Savings	**-6.56 kW**	**Total**	**$ 4,957.00**

Measure Life:

14 years (DEER)

13.2 High Efficiency HVAC

13.2.1 Chiller

Version Date & Revision History:
Draft date: February 24, 2011
Revision date: April 12, 2016

Referenced Documents:
- Econorthwest TRM Review – 6/23/10
- IECC 2006

TRM Review Actions:
- 6/23/10 Rec. #23 – Utilize IECC 2006 Efficiencies as the Baseline Efficiency and Efficient Packaged
  Unit 15% better than IECC 2006 – Adopted
- 6/23/10 Rec. #24 - break down the savings by chiller type and size. Conduct additional research for future program years to calibrate claimed savings for Hawaii customer base.- Adopted

Major Changes:
- Chiller efficiency selected at 15% improvement over IECC 2006.
- 4/12/2016 – Added second requirement of 15% improvement over IECC for full load efficiency (COP) in addition to 15% improvement over IECC for part load efficiency (IPLV) per requirements of IECC 2006. Qualifying chillers must meet both COP and IPLV efficiency requirements.

Description: The replacement of chillers with Energy Efficiency above the code efficiency values in place at the time of permitting the project. In multiple unit chiller plants, a review of operational chillers will be conducted to determine what fraction of installed chillers will be incentivized. This is to avoid paying for standby units.

Water Cooled Chiller Efficiency

High Efficiency Chiller - 15% higher than IECC 2006

		IECC 2006 IPLV (kW/Ton)	IECC 2006 COP (kW/ton)	Hawaii Energy Premium Efficiency IPLV (kW/Ton)	Hawaii Energy Premium Efficiency COP (kW/Ton)
Reciprocating	All	0.70	0.84	0.60	0.71
Rotary Screw and Scroll	< 150 tons	0.68	0.79	0.58	0.67
	150-300 tons	0.63	0.72	0.54	0.61
	> 300 tons	0.57	0.64	0.48	0.54
Centrifugal	< 150 tons	0.67	0.70	0.57	0.60
	150-300 tons	0.60	0.63	0.51	0.54
	> 300 tons	0.55	0.58	0.47	0.49

Note: Qualifying chillers must meet both IPLV and COP efficiency requirements, per IECC 2006.

Air Cooled Chiller Efficiency

2006 IECC

Equipment Type	Size	Min Eff	Type	kW/ton	15% Better kW/ton	Test Procedure
Air cooled, with condenser, electrically operated	< 150 tons	2.8	COP	1.256	1.068	ARI 550/590
		2.8	IPLV	1.256	1.068	
	> = 150 tons	2.5	COP	1.407	1.196	
		2.5	IPLV	1.407	1.196	

Water Cooled Energy Savings:

High Efficiency Chiller - 15% higher than IECC 2006 - Energy Reduction (kWh/Ton)

Building Type	Reciprocating	Rotary Screw or Scroll			Centrifugal		
	All	<150	150-300	>300	<150	150-300	>300
Misc. Commercial	312.5	303.6	281.2	254.4	299.1	267.8	245.5
Cold Storage	536.7	521.3	483.0	437.0	513.7	460.0	421.7
Education	307.9	299.1	277.1	250.7	294.7	263.9	241.9
Grocery	536.7	521.3	483.0	437.0	513.7	460.0	421.7
Health	435.7	423.3	392.1	354.8	417.0	373.5	342.3
Hotel/Motel	312.4	303.5	281.2	254.4	299.0	267.8	245.5
Industrial	435.7	423.3	392.1	354.8	417.0	373.5	342.3
Office	520.1	505.3	468.1	423.5	497.8	445.8	408.7
Restaurant	349.0	339.0	314.1	284.2	334.1	299.2	274.2
Retail	273.9	266.1	246.5	223.1	262.2	234.8	215.2
Warehouse	536.7	521.3	483.0	437.0	513.7	460.0	421.7

Air Cooled Energy Savings:

Air Cooled Chiller Energy Savings (kWh/ton)		
Building Type	Chiller <150 tons	Chiller >= 150 tons
Misc. Commercial	559.5	627.9
Cold Storage	960.9	1078.5
Education	551.2	618.7
Grocery	960.9	1078.5
Health	780.1	875.6
Hotel/Motel	559.3	627.8
Industrial	780.1	875.6
Office	931.3	1045.2
Restaurant	624.9	701.4
Retail	490.5	550.5
Warehouse	960.9	1078.5

Water Cooled Demand Savings:

High Efficiency Chiller - 15% higher than IECC 2006 - Demand Reduction (kW/Ton)

Building Type	Reciprocating	Rotary Screw or Scroll			Centrifugal		
	All	<150	150-300	>300	<150	150-300	>300
Misc. Commercial	0.064	0.062	0.058	0.052	0.061	0.055	0.050
Cold Storage	0.072	0.070	0.065	0.059	0.069	0.062	0.057
Education	0.084	0.082	0.076	0.068	0.080	0.072	0.066
Grocery	0.056	0.054	0.050	0.045	0.053	0.048	0.044
Health	0.071	0.069	0.064	0.058	0.068	0.061	0.056
Hotel/Motel	0.055	0.053	0.049	0.044	0.052	0.047	0.043
Industrial	0.064	0.062	0.058	0.052	0.061	0.055	0.050
Office	0.048	0.047	0.043	0.039	0.046	0.041	0.038
Restaurant	0.056	0.054	0.050	0.045	0.053	0.048	0.044
Retail	0.069	0.067	0.062	0.056	0.066	0.059	0.054
Warehouse	0.063	0.061	0.057	0.051	0.060	0.054	0.050

Air Cooled Demand Savings:

Air Cooled Chiller Demand Savings (kW/ton)		
Building Type	Chiller <150 tons	Chiller >= 150 tons
Misc. Commercial	0.094	0.106
Cold Storage	0.094	0.106
Education	0.038	0.042
Grocery	0.160	0.179
Health	0.122	0.137
Hotel/Motel	0.113	0.127
Industrial	0.094	0.106
Office	0.094	0.106
Restaurant	0.141	0.158
Retail	0.113	0.127
Warehouse	0.085	0.095

Measure Life
20 years (DEER)

13.2.2 VFD – Chilled Water/Condenser Water

Version Date & Revision History:
Draft date: March 4, 2016
Revision date: May 19, 2016

Referenced Documents:

- Energy and Peak Demand Impact Evaluation Report of the 2005-2007
- Demand Management Programs – KEMA (KEMA 2005-07).
- Econorthwest TRM Review – 6/23/10
- IECC 2006

TRM Review Actions:

- 6/23/10 Rec. #25 - Breakdown the savings by building types. Conduct additional research for future program years to calibrate claimed savings for Hawaii customer base – Adopted
- 10/5/11 – Currently Under Review.
- 3/4/16 – Added section for baseline efficiency description.

Major Changes:

- Energy savings separated into building type breakdown.
- 5/19/2016 – Added measure life

Measure Description: The installation of variable frequency drives on chilled and/or condenser water pumps used in HVAC systems.

Baseline Efficiency: The baseline efficiency for this measure is no a chilled water/condenser water motor/pump with no VFD. The pump/motor is assumed to be a 10 hp motor running at full power for 6000 hours per year.

Qualification

- Require pre-notification before projects begin.
- The program reserves the right to perform on-site verifications, both pre- and post-installation.
- Existing equipment must not have a VFD. (i.e. – incentives are not available for replacement)
- For existing facilities, motor hp must be between 3 and 100.
- For new facilities, motor hp must be between 3 and 50.
- The VFDs must actively control and vary the pump speed.

Energy and Demand Savings

Energy Savings = 902.7 kWh per HP
Demand Savings = 0.245 kW per HP

Measure Life:
15 years

HVAC Pump Motor VFD

DSMIS Values for All Commercial
kW = 0.245 per HP
kWh = 902.7 per HP

KEMA 2008 Values for All Commercial (HECO):
kW = none available
kWh = none available

Base Pump Motor Use:

Base HP =	10 HP	Example
Motor Efficiency =	92%	Estimated Typical
Average Load =	75%	Estimated Typical
HP to kW conversion =	0.746	
kW load = HP*0.746*% Load/eff =	6.1 kW	
Hours of operation =	6000 hours	Estimated
kWh Used Annually = kW load * Hours =	36,489	

Pump Motor Savings with VFD:

Energy Savings percentage =	24.74%	Needed to meet the kWh savings from DSMIS
kWh savings = % savings * kWh annual use =	9,027 kWh	
kW average savings = kWh savings/Hours =	1.50 kW	
kW savings = average kW savings * CF =	2.45 kW	Based on DSMIS value of 245 watts per HP
CF needed = kW savings (program) / kW average =	1.63	

13.2.3 VFD – AHU

Version Date & Revision History:
Draft date: March 4, 2016
Revision date: May 19, 2016

Referenced Documents:
- Energy and Peak Demand Impact Evaluation Report of the 2005-2007
- Demand Management Programs – KEMA (KEMA 2005-07).
- Econorthwest TRM Review – 6/23/10
- IECC 2006
- Evergreen TRM Review – 2/23/12

TRM Review Actions:
- 6/23/10 Rec. #25 - Breakdown the savings by building types. Conduct additional research for future program years to calibrate claimed savings for Hawaii customer base – Adopted
- 10/5/11 – Currently Under Review.
- 3/4/2016 – Added section for Baseline Efficiency description

Major Changes:
- Energy savings separated into building type breakdown.
- Updated energy and demand savings based on EM&V review.

Measure Description: The installation of variable frequency drives on fans used in HVAC systems.

Measure Life:
15 years

Baseline Efficiency: The baseline efficiency for this measure is an air-handling unit with no VFD. The AHU is assumed to be a 10 hp motor operating at full power for 3,720 hours per year.

Values for this measure are not called out in the KEMA report. The DSMIS values for this measure are 200 watts and 760.9 kWh per horsepower. The primary assumption used for the savings calculation is that the percentage savings of the energy used before the VFD is applied. This percent savings is shown in the calculations below as about 21%. Based on information from the EPRI Adjustable Speed Drive directory and comparing energy use for outlet damper, inlet damper and VFD controls the average savings for this profile would be 50% for replacement of an outlet damper and 33% for replacement of an inlet damper. See table below.

Percentage of Full Load Power				Power Savings %	
% Flow	Outlet Dampers	Inlet Dampers	VFD	Outlet Savings	Inlet Savings
100	111	109	105	6	4
90	107	93	73	34	20
80	104	82	57	47	25
70	99	75	44	55	31
60	94	69	32	62	37
50	87	65	21	66	44
40	80	63	14	66	49
30	72	60	8	64	52
			Average	**50**	**33**

Therefore, the 21% of base case savings used in to match the DSMIS values in the calculations below appears to be reasonable and possibly conservative. The actually savings for the customer will depend on many factors related to their type of building, system and hours of operation.

VFD AHU – Energy and Demand Savings:

Building Type	Hours	Demand Savings (kW/HP)	Energy Savings (kWh/HP)
Misc. Commercial	3,720	0.20	471.69
Cold Storage	6,389	0.20	810.12
Education	3,665	0.20	464.72
Grocery	6,389	0.20	810.12
Health	5,187	0.20	657.71
Hotel/Motel	3,719	0.20	471.57
Industrial	5,187	0.20	657.71
Office	6,192	0.20	785.14
Restaurant	4,155	0.20	526.85
Retail	3,261	0.20	413.49
Warehouse	6,389	0.20	810.12

Example Calculation:

HVAC Fan Motor VFD

DSMIS Values for All Commercial
kW = 0.200 per HP
kWh = 760.9 per HP

KEMA 2008 Values for All Commercial (HECO):
kW = none available
kWh = none available

Base Pump Motor Use:

Base HP =	10 HP	Example
Motor Efficiency =	92%	Estimated Typical
Average Load =	75%	Estimated Typical
HP to kW conversion =	0.746	
kW load = HP*0.746*% Load/eff =	6.1 kW	
Hours of operation =	3,720 hours	Estimated
kWh Used Annually = kW load * Hours =	22,623	22623.26

Pump Motor Savings with VFD:

Energy Savings percentage =	20.85%	Needed to meet the kWh savings from DSMIS
kWh savings = % savings * kWh annual use =	4,717 kWh	
kW average savings = kWh savings/Hours =	1.268 kW	
kW savings = average kW savings * CF =	2.0 kW	Based on DSMIS value of 200 watts per HP
CF needed = kW savings (program) / kW average =	1.58	

13.2.4 Garage Demand Ventilation Control

Version Date & Revision History:
Draft date: October 3, 2011

Referenced Documents:
- ASHRAE Standard 62
- International Mechanical Code
- Department of Health (DOH) Title 11 Chapter 39 (Air Conditioning and Ventilation)

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- New program offering.
- 11/22/11 – Under *Description,* the phrase "City Codes" was changed to "Codes" for accuracy.

Description:

Demand-controlled ventilation (DCV) using carbon monoxide (CO) sensing is a combination of two technologies: Sensors that monitor CO levels in the parking garage, and an air-handling system that uses data from the sensors to regulate the amount of ventilation air admitted. CO sensors continually monitor the air in a parking garage. Given a predictable activity level, automobiles will exhaust CO at a predictable level. Thus CO production in the parking garage will closely track activity. Given these two characteristics, a CO measurement can be used to measure and control the amount of outside air that is being introduced to dilute the CO generated by automobiles. The result is that ventilation rates can be measured and controlled to a specific cfm/ft2. This is in contrast to the traditional method of ventilating at a fixed rate regardless of occupancy.

City codes for enclosed parking areas require ventilation during all hours of operation to protect against an unhealthful build-up of carbon monoxide (CO). As a result, exhaust fans generally run 100% of operating hours. Although some buildings use timers to cut fan run time, it is important to note that the use of timers may not meet code compliance and health considerations. To achieve major energy savings and meet all health requirements, carbon monoxide sensors have now been authorized by code and mandated in some jurisdictions for new construction. Sensors measure CO levels, activating fans only when necessary to maintain CO at an acceptable level, saving upwards to 90% of energy cost.

Program Requirements:

1. Pre-notification before equipment is purchased and installed.
2. New construction is not eligible.
3. Incentive amount not to exceed 85% of installed Cost.
4. Failure of devices causes the exhaust fans to operate in the ON position

Energy and Demand Savings:
All assumptions, data and formulas used in the calculations must be clearly documented. Standard engineering principles must be applied, and all references cited. Pre and post monitoring will be conducted to determine measured energy and demand savings.

Savings Algorithms
Gross energy and demand savings estimates for custom projects are calculated using engineering analysis and project-specific details including pre and post monitoring. A physical fan motor audit will be performed as well as spot amperage checks and logging of pre and post operational times.

Baseline Efficiency
The baseline efficiency case assumes compliance with the efficiency requirements as mandated by the Hawaii State Energy Code or industry accepted standard practice.

High Efficiency
The high efficiency case is the installation of a parking garage ventilation demand control device utilizing carbon monoxide sensors.

Persistance Factor
PF = 1 since all custom projects require verification of equipment installation.

Notes

- Incentives is limited to 85% of incremental cost.
- Installations are subject to inspection for up to 5 years. Removal will be cause for incentive forfeiture.

Measure Life
8 years

Example

Zone	New Fan Tag	Fan Location	Old Fan Tag	HP	Measured kW		100% 8,760 hr/yr.	1.0% 88 hr/yr.	6/7 to 6/15	Notes			
1	GEF-1	1-B	PEF-2	10.0	7.2		63,072	631	100.0%	Data logger installed	7.5	0.3	96.5%
	GSF-1	1-B	PSF-4	5.0	3.4		29,784	298			3.7	0.3	91.2%
	GSF-2	1-B	PSF-4	5.0	3.4		29,784	298			3.7	0.3	91.2%
2	GEF-3	2-B	PEF-2	10.0	7.7		67,452	675			7.5	(0.2)	103.2%
	GSF-3	2-B	PSF-4	10.0	7.5		65,700	657	100.0%	Data logger installed	7.5	(0.0)	100.5%
3	GEF-6	3-B	PEF-2	10.0	7.4		64,824	648	99.9%	Data logger installed	7.5	0.1	99.2%
	GSF-4	3-B	PSF-2	10.0	7.4		64,824	648	100.0%	Data logger installed	7.5	0.1	99.2%
4	GEF-9	4-B	PEF-1	7.5	4.5		39,420	394	100.0%	Data logger installed	5.6	1.1	80.4%
	GEF-10	4-B	PEF-4	3.0	2.6		22,776	228			2.2	(0.4)	116.2%
5	GEF-7	4-A	PEF-1	7.5	4.5		39,420	394			5.6	1.1	80.4%
	GSF-5	4-A	PSF-3	7.5	5.8		50,808	508	100.0%	Data logger installed	5.6	(0.2)	103.7%
6	GEF-11	5-A	PEF-1	7.5	4.9		42,924	429			5.6	0.7	87.6%
	GSF-6	5-A	PSF-3	7.5	5.8		50,808	508	100.0%	Data logger installed	5.6	(0.2)	103.7%
7	GEF-13	6-A	PEF-2	10.0	7.5		65,700	657			7.5	(0.0)	100.5%
	GSF-7	6-A	PSF-3	7.5	5.0		43,800	438	100.0%	Data logger installed	5.6	0.6	89.4%
8	GEF-2	1-B	PEF-1	7.5	3.6		31,536	315			5.6	2.0	64.3%
	GEF-4	2-A	PEF-2	10.0	7.4		64,824	648			7.5	0.1	99.2%
	GEF-5	3-A	PEF-3	5.0	3.1		27,156	272			3.7	0.6	83.1%
	GEF-8	4-A	PEF-3	5.0	3.1		27,156	272			3.7	0.6	83.1%
	GEF-12	5-A	PEF-1	7.5	4.9		42,924	429	99.9%	Data logger installed	5.6	0.7	87.6%
	GEF-14	6-A	PEF-4	3.0	2.4		21,024	210			2.2	(0.2)	107.2%
TOTALS				**156.0**	**109.1** kW	Pre-Project	955,716	9,557			116.4	7.3	
			Coincidence Factor		1.0	Post-Project	(9,557)						
			On Peak Demand Savings		109.1 kW	Energy Savings per Year	946,159 kWh						

		109.1 kW			946,159 kWh/yr.
Demand Cost per Unit	$	12.60 /kW month	Energy Cost per Unit	$	0.21 /kWh
Demand Cost Savings	$	1,375 /month	Energy Cost Savings	$	200,586 /yr.
		12 months			
	$	16,496 /Year			

Incentive $ 0.18

Demand Cost Savings	$	16,496
Energy Cost Savings	$	200,586
	$	217,082 /yr.

Project Cost	**$ 152,323**
Incentive not to exceed 100% of project cost	**170,308.6**
Incentive	**152,323.0**

13.2.5 Package Unit AC

Version Date & Revision History:
Draft date: February 24, 2011

Referenced Documents:
- Econorthwest TRM Review – 6/23/10
- Econorthwest Email Correspondence – 1/23/12
- IECC 2006, pg. 34

TRM Review Actions:
- 6/23/10 Rec. #21 – Utilize IECC 2006 Efficiencies as the Baseline Efficiency and Efficient Packaged Unit 15% better than IECC 2006 – Adopted
- 6/23/10 Rec. #22 - Break down packaged AC savings based on equipment size. – Adopted
- 10/5/11 – Currently Under Review.

Major Changes:
- Package chiller unit AC efficiency selected at 15% improvement over IECC 2006.
- 12/12/11 – kW/ton and EER values updated to match IECC 2006 package unit values as per Econorthwest's direction, high efficiency numbers adjusted accordingly. Energy & demand savings updated accordingly.

Description: The replacement of package and split unit air conditioners with Energy Efficiency above the Hawaii Model Energy Code.

Measure Life:
15 years

Package Units

Unit Size (Btu/Hr.)	IECC 2006 Efficiency (kW/ton)	SEER/EER	Hawaii Energy Premium Efficiency (kW/ton)	SEER/EER
< 65,000	1.364	9.7 SEER	1.159	11.2 SEER
65,000 to 134,999	1.165	10.3 EER	0.990	11.8 EER
135,000 to 239,999	1.237	9.7 EER	1.052	11.2 EER
240,000 to 759,999	1.263	9.5 EER	1.074	10.9 EER
> 760,000	1.304	9.2 EER	1.109	10.6 EER

Energy Savings

Package Unit AC - 15% higher than IECC 2006 - Energy Reduction – kWh per ton

Building Type	< 65,000	65,001 to 135,000	135,001 to 240,000	240,001 to 760,000	> 760,000
Misc. Commercial	608.7	520.1	552.2	563.9	582.3
Cold Storage	1,045.4	893.2	948.5	968.4	1,000.0
Education	599.7	512.4	544.1	555.5	573.7
Grocery	1,045.4	893.2	948.5	968.4	1,000.0
Health	848.8	725.2	770.0	786.2	811.9
Hotel/Motel	608.5	519.9	552.1	563.7	582.1
Industrial	848.8	725.2	770.0	786.2	811.9
Office	1,013.2	865.7	919.2	938.6	969.2
Restaurant	679.9	580.9	616.8	629.8	650.3
Retail	533.6	455.9	484.1	494.3	510.4
Warehouse	1,045.4	893.2	948.5	968.4	1,000.0

Military Energy Savings = 559.5 kWh per ton (which is 1.5 times the residential AC values)

Demand Savings

Package Unit AC - 15% higher than IECC 2006 - Demand Reduction – kW per ton

Building Type	< 65,000	65,001 to 135,000	135,001 to 240,000	240,001 to 760,000	> 760,000
Misc. Commercial	0.061	0.052	0.056	0.057	0.059
Cold Storage	0.102	0.087	0.093	0.095	0.098
Education	0.041	0.035	0.037	0.038	0.039
Grocery	0.174	0.149	0.158	0.161	0.166
Health	0.133	0.114	0.121	0.123	0.127
Hotel/Motel	0.123	0.105	0.111	0.114	0.117
Industrial	0.102	0.087	0.093	0.095	0.098
Office	0.102	0.087	0.093	0.095	0.098
Restaurant	0.153	0.131	0.139	0.142	0.147
Retail	0.123	0.105	0.111	0.114	0.117
Warehouse	0.092	0.079	0.084	0.085	0.088

Military Demand Savings = 0.19 kW per ton

13.2.6 Inverter Variable Refrigerant Flow (VRF) Split Air Conditioning Systems

Version Date & Revision History:
Draft date: March 4, 2016

Referenced Documents:

- Evergreen TRM Review – 2/23/12
- Evergreen TRM Review – 1/15/14

TRM Review Actions:

- 10/5/11 – Currently Under Review.

Major Changes:

- Original TRM values was divided by .8 but have been corrected to be multiplied by 1.2 in order to obtain a 20% increase in efficiency.
- 3/4/2016 – added section for baseline efficiency description

Description: Inverter driven variable refrigerant flow (VRF) air conditioning systems are direct expansion AC systems that utilize variable speed evaporator/condenser fans, and a combination of fixed and variable speed compressors along with most often multiple individual zone evaporators to provide the ability to more closely match the AC system's output with the building's cooling requirements. Savings comes from:

- *Part Load Efficiencies*: Increased part-load efficiency operation
- *High Efficiency Motors*: Many systems use ECM motors
- *Higher Room Temperatures*: The capacity matching allows for better humidity control through longer cooling operation.
- *Reduction of Distribution Losses*: Duct losses are reduced with DX systems. This may be offset by dedicated outside air distribution systems when needed.

Payback Qualifications: VRF products need a payback requirement of 1 year or greater. The TRB/TRC must be greater than 1.

Baseline Efficiency: The baseline efficiency for this measure is defined as ***

Energy and Demand Savings: VRF systems have demonstrated a 20-30% reduction in energy consumption as compared to standard DX equipment. The energy savings and demand tables that follow provide the savings by building type and system size for VRF systems. These figures are conservatively determined to be 20% greater than provided by the "Standard" Package Unit AC measures that require EERs 15% greater than IECC 2006 requirements.

The VRF applications have been new construction projects with no ability to perform pre and post measurements. Hawaii Energy will perform field pre and post field measurements to determine the measure effectiveness in the local environment

Measure Life:
15 years

VRF Energy Savings per Ton

Building Type	< 65,000	65,001 to 135,000	135,001 to 240,000	240,001 to 760,000	> 760,000
Misc. Commercial	730.4	624.1	662.6	676.7	698.8
Cold Storage	1,254.5	1,071.8	1,138.2	1,162.1	1,200.0
Education	719.6	614.9	652.9	666.6	688.4
Grocery	1,254.5	1,071.8	1,138.2	1,162.1	1,200.0
Health	1,018.6	870.2	924.0	943.4	974.3
Hotel/Motel	730.2	623.9	662.5	676.4	698.5
Industrial	1,018.6	870.2	924.0	943.4	974.3
Office	1,215.8	1,038.8	1,103.0	1,126.3	1,163.0
Restaurant	815.9	697.1	740.2	755.8	780.4
Retail	640.3	547.1	580.9	593.2	612.5
Warehouse	1,254.5	1,071.8	1,138.2	1,162.1	1,200.0

VRF Demand Savings per Ton

Building Type	< 65,000	65,001 to 135,000	135,001 to 240,000	240,001 to 760,000	> 760,000
Misc. Commercial	0.074	0.063	0.067	0.068	0.070
Cold Storage	0.123	0.105	0.111	0.114	0.117
Education	0.049	0.042	0.045	0.045	0.047
Grocery	0.209	0.178	0.189	0.193	0.200
Health	0.160	0.136	0.145	0.148	0.153
Hotel/Motel	0.147	0.126	0.134	0.136	0.141
Industrial	0.123	0.105	0.111	0.114	0.117
Office	0.123	0.105	0.111	0.114	0.117
Restaurant	0.184	0.157	0.167	0.171	0.176
Retail	0.147	0.126	0.134	0.136	0.141
Warehouse	0.110	0.094	0.100	0.102	0.106

13.3 High Efficiency Water Heating

13.3.1 Commercial Solar Water Heating

Version Date & Revision History:
Draft date: May 30, 2011
Revision date: July 7, 2015

Referenced Documents:
- n/a

TRM Review Actions:
- 10/5/11 – Currently Under Review.
- 11/14/13 – more research should be done to determine typical baseline efficiencies for both standard electric resistance and heat pump water heaters.

Major Changes:
- July 7, 2015 – Changes EUL from 15 to 20 years to be consistent with residential SWH and historical data available through literature review

Measure Description:
Replacement of a Standard Electric Resistance Water Heater (SERWH) or heat pump with a Solar Water Heater. Solar equipment must comply with Solar Rating and Certification Corporation (SRCC) standards.

Baseline Efficiencies:
Baseline usage is a 0.9 COP Electric Resistance Water Heater or heat pump with a COP of 3.5.

The baseline water heater energy consumption is by a single 4.0 kW electric resistance element that is controlled thermostatically on/off controller based of tank finish temperature set point. The tank standby loss differences between baseline and high efficiency case are assumed to be negligible.

Energy Savings
Energy savings is based on the following commercial solar water heating worksheet.

COMMERCIAL SOLAR HOT WATER INCENTIVE WORKSHEET

Hawaii Energy, Efficiency Program • Program Year 2014

(Effective July 1, 2014)

Hawaii Energy

CUSTOMER INFORMATION

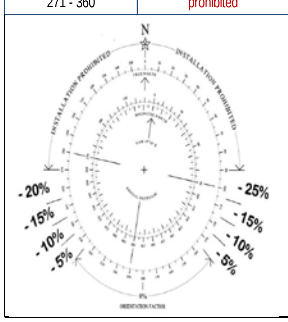
Customer Name:				Island:	Oahu	Application Number:	
Project Name:				T&D Loss Factor:	11.17%	Existing or New:	Existing
Storage Capacity:		# Tanks:		Design Finish Temp:		OG-100 Collector Rating (BTU):	
Panel Size (W x L):		# of Panels:		Total Cost of Project:		Existing System (electric / heat pump):	Electric
Building sq. ft.:		Year Built:		Installation Date:		Back-up Technology (gas / electric / heat pump):	Electric
Number of Units:		Num of Floors:		Building Type			

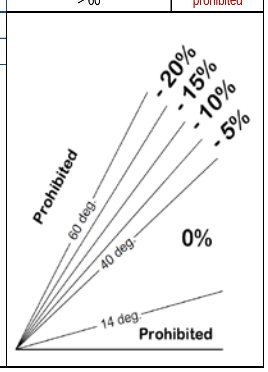
SOLAR INCENTIVE CALCULATION

	A	B	C	D		E	F	G		H	I		
Solar Panel Brand/Model	No. of Panels	Sun Zone	Panel rated Output BTU/Day	Total BTU D=A*C	N = New B=Burned out R=Retrofit	Orientation Factor	Tilt Factor	Total BTU Derating =(E*D+F*D)	Adjusted Solar Output =D-G BTU/Day	Adjusted Tons of Heating =H/K	Incentive factor		Incentive Amount =H*I
Example: SunEarth EC40	10	500	39,668	396,680	R	15%	5%	79,336	317,344	26.4	$250/ton	=	$6,611
		400		0	N - New	0%	0%	0	0	0.0	$250/ton	=	$ -
	0	300	0	0	N - New	0%	0%	0	0	0.0	$250/ton	=	$ -
								Total Adjusted Solar Output:	0			Total	$ -

SOLAR PANEL DERATING FACTORS

Collector Orientation	Derating	Collector Tilt	Derating
(Degrees True North)	(percent)	(degrees)	(percent)
0 - 89	prohibited	0 - 13	prohibited
90 - 115	25%	14 - 40	0%
105 - 115	10%	40 - 45	5%
115 - 125	5%	45 - 50	10%
125 - 225	0%	50 - 55	15%
225 - 235	5%	55 - 60	20%
235 - 245	10%	60	25%
245 - 255	15%	> 60	prohibited
255 - 270	20%		
271 - 360	prohibited		





Analysis

Impacts	kW	kWh/yr
Utility	0.67	#VALUE!
Customer	0.60	#VALUE!
Simple Payback (yrs)		#DIV/0!
TRB Ratio (TRB/Incremental Cost)		#VALUE!
* TRB Ratio must be ≥ 1		#VALUE!

Solar System Energy Production

Installed Capacity	-	Btu/day
Realized Annual Output	90%	
Annual Output	-	Btu/year

Existing System Energy Displaced

Energy Conversion	3,412	kWh/Btu
Electric Res. (COP 0.9)	-	kWh/Year
Heat Pump (COP 3.5)	-	kWh/Year
Additional Pump Energy	p	kWh/Year

Existing System On-Peak Demand Removed

	-	kWh/day
Electric Resistance Power	4.0	kW
Heat Pump Average Power		kW
Run Time	-	Hours / Day
On-Peak Fraction	15%	
On-Peak Energy	0.60	kW On-Peak

TRB Calculation Table — 6% Discount Rate

System Life	Year	$/kW/yr.	$/kWh/yr.	Utility Benefits NPV
1	2012	$ 280	$ 0.099	#VALUE!
2	2013	$ 306	$ 0.100	#VALUE!
3	2014	$ 339	$ 0.104	#VALUE!
4	2015	$ 353	$ 0.104	#VALUE!
5	2016	$ 371	$ 0.109	#VALUE!
6	2017	$ 383	$ 0.112	#VALUE!
7	2018	$ 386	$ 0.113	#VALUE!
8	2019	$ 388	$ 0.114	#VALUE!
9	2020	$ 389	$ 0.114	#VALUE!
10	2021	$ 392	$ 0.115	#VALUE!
11	2022	$ 391	$ 0.115	#VALUE!
12	2023	$ 395	$ 0.116	#VALUE!
13	2024	$ 398	$ 0.117	#VALUE!
14	2025	$ 397	$ 0.117	#VALUE!
15	2026	$ 401	$ 0.118	#VALUE!
		Total Resource Benefit (TRB):		#VALUE!

Cost of Base Alternative:	$ 1,000
Cost of Solar System:	$ -
Incremental Cost:	$ (1,000)
Energy Savings:	-
Marginal Energy Cost:	$ 0.38 /kWh
First Year Project Savings:	$ -

Requirement: Must comply with Solar Rating and Certification Corporation (SRCC) Standards

Questions: Call the Business Program 839-8880 (Oahu) or toll free at 877-231-8222 • www.hawaiienergy.com

Measure Life

20 years

13.3.2 Heat Pump

Version Date & Revision History:
Draft date: February 24, 2011

Referenced Documents:
- Evergreen TRM Review – 2/23/12

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- Adjust the assumptions so the description and calculations are consistent.

Measure Description
This measure relates to the installation of a heat pump water heater (HPWH) in place of a standard electric water heater. HPWHs can be added to existing domestic hot water (DHW) systems to improve the overall efficiency. HPWHs utilize refrigerants (like an air source heat pump) and have much higher coefficients of performance (COP) than standard electric water heaters. HPWHs remove waste heat from surrounding air sources and preheat the DHW supply system. HPWHs come in a variety of sizes and the size of HPWH will depend on the desired temperature output and amount of hot water needed by application. The savings from water heater heat pumps will depend on the design, size (capacity), water heating requirements, building application and climate. This measure could relate to either a retrofit or a new installation.

Definition of Efficient Equipment
In order for this characterization to apply, the efficient equipment is assumed to be a heat pump water heater with or without an auxiliary water heating system.

Definition of Baseline Equipment
In order for this characterization to apply, the baseline equipment is assumed to be a standard electric storage tank type water heater with a thermal efficiency of 98%. This measure does not apply to natural gas-fired water heaters.

Deemed Lifetime of Efficient Equipment
The expected measure life is assumed to be 10 years

Deemed Measure Cost
Due to the complexity of heat pump water heater systems, incremental capital costs should be determined on a case by- case basis. High capacity heat pump water heaters will typically have a supplemental heating source such as an electric resistance heater. For new construction applications, the incremental capital cost for this measure should be calculated as the difference in installed cost of the entire heat pump water heater system including any auxiliary heating systems and a standard electric storage tank water heater of comparable capacity. For retrofit applications, the total installed cost of heat pump water heater should be used.

Savings Algorithm

Heat Pump Water Heater

Energy per Day (BTU) = (Gallons per Day) x (lbs. per Gal.) x (Temp Rise) x (Energy to Raise Water

Hot Water needed per Person		13.3	Gallons per Day per Person	HE
Average Occupants	x	3.77	Persons	KEMA 2008
Household Hot Water Usage		50.1	Gallons per Day	
Mass of Water Conversion		8.34	lbs/gal	
Finish Temperature of Water		130	deg. F Finish Temp	
Initial Temperature of Water	-	75	deg. F Initial Temp	
Temperature Rise		55	deg. F Temperature Rise	
Energy to Raise Water Temp		1.0	BTU / deg. F / lbs.	
Energy per Day (BTU) Needed in Tank		12,000	BTU/Ton	
Energy per Day (BTU) Needed in Tank		12,000	BTU/Ton	
BTU to kWh Energy Conversion	÷	3,412	kWh / BTU	
Energy per Day (kWh)		3.5	kWh /Ton	
Days per Month	x	30.4	Days per Month	
Energy (kWh) per Month		107	kWh / Month	
Days per Year	x	365	Days per Year	
Energy (kWh) Needed in Tank to Heat Water per Year		1,283	kWh /Ton	
Elec. Res. Water Heater Efficiency	÷	0.98	COP	
Base SERWH Energy Usage per Year at the Meter		1,309	kWh /Ton	KEMA 2008 - HECO

Energy (kWh) Needed to Heat Water per Year		1,283	kWh /Ton	
Heat Pump Water Heating Efficiency	÷	3.50	COP	
Heat Pump Water Heating Energy Usage		367	kWh /Ton	
Base SERWH Energy Usage per Year at the Meter		1,309	kWh /Ton	
Heat Pump Water Heating Energy Usage	-	367	kWh /Ton	
Commercial Heat Pump Water Heating Savings		943	kWh /Ton	
Hours per Day		10		
Hours per Year		3,650		
Heat Pump Power Consumption		0.3	kW	
Coincedence Factor	x	0.08	cf	4.80 Minutes per hour
		0.02	kW On Peak	
Base SERWH Element Power Consumption		0.4	kW	
Coincidence Factor	x	0.143	cf	8.6 Minutes per hour
Base SERWH On Peak Demand		0.05	kW On Peak	KEMA 2008
Base SERWH On Peak Demand	-	0.05	kW On Peak	
Heat Pump Water Heater Demand	-	0.02	kW On Peak	KEMA 2008
		0.03	kW On Peak	

Commercial Solar Water Heater Demand Savings 0.03 kW Savings per Ton

13.4 High Efficiency Water Pumping

13.4.1 Domestic Water Booster Packages

Version Date & Revision History:
Draft date: May 23, 2011
Revision date May 19, 2016

Referenced Documents:
- The increased incentive was based on previous paid booster pump installations and measured energy/demand savings.
- The energy and demand impacts are based on HECO's evaluation from past projects and monitoring.

TRM Review Actions:
- 10/5/11 – Currently Under Review.
- Evergreen TRM Review – 1/15/14

Major Changes:
- Updated the TRM algorithm. Clarified energy savings to calculate per HP.
- 6/10/2016 – Removed incentive dollar values.

Description:
The purpose of this measure is to reduce energy consumption through more efficient domestic water booster systems by installing a VFD and/or reducing pump HP. Pump improvements can be done to optimize the design and control of water pumping systems. The measurement of energy and demand savings for commercial and industrial applications will vary with the type of pumping technology, operating hours, efficiency and current and proposed controls. Depending on the specific application, slowing the pump, trimming or replacing the impeller, or replacing the pump may be suitable options for improving pumping efficiency.

Base Efficiency
The baseline equipment is assumed to be a non-optimized existing pumping system. Baseline pumps are assumed to run 60% of the time.

High Efficiency
In order for this characterization to apply, the efficient equipment is assumed to be an optimized pumping system meeting applicable program efficiency requirements. The proposed Booster Pump System must be a more efficient design than the existing system. (i.e. Installed with VFD.). All pump motors must meet NEMA Premium Efficiency standards. As in the base case, enhanced pumps are assumed to run 60% of the time. Savings result from two aspects: (1) reduced horsepower and (2) reduced speed on the motor due to VFD. VFD load reduction is assumed to be 15% conservatively.

Qualification
Booster Pump applications require pre-notification before equipment is purchased and installed.
The new Booster Pump System's total horsepower must be equal to or less than that of the existing system.
The system horsepower reduction must be between 0 to 129 hp. For projects with greater than 129hp, please contact the program. Booster Pump applications do not apply to New Construction.

Measure Life:
15 years

Energy and Demand Savings:

Source of Savings *(per HP)*	Yearly kWh Reduction	kW Reduction
Reduced HP	3921	0.373
Installation of VFD	588	0.056

Savings Algorithm:

Domestic Water Booster Packages

REDUCED HP

Motor Energy Consumption		0.746	kW / hp
Run Time	x	8760	hrs / year
Percent Run Time	x	60%	percent run / day
Yearly Savings per HP Reduction		3921	Total kWh savings / hp / year
		3921	**kWh Reduction / HP / Year**
Demand Savings per HP		0.746	kW savings per hp
Coincidence Factor	x	50%	peak coincidence factor
Peak Demand Savings		0.373	kW savings per hp during peak hour *(5 p.m. to 9 p.m.)*
		0.373	**Peak kW Reduction / HP**

INSTALLATION OF VFD

Motor Energy Consumption		0.746	kW / hp	
Percent Load Reduction with VFD	x	15%	percent load reduction	
Demand Savings per HP		0.112	kW savings per hp	
Run Time	x	8760	hrs / year	
Energy Savings per hp with VFD		980.24	kWh savings / hp / year	
Percent Run Time	x	60%	pump percent run time	
Total Energy Savings per hp with VFD		588	Total kWh savings / hp / year	EM&V review comments recommend 500 - 700 kWh savings (Feb. 23, 2012)
		588.15	**kWh Reduction / HP / Year**	
Demand Savings per HP		0.112	kW savings per hp	
Coincidence Factor	x	50%	peak coincidence factor	
Peak Demand Savings		0.056	kW savings per hp during peak hour *(5 p.m. to 9 p.m.)*	
		0.056	**Peak kW Reduction / HP**	

13.4.2 VFD Pool Pump Packages

Version Date & Revision History:
Draft date: February 24, 2010

Referenced Documents:
- n/a

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- 12/15/11 – Updated algorithm average pump size from 1.5 HP pump to 1 HP pump. Updated baseline and high efficiency calculations accordingly.

Measure Description
A variable speed commercial pool pump motor in place of a standard single speed motor of equivalent horsepower.

Definition of Efficient Equipment
The high efficiency equipment is a variable speed commercial pool pump.

Definition of Baseline Equipment
The baseline efficiency equipment is assumed to be a single speed commercial pool pump.

$$\Delta kWh = (kWBASE \times Hours) \times 55\%$$

Where:

Unit	= 2-speed or variable speed pool pump
ΔkWh	= Average annual kWh reduction
Hours	= Average annual operating hours of pump
kWBASE	= connected kW of baseline pump
55%	= average percent energy reduction from switch to 2-speed or variable speed pump (1)

Baseline Efficiency
The baseline efficiency case is a single speed pump.

High Efficiency
The high efficiency case is a 2-speed or variable speed pump.

Energy and Demand Savings
Demand Savings: 0.093 kW / HP
Energy Savings: 1123 kWh per year / HP

(1) Davis Energy Group (2008). Proposal Information Template for Residential Pool Pump Measure Revisions. Prepared for Pacific Gas and Electric Company; Page 2.

Savings Algorithm

Commercial Pool Pump

Pool Pump Horesepower	1	HP
Efficiency	0.8	
Hours of operation per day	6	hours
Number of days pool in use	365	days per year
1 HP Equals	0.746	kW

Baseline

Pump Size		1.00	HP
kW / HP	x	0.75	kW / HP
		0.75	kW
Efficiency	÷	0.80	
Based Demand		0.93	kW
Hours of operation	x	6	hours/day
Base Energy Usage per day		5.60	kWh/day
Base Energy Usage per year		2042	kWh/year

High Efficiency

Base Demand	0.93	kW
Demand Reduction	10%	
High Efficiency Demand	0.839	kW
Base Energy Usage	2042	kWh/year
Energy Reduction	55%	
High Efficiency Energy Usage	919	kWh/year

Demand Savings	**0.093**	**kW per HP**

Energy Savings per year	**1123**	**kWh/year per HP**

Deemed Lifetime of Efficient Equipment

The estimated useful life for a variable speed pool pump is 10 years.

Deemed Measure Cost

The incremental cost is estimated to be $350 for a two speed motor and $1,500 for a variable speed motor

Incremental Cost

$161 per motor. – (from: 2001 DEER Update Study, CCIG-CRE-02, p. 4-84, Xenergy, Oakland, CA.

13.5 High Efficiency Motors

13.5.1 CEE Tier 1 Listed Premium Efficiency Motors

Version Date & Revision History:
Draft date: March 2, 2011

Referenced Documents:

- n/a

TRM Review Actions:

- 10/5/11 – Currently Under Review.

Major Changes:

- 11/22/11 – Removed the following sentence from *Measure Description*: "Therefore, this measure should be suspended at that time."

Measure Description
This measure relates to the installation of premium efficiency three phase Open Drip Proof (ODP) and Totally Enclosed Fan-Cooled (TEFC) motors less than or equal to 200 HP, meeting minimum qualifying efficiency for the following HVAC applications: supply fans, return fans, exhaust fans, chilled water pumps, and boiler feed water pumps. On December 9, 2010, new federal efficiency standards will take effect requiring motors in this size category to meet National Electric Manufacturers Association (NEMA) premium efficiency levels.

- Incentives apply to both ODP and TEFC enclosures with 1200 RPM, 1800 RPM or
- 3600 RPM motors.
- Motors must meet minimum efficiency requirements as shown in the Motor Incentive Reference Table on the CEE Premium Efficient Motors list available at www.cee1.org.
- Motors greater than 200 hp will be given consideration under the Hawaii Energy Customized Program
- If motors are not listed on the CEE website, submit manufacturer specifications, motor curve and performance data to Hawaii Energy for consideration

Baseline
2007 EISA nominal efficiency (as defined in NEMA MG1 Table 12-12) motors.

High Efficient Condition
The CEE Motors List includes motors that are 1-200 hp NEMA Design A/B, 460 volts, TEFC or ODP and 1200rpm, 1800 rpm, or 3600 rpm.

Energy Savings
Based on per HP

Demand Savings	0.0283 kW
Energy Savings	46.4 kWh/year

Savings Algorithm

$$\Delta kWh = HP \times 0.746 \times ((1/\eta BASE)-(1/\eta EE)) \times LF \times HOURS$$

Where:

HP	= Motor Horse Power
	= Actual installed
ηBASE	= Efficiency of baseline motor. Based on EPACT 92 for installed HP
ηEE	= Efficiency of premium efficiency motor
	= Actual installed
LF	= Load factor of motor = 0.75
HOURS	= Annual motor run hours

1	HP	equals	0.746 kW
Hours of Operation		6 per day	
Hours of Operation		2190 per year	
Load Factor		0.75	

Demand	0.746 kW
Base Efficiency	80%
Base Demand	0.933 kW
Base Energy	1531.6 kWh/year
Demand	0.746 kW
High Efficiency	82.50%
High Efficiency Demand	0.904 kW
High Efficiency Energy	1485.2 kWh/year

Demand Savings	0.0283 kW
Energy Savings	46.4 kWh/year

Measure Life
15 years

Incremental Cost
1 to 5HP ($35.20 per HP)
7.5 to 20HP ($17.30 per HP)
25 to 100HP ($10.28 per HP)
125 to 250HP ($5.95 per HP)

13.5.2 Refrigeration – ECM Evaporator Fan Motors for Walk-in Coolers and Freezers

Version Date & Revision History:
Draft date:

Referenced Documents:

- 2007 Arkansas Deemed Savings Quick Start Programs
  http://www.aepefficiency.com/oklahoma/ci/downloads/Deemed_Savings_Report.pdf

TRM Review Actions:

- 10/5/11 – Currently Under Review.

Major Changes:

- n/a

Measure Description:
An electronically commutated motor (ECM) is a fractional horsepower direct current (DC) motor used most often in commercial refrigeration applications such as display cases, walk-in coolers/freezers, refrigerated vending machines, and bottle coolers. ECMs generally replace shaded pole (SP) motors and offer at least 50% energy savings. Analysis efforts summarized in this report focused on the most prevalent use of ECMs – refrigeration, where motor sizes are typically listed in watts (10-140 W).

Measure/Technology Review
Five of the primary data sources reviewed for this effort contained data for ECMs in refrigeration and HVAC applications. The NPCC study gave savings estimates for upgrading a CAV box single speed motor to an ECM. The other four studies gave wide ranging savings and cost data for compressor, condenser, and evaporator fan motors. KW Engineering completed a study for PacifiCorp in October of 2005 regarding the market for ECMs in walk-in refrigerators (kW Engineering, 2005). This study included the market share in each state for refrigeration ECMs as well as cost and energy savings data. These values for energy and demand savings are given in Table 1 below.

Measure Information Available	Resource	Application	Annual Energy Savings[1] (kWh/unit)	Demand Savings[1] (kW/unit)
Yes	Ecotope 2003	Small Evaporator Fan ECM	200	-
Yes	PG&E 2003	Evaporator Fan	673	0.077
Yes	Stellar Processes 2006	Small Evaporator Fan ECM	200	-
No	Xcel Energy 2006			
No	Quantec 2005			
No	DEER			
No	KEMA 2006			
Yes	CEE	Evaporator Fan – Freezer Condenser Fan – Freezer Compressor Fan – Freezer Evaporator Fan – Refrigerator Condenser Fan – Refrigerator Compressor Fan - Freezer	115 141 985 294 141 690	0.013 0.016 0.112 0.034 0.016 0.079
No	Energy Star			
No	RTF			
Yes	NPCC 2005	CAV Box	517	0.397
Yes	kW Engineering 2005	Evaporator Fan	734	0.084

[1] Savings values reflect gross savings at the customer meter

Table 1

Baseline Efficiencies:
The standard motor type for this application is a shaded pole (SP) motor. Table 2 contains the baseline annual energy consumption and demand for ECM equivalent SP motors.

Table 2 (Baseline Efficiency)

Measure	Annual Energy Consumption	Demand
Shaded Pole (SP) motor	18 kWh/W	0.002 kW/W

Minimum Requirements/High Efficiency
Any ECM up to 1 hp in size will meet the minimum requirements for both retrofit and new construction installations. Table 3 contains the estimated annual energy consumption, demand, and cost for the ECM application.

Table 3 (High Efficiency)

Measure	Annual Energy Consumption	Demand
ECM	8.7 kWh/W	0.001 kW/W

Energy Savings:

Annual Energy Savings	Demand Savings
9.3 kWh/W	0.001 kW/W

Savings Algorithms

Deemed demand and energy savings should be calculated by the following formulas for Refrigeration applications:

kW savings = Rated Wattage x (kW/Wpre - kW/Wpost)
kWh savings = Rated Wattage x (kWh/Wpre – kWh/Wpost)

Where:

Rated Wattage =	Rated Wattage of the electronically commutated motor
kW /W pre =	Demand of the existing electronically commutated motor. If unavailable, demand listed in Table 2 should be used
kW /W post =	Demand of the new electronically commutated motor. If unavailable, demand listed in Table 3 should be used
kWh /W pre =	Annual energy consumption of the existing electronically commutated motor. If unavailable, annual energy consumption listed in Table 2 should be used
kWh /W post =	Annual energy consumption of the new electronically commutated motor. If unavailable, annual energy consumption listed in Table 3 should be used

Lifetime
DEER – 15 years

13.5.3 EC Motors – Fan Coil Units

Version Date & Revision History:
Draft date:

Referenced Documents:
- n/a

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- n/a

Measure Description: Electronically commutated motors provide clear advantages over AC or conventional DC motors in terms of service life, controllability, flexibility, and cost-effectiveness.

For the past 30 years, forward-bladed centrifugal fans in fan coil-units have been driven by AC motors, which are typically around 45% efficient. However, the latest electronically commutated (EC) motors are 80% efficient, leading to significant operational benefits. The term EC is applied to a DC motor having electronic commutation achieved with a microprocessor.

Commutation means applying a current to the motor phases to produce the best torque at the motor's shaft. In brush-type motors, commutation is done electromechanically using graphite brushes and a commutator. In brushless motors, however, it is achieved by switching electronics using rotor-position information obtained by sensors. Thus, the EC motor is essentially a DC motor that can be connected direct to an AC mains supply.

Baseline Efficiencies:

BASE CASE		
Base demand 4 pole (1800 rpm)	107	watts

High Efficiency:

ENHANCED CASE		
High efficiency DC/EC demand	54	watts

The major advantage of EC motors over their AC counterparts is far higher efficiency, which enables a fan-coil unit to achieve a specific fan power (SFP) of 0.3 compared with 0.8 for an AC motor (the limit in the latest Building Regulations is 0.8 W/l/s).

This higher efficiency can be maintained at low speeds, so less motor heat is absorbed by the cold air discharged from the FCU, which in turn leads to more cooling applied in the space. Lower temperatures increase motor life, and in-built soft starting gives longer bearing life.

Speed control is simple, and results in impressive energy saving performance. The maximum cooling load on an FCU may only apply for 500 hour out of a total annual running time of 3,000 hour. With a typical fan coil unit, the fans deliver more air than necessary for 2500 hour/year — a shocking waste of energy.

By using the temperature controller on an FCU to reduce the speed of the EC motor during periods of reduced cooling demand, we can cut energy wastage dramatically. For example, an annual fan energy consumption of 620 kWh can be reduced to 140 kWh using speed control.

The reduction of air volume is, however, limited by considerations of the room air distribution. That is why we recommend that tests are undertaken in a suitable test facility to determine the optimum range of air volume.

Energy Savings:

ENERGY SAVINGS		
Energy savings 4 pole	232	kWh/year

PEAK DEMAND SAVINGS (5PM-9PM)		
Coincidence factor	0.5	
Peak demand savings (4 pole)	0.0265	kW

Electronically commutated motors offer six major benefits when used in fan-coil units.

- High efficiency of 85%, leading to lower input power.
- Lower rise in air temperature on the air stream.
- Efficient speed control.
- Longer motor life resulting from lower running temperatures.
- Longer bearing life because of the soft-start feature.
- Suitable for a 230 V supply.

By considering a typical 2 fan, fan coil unit providing 190l/s of air against an external resistance of 30Pa, from the testing undertaken by Caice the following figures were derived:

- 4 pole AC Motor Fan Unit powered by 2 off fans energy consumed = 107 watts, sfp 0.55 = w/l/s
- DC/EC Motor Fan Unit powered by 2 off fans energy consumed = 54 watts, sfp = 0.28 w/l/s.

Savings Algorithms

BASE CASE		
Base demand 4 pole (1800 rpm)	107	watts
ENHANCED CASE		
High efficiency DC/EC demand	54	watts
DEMAND SAVINGS		
Demand savings 4 pole	53	watts
hours of operation	12	hours/day
hours of operation	4380	hours/year
ENERGY SAVINGS		
Energy savings 4 pole	232	kWh/year
PEAK DEMAND SAVINGS (5PM-9PM)		
Coincidence factor	0.5	
Peak demand savings (4 pole)	0.0265	kW

Operating Hours
4,380 hours/year (12 hours/day)

Demand Coincidence Factor
0.5

Lifetime
15 years

13.6 Commercial Industrial Processes

13.6.1 Demand Control Kitchen Ventilation (DCKV)

Version Date & Revision History:
Draft date:

Referenced Documents:
- Detailed Energy Savings Report, Melink Corporation, http://www.melinkcorp.com/Intellihood/Energy_Analysis.pdf

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- n/a

Measure Description:
Kitchen ventilation with DCKV hood exhaust. Demand ventilation uses temperature and/or smoke sensing to adjust ventilation rates. This saves energy comparing with the traditional 100% on/off kitchen ventilation system.

Baseline Efficiencies:
Kitchen ventilation without DCKV. Usage per HP:

Basecase = (HP x .746 KW/HP x Hours per Year)/efficiency

Basecase fan motor usage per HP (kWh/year)	4827
Basecase fan motor demand (kW)	0.83

High Efficiency:

Usage per HP:

Enhanced case fan motor usage per HP (kWh/year)	2194
Enhanced case fan motor demand (kW)	0.38

Energy Savings:
The demand control kitchen ventilation savings were determined using the method described in the Melink Detailed Energy Savings Report.

Energy Savings from fan motor per HP (kWh/year)	2633
Demand Savings from fan motor per HP (kW)	0.45

Savings Algorithms

% Rated RPM	% Run Time	Time HRS/YR	Output KW/HP	System Efficiency	Input KW/HP	KWH/HP/YR
H	I	J=GXI	K	L	M=K/L	N=JXM
100	5%	291.2	0.746	0.9	0.829	241
90	20%	1164.8	0.544	0.9	0.604	704
80	25%	1456	0.382	0.9	0.424	618
70	25%	1456	0.256	0.9	0.284	414
60	15%	873.6	0.161	0.9	0.179	156
50	10%	582.4	0.093	0.9	0.103	60
40	0%	0	0.048	0.9	0.053	0
30	0%	0	0.02	0.9	0.022	0
20	0%	0	0.015	0.9	0.017	0
10	0%	0	0.01	0.9	0.011	0
Total kWh/HP/YR						**2194**

Basecase = (HP x .746 KW/HP x Hours per Year)/efficiency

Basecase fan motor usage per HP (kWh/year)	4827
Basecase fan motor demand (kW)	0.83

Enhanced case fan motor usage per HP (kWh/year)	2194
Enhanced case fan motor demand (kW)	0.38

Energy Savings from fan motor per HP (kWh/year)	2633
Demand Savings from fan motor per HP (kW)	0.45

Operating Schedule	
16	HR/DAY
7	DAY/WK
52	WK/YR
5824	

Demand Coincidence Factor
TBD

Persistence
TBD

Lifetime
15 Years (Hawaii Energy assumption)

Measure Costs
Measure Cost: $1,200 - $1,700 per HP based on business vertical and site complications (provided my Melink)

13.6.2 Refrigeration – Cooler Night Covers

Version Date & Revision History:
Draft date: March 4, 2016

Referenced Documents:

- CL&P Program Savings Documentation for 2011 Program Year (2010). Factors based on Southern California Edison (1997). Effects of the Low Emissive Shields on Performance and Power Use of a Refrigerated Display Case.
- Energy & Resource Solutions (2005). Measure Life Study. Prepared for the Massachusetts Joint Utilities; Page 4-5 to 4-6.

TRM Review Actions:

- 3/4/2016 – TRM entry is missing section for "TRM Review Actions"

Major Changes:

- 3/4/2016 – Added section for TRM Review Actions

Measure Description:
Installation of retractable aluminum woven fabric covers for open-type refrigerated display cases, where the covers are deployed during the facility unoccupied hours in order to reduce refrigeration energy consumption.

Baseline Efficiencies:
The baseline efficiency case is the annual operation of open-display cooler cases.

High Efficiency:
The high efficiency case is the use of night covers to protect the exposed area of display cooler cases during unoccupied hours.

Energy Savings:
ΔkWh = (Width)(Save)(Hours)
ΔkW = (Width)(Save)

Where:

Width = Width of the opening that the night covers protect (ft)
Save = Savings factor based on the temperature of the case (kW/ft) – see table below
Hours = Annual hours that the night covers are in use.

Cooler Case Temperature	Savings Factor
Low Temperature (-35 to -5 F)	0.03 kW/ft
Medium Temperature (0 F to 30 F)	0.02 kW/ft
High Temperature (35 F to 55 F)	0.01 kW/ft

Operating Hours
Hours represent the number of annual hours that the night covers are in use, and should be determined on a case-by-case basis.

Demand Coincidence Factor
Coincidence factors are set to zero since demand savings typically occur during off-peak hours

Lifetime
10 years

Eligibility

- Must install a cover on an existing open refrigerated display case to decrease its cooling load during off hours.
- The equipment manufacturer must not object to the use of night covers for the existing display case model.
- This incentive is based on linear footage of the installed night cover.
- The cover must be applied for a period of at least six hours.

Measure Costs

13.7 Building Envelope Improvements

13.7.1 Window Tinting

Version Date & Revision History:
Draft date: March 4, 2016

Referenced Documents:
- Basis for a Prescriptive Window Film Rebate Program (Attachment G) prepared for HECO (XENERGY Inc.) November 5, 1999

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- Rebate increased from $0.35 to $1.00 per square foot
- Changed from 0.4 shading coefficient (SC) to 0.5 SC
- 3/4/2016 – added section for baseline efficiency description

Description:

- *Warranty* – Film must have a minimum five-year manufacturer's warranty and one-year installer's warranty
- *Conditioned Space* – Rebates shall be paid on actual square footage of glass in a conditioned space
- *Eligible Types* – Windows may be clear or factory tinted, single or double pane, but must not have reflected glass. All orientations are eligible.
- *Unshaded* – Windows significantly shaded by buildings, trees or awnings are not eligible for rebates.
- *Replacement Film* – Replacement of deteriorated window film is eligible for 50% of the rebate if the customer did not receive a rebate for the existing film.

Equipment Qualifications:

- Shading Coefficient < 0.5
- Solar Heat Gain Coefficient (SHGC) < 0.435
- SC = 0.87*SHGC
- Replacement of deteriorated window film is eligible for 50% of the incentive if the customer did not receive an incentive from the existing window film. The incentive will be rounded up.

Baseline Efficiency:

The baseline efficiency for this measure is no window tinting.

Energy and Demand Savings:

Savings	Hotel	Office	Other	Average
Energy Savings (kWh/ft2)	5.6	4.5	4.5	**4.9**
Demand Savings (kW/ft2)	0.0014	0.0008	0.0016	**0.0013**

Persistence Factor

1.0

Coincidence Factor

1.0

Lifetime

10 years (DEER)

13.7.2 Cool Roof Technologies

Measure ID:

Version Date & Revision History:
Draft date:
Revision date:

Referenced Documents:
- Evergreen TRM Review – 2/23/12
- (1) Maximum value to meet Cool Roof standards under California's Title 24
- (2) Itron. 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study. December 2005.
- (3) 2008 Database for Energy-Efficiency Resources (DEER), Version 2008.2.05, "Effective/Remaining Useful Life Values",California Public Utilities Commission, December 16, 2008
- (4) 2005 Database for Energy-Efficiency Resources (DEER), Version 2005.2.01, "Technology and Measure Cost Data",California Public Utilities Commission, October 26, 2005
- (5) Coincidence factor supplied by Duke Energy for the commercial HVAC end-use. Pending verification based on information from the utilities.

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- n/a

Description
This section covers installation of "cool roof" roofing materials in commercial buildings with mechanical cooling. The cool roof is assumed to have a solar absorptance of 0.3(1) compared to a standard roof with solar absorptance of 0.8(2). Energy and demand saving are realized through reductions in the building cooling loads. The approach utilizes DOE-2.2 simulations on a series of commercial prototypical building models. Energy and demand impacts are normalized per thousand square feet of roof space.

Definition of Efficient Equipment
The efficient condition is a roof with a solar absorptance of 0.30.

Definition of Baseline Equipment
The baseline condition is a roof with a solar absorptance of 0.80.

Deemed Lifetime of Efficient Equipment
The expected lifetime of the measure is 15 years.

Deemed Measure Cost
The full installed cost for retrofit applications is $8,454.67 per one thousand square feet (4).

Deemed O&M Cost Adjustments
There are no expected O&M cost adjustments for this measure.

Coincidence Factor
The coincidence factor (CF) is 0.50.

Energy Savings
ΔkWh = SF / 1000 * ΔkWhkSF
ΔkWh = 0.25 kWh / square feet

Demand Savings
ΔkW = ΔkW x CF

Demand Savings per square feet

ΔkW = 0.0001/SF * 0.50
ΔkW = 0.00005 kW

Baseline Adjustment
There are no expected future code changes to affect this measure.

Deemed O&M Cost Adjustment Calculation
There are no expected O&M costs or savings associated with this measure.

Unit energy, demand, and gas savings data is based on a series of prototypical small commercial building simulation runs.

13.8 Energy Star Business Equipment

13.8.1 Refrigerators w/Recycling

Version Date & Revision History:
Draft date: February 24, 2010

Referenced Documents:
- HECO DSM Docket – Backup Worksheets - Global Energy (07-14-06)
- Econorthwest TRM Review – 6/23/10
- Department of Energy Refrigerator Profile – Updated December 2009

TRM Review Actions:
- 6/23/10 Rec. # 11 – Revise savings to be consistent with ENERGY STAR estimates. – Adopted with modifications on refrigerator figures based on DOE Refrigerator profile and the addition of bounty, recycle with new figures.
- 6/23/10 Rec. # 12 – Split the claimed savings by appliance. – Adopted.
- 6/23/10 Rec. # 14 – Revise demand savings values for ENERGY STAR appliances – Adopted.
- 10/5/11 – Currently Under Review.

Major Changes:
- Split between ESH appliances
- Incorporation of three refrigerator categories (new, new with turn in, and bounty (turn in only))
- All ESH 313 kWh and 0.12 kW changed to:
  - New ES Refrigerator Only – 105 kWh, .017 kW
  - New ES Refrigerator with Turn-In – 822 kWh, .034 kW

Measure Description:
The replacement of standard Refrigerators for business locations.

Appliances must comply with:
- Energy Star

Refrigerators – ENERGY STAR refrigerators utilize improvements in insulation and compressors.

Baseline Efficiencies:
Baseline energy usage based on 2009 Energy Star Information for the appliances are as follows:

	Demand Baseline (kW)	Energy Baseline (kWh)	Notes
Non ES Qualifying Refrigerator		537	19.0-21.4 Top Freezer

High Efficiency:

The high efficiency case Energy Star energy usage based on 2009 Energy Star Calculator Information and DOE Refrigerator Market Profile for the appliances is as follows:

	Demand High Efficiency (kW)	Energy High Efficiency (kWh)	Notes
ES Qualifying Refrigerator		435	19.0-21.4 Top Freezer

Energy Savings:

Energy Star Appliance Gross Savings before operational adjustments:

	Demand Savings (kW)	Energy Savings (kWh)
ES Refrigerator	0.017	105
ES Refrigerator with Turn-In	0.034	822

Energy Star Appliance Net Savings operational adjustments:

Operational Factor	Adjustment Factor
Persistence Factor (pf)	1.0
Demand Coincidence Factor (cf)	1.0

Savings Algorithms

Energy Star Refrigerator and Turn In Refrigerator - Single and Multi Family Residential Home

Opportunity		Energy Usage		
New Non-ENERGY STAR		540		Table 2
New ENERGY STAR Refrigerator	-	435		Table 2
		105	kWh/Year	Table 1
#1 - Purchase of ENERGY STAR Refrigerator		105		Table 1
#2 - Removal of Old Unit from Service (off the grid)	+	717		Table 1
#1 + #2 = Purchase ES and Recycle old unit		822	kWh/Year	

	Energy Usage	Ratio	Contribution		
Post-1993 Refrigerator	640	55%	354.54		Table 3
Pre-1993 Refrigerator	1,131	45%	504.46		Table 3
			859	kWh/Year	

Table 1

Energy Savings Opportunities for Program Sponsors

Opportunity	Annual Savings			
	Per Unit		Aggregate U.S. Potential	
	kWh	$	MWh	$ million
1. Increase the number of buyers that purchase ENERGY STAR qualified refrigerators. • 9.3 million units were sold in 2008. • 70 percent were not ENERGY STAR. • 6.5 million potential units per year could be upgraded.	105	11.64	675,928	75
2. Decrease the number of units kept on the grid when new units are purchased. • 8.7 million primary units were replaced in 2008. • 44 percent remained in use, whether they were converted to second units, sold, or given away. • 3.8 million units are candidates for retirement every year.	717	79.53	2,746,062	305
3. Decrease the number of second units. • 26 percent of households had a second refrigerator in 2008. • 29.6 million units are candidates for retirement.	859	95.28	25,442,156	2,822
4. Replace pre-1993 units with new ENERGY STAR qualified models. • 19 percent of all units in use in 2008 were manufactured before 1993. • 27.3 million total potential units are candidates for targeted replacement.	730	81	19,946,440	2,212

Sources: See endnote 10.

Table 2

Energy and Cost Comparison for Upgrading to ENERGY STAR

Purchase Decision	New Non-ENERGY STAR Qualified Refrigerator	New ENERGY STAR Qualified Refrigerator
Annual Consumption	540 kWh	435 kWh
	$60	$48
Annual Savings	–	105 kWh
	–	$12
Average Lifetime	12 years	12 years
Lifetime Savings	–	1,260 kWh
	–	$140
Price Premium	–	$30 - $100
Simple Payback Period	–	3-9 years

Note: Calculations based on shipment-weighted average annual energy consumption of 2008 models. An ENERGY STAR qualified model uses 20 percent less energy than a new non-qualified refrigerator of the same size and configuration.

Source: See endnote 10.

Table 3

Energy and Cost Comparison for Removing a Second Refrigerator from the Grid

Fate of Unit	Post-1993 Unit		Pre-1993 Unit	
	Remains on the Grid	Removed from the Grid	Remains on the Grid	Removed from the Grid
Annual Consumption	640 kWh	–	1,131 kWh	–
	$71	–	$125	–
Annual Savings	–	640 kWh	–	1,131 kWh
	–	$71	–	$125
Average Lifetime*	6	–	6	–
Lifetime Savings*	–	3,840 kWh	–	6,788 kWh
	–	$426	–	$753
Removal Cost	–	$50 - $100	–	$50 - $100
Simple Payback Period	–	1-2 years	–	<1 year

*Assumes unit has six years of functionality remaining.

Sources: See endnote 10.

Operating Hours
Refrigerators = 8,760 hours per year

Loadshape
TBD

Freeridership/Spillover Factors
TBD

Demand Coincidence Factor
NA

Persistence
NA

Lifetime
14 years

Measure Costs and Incentive Levels

Residential Measure Costs and Incentive Levels

Description	Unit Incentive	Incremental Cost HECO DSM Docket 2006	Average Incremental Cost Energy Star 2009
ES Refrigerator	$50	$ 60.36	$ 65
ES Refrigerator w/turn in	$125		$130*

***Estimated value**

13.9 Energy Awareness, Measurement and Control Systems

13.9.1 Condominium Submetering

Version Date & Revision History:
Draft date: March 4, 2016

Referenced Documents:

- n/a

TRM Review Actions:

- 10/5/11 – Currently Under Review.

Major Changes:

- 3/4/2016 – added measure description and equipment qualifications

Measure Description:
This program is to assist master-metered condominiums and their Association of Apartment Owners (AOAO) efforts to reduce energy consumption and implement the current submetering proposal as one that will insure both equity and fairness in allocating energy costs as well as encouraging energy conservation through direct feedback of personal energy use to tenants.

The combination of billing submeters, along with education, peer group comparisons and special equipment offerings, will assist the tenant achieve significant energy conservation and efficiency.

Equipment Qualifications:
The manufacturer's submetering system model type to be installed (meter and CTs) must have been tested by an independent third party that is Nationally Rated Testing Laboratory certified for ANSI C12.1. The certification documentation must be provided to the Program prior to installation. Additionally, manufacturers must have a factory-quality compliance procedure in place to ensure meter accuracy. Documentation of this procedure must be available to the Program upon request. The submeter must be UL, CSA or ETL listed (Electrical Safety).

Requirements:

- The metering system must remain in place and billing to occur for a period of at least five (5) years or a pro-rated portion of the incentive will be recovered by Hawaii Energy. Provide Hawaii Energy with energy meter data for analysis purposes.

- A joint educational and monitoring program will be undertaken with AOAO to assist in the verification of savings and development of an ongoing energy incentive offering for other condominiums in Hawaii.

Baseline

The base case is no submetering. Baseline Annual Energy Usage is the actual average usage (kWh/year) based on historical usage for past 24 months (or as appropriate) for entire condominium (master metered) divided by the number of condominium units. Baseline demand (kW) is the Average Historical Demand divided by the number of condominium units.

Building Types	Demand Baseline (kW)	Energy Baseline (kWh/year)
Condominium	1.42	7,200

High Efficiency

The high efficiency case is with submetering. It is expected there will be a 10% reduction in energy usage and 8% reduction in peak demand during (5PM – 9PM).

Building Types	Efficient Case (kW)	Efficient Case (kWh/year)
Condominium	1.30	6,480

Energy and Demand Savings (for illustration purposes only):

Building Types	Gross Customer Savings (kW)	Gross Customer Savings (kWh/year)
Condominium	0.113	720

Operational Factor	Adjustment Factor
Persistence Factor (pf)	1.00
Demand Coincidence Factor (cf)	1.00

Building Types	Net Customer Savings (kW)	Net Customer Savings (kWh/year)
Condominium	0.113	720

Example Savings Algorithm:

Submetering (Condominium)				
Average Master Meter Energy Usage (kWh/month)		180,000	kWh per month	
Number of tenant Units	÷	300	Units	
Average Tenant Energy Usage (Example)		600	kWh per home per month	
	x	12	month per year	
Baseline Annual Household Energy Usage		7,200	kWh per Year	
Average Master Meter Demand (kW)		425		
Number of tenant Units	÷	300		
Baseline Demand (kW)		1.42	kW	
Energy Reduction		10.0%		
Actively Informed Household Energy Usage		6,480	kWh per Year	
Baseline Annual Household Energy Usage		7,200	kWh per Year	
Actively Informed Household Energy Usage	-	6,480	kWh per Year	
Gross Customer Level Energy Savings		720	kwh per Year	
Gross Customer Level Energy Savings		720	kwh per Year	
Persistance Factor	x	1.0		
Net Customer Level Savings		720	kwh per Year	
Submetering Energy Savings		720	kWh / Year Savings	
Baseline Household Demand		1.42	kW	HECO 2008 Load Study
Peak Demand Reduction		8.00%		
Actively Informed Household Demand		1.30	kW	
Baseline Household Demand		1.42	kW	
Actively Informed Household Demand	-	1.30	kW	
Gross Customer Demand Savings		0.113	kW	
Gross Customer Demand Savings		0.113	kW	
Persistance Factor	x	1.0		
Coincidence Factor	x	1.0		
		0.113	kW	
Condominium Sub-Metering Demand Savings		0.113	kW Savings	

Notes

- Incentive payment will be made upon billing individual tenants.
- Incentive payment cannot exceed 50% of total project cost.
- The payment of the incentive will be based on the AOAO securing the approval, installing and utilizing the submeters for billing purposes.

- There is no minimum reduction in electrical use to be required by AOAO to retain the incentive.

Measure Life:
8 years (based on DEER. Similar technology as time-clocks and occupancy sensors)

13.9.2 Small Business Submetering Pilot

Version Date & Revision History:
Draft date: March 4, 2016

Referenced Documents:

- n/a

TRM Review Actions:

- 10/5/11 – Currently Under Review.

Major Changes:

- 3/4/2016 – Added measure description and equipment qualifications

Measure Description:
This program is to assist master-metered small businesses to reduce energy consumption that will insure both equity and fairness in allocating energy costs as well as encouraging energy conservation through direct feedback of personal energy use to business tenants.

The combination of billing submeters, along with education, peer group comparisons and special equipment offerings, will assist the tenant achieve significant energy conservation and efficiency.

Equipment Qualifications:
The manufacturer's submetering system model type to be installed (meter and CTs) must have been tested by an independent third party that is Nationally Rated Testing Laboratory certified for ANSI C12.1. The certification documentation must be provided to the Program prior to installation. Additionally, manufacturers must have a factory-quality compliance procedure in place to ensure meter accuracy. Documentation of this procedure must be available to the Program upon request. The submeter must be UL, CSA or ETL listed (Electrical Safety).

Requirements:

- The metering system must remain in place and billing to occur for a period of at least five (5) years or a pro-rated portion of the incentive will be recovered by Hawaii Energy. Provide Hawaii Energy with energy meter data for analysis purposes.

- A joint educational and monitoring program will be undertaken with the businesses to assist in the verification of savings and development of an ongoing energy incentive offering for other condominiums in Hawaii.

Baseline

The base case is no submetering

Building Types	Demand Baseline (kW)	Energy Baseline (kWh/year)
Small Business	3.00	10,800

High Efficiency

The high efficiency case is with submetering

Building Types	Efficient Case (kW)	Efficient Case (kWh/year)
Small Business	2.76	9,720

Energy and Demand Savings:

Building Types	Gross Customer Savings (kW)	Gross Customer Savings (kWh/year)
Small Business	0.24	1,080

Operational Factor	Adjustment Factor
Persistence Factor (pf)	1.00
Demand Coincidence Factor (cf)	1.00

Building Types	Net Customer Savings (kW)	Net Customer Savings (kWh/year)
Small Business	0.24	1,080

It is expected there will be at least 10% reduction in energy usage and 8% reduction in peak demand during (5PM – 9PM), however, there is no minimum reduction in electrical use to be required to retain the incentive.

Example Savings Algorithm:

Small Business Submetering			
Average Tenant Energy Usage		900	kWh per business per month (Schedule G)
	x	12	
Baseline Business Energy Usage		10,800	kWh per Year
Energy Reduction		10.0%	
Actively Informed Business Energy Usage		9,720	kWh per Year
Baseline Business Energy Usage		10,800	kWh per Year
Actively Informed Business Energy Usage	-	9,720	kWh per Year
Gross Customer Level Energy Savings		1,080	kwh per Year
	x	1,000	Watts per kW
	÷	8,760	Hours per Year
Average 24/7 Demand Reduction		123	Watts
Gross Customer Level Energy Savings		1,080	kwh per Year
Persistance Factor	x	1.0	
Net Customer Level Savings		1,080	kwh per Year
Submetering Energy Savings		1,080	kWh / Year Savings
Baseline Business Demand		3.00	kW
Peak Demand Reduction		8.00%	
Actively Informed Business Demand		2.76	kW
Baseline Business Demand		3.00	kW
Actively Informed Business Demand	-	2.76	kW
Gross Customer Demand Savings		0.240	kW
Gross Customer Demand Savings		0.240	kW
Persistance Factor	x	1.00	
Coincidence Factor	x	1.00	
		0.240	kW
Small Business Demand Savings		0.24	kW Savings

Incentives/Incremental Cost

- Incentive payment will be made upon billing individual tenants.
- Incentive payment cannot exceed 50% of total project cost.

13.9.3 Vending Misers

Measure ID:

Version Date & Revision History:
Draft date: March 2, 2011

Referenced Documents:

(1) USA Technologies Energy Management Product Sheets (2006). http://www.usatech.com/energy_management/energy_productsheets.php. Accessed 9/1/09.

TRM Review Actions:

- n/a

Major Changes:

- none

Measure Description
Controls can significantly reduce the energy consumption of vending machine lighting and refrigeration systems. Qualifying controls must power down these systems during periods of inactivity but, in the case of refrigerated machines, must always maintain a cool product that meets customer expectations. This measure applies to refrigerated beverage vending machines, non-refrigerated snack vending machines, and glass front refrigerated coolers. This measure should not be applied to ENERGY STAR® qualified vending machines, as they already have built-in controls.

Algorithms for Calculating Primary Energy Impact
Unit savings are deemed based on the following algorithms and assumptions:

$\Delta kWh = (kWrated)(Hours)(SAVE)$
$\Delta kW = \Delta kWh / Hours$

Where:

kWrated = Rated kW of connected equipment. See Table below for default rated kW by connected equipment type.
Hours = Operating hours of the connected equipment: default of 8,760 hours
SAVE = Percent savings factor for the connected equipment. See table below for values.

Vending Machine and Cooler Controls Savings Factors

Machine Type	kW Savings	kWh/year Savings
Refrigerated beverage vending maching (cans or bottles)	0.184	1612
Refrigerated	0.124	1086
Non-refrigerated snack vending machine	0.044	387
All (Average)	0.117	1028

Baseline Efficiency
The baseline efficiency case is a standard efficiency refrigerated beverage vending machine, non-refrigerated snack vending machine, or glass front refrigerated cooler without a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

High Efficiency
The high efficiency case is a standard efficiency refrigerated beverage vending machine, non-refrigerated

snack vending machine, or glass front refrigerated cooler with a control system capable of powering down lighting and refrigeration systems during periods of inactivity.

Hours
It is assumed that the connected equipment operates 24 hours per day, 7 days per week for a total annual operating hours of 8,760.

Measure Life
8 Years

13.9.4 Water Cooler Timer (H_2Off)

Measure ID:

Version Date & Revision History:
Draft date:

Referenced Documents:

- LBNL 2007
  - http://enduse.lbl.gov/info/LBNL-56380%282007%29.pdf
  - EPA2012
    http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=WA#

TRM Review Actions:

- Currently Under Review.

Major Changes:

- N/A

Measure Description:
Many businesses have water coolers, often equipped with both cold and hot water spigots. Unbeknownst to many, however, is how much energy is used to continuously keep that water hot and cold. Think about it: Water coolers are generally plugged in 24/7, so they're ready and waiting to make a nice cup of hot tea if someone happens to drop by the office at 3 a.m.

Similar to the timers you might use to control lights in your home, plug-in appliance timers allow you to pre-program the times that various appliances in your business are turned on and drawing electricity. So you could pre-program the water cooler so it turns on one hour before the office opens and turns off again after everyone leaves.

Baseline Efficiencies:
No timer

	Energy Usage	
Type of Water Cooler	Cold Only (kWh/day)	Hot/Cold (kWh/day)
ENERGY STAR	0.16	1.20
Conventional	0.29	2.19

Hours per Day	24
Days per year	365

Base Case Usage	Cold Only	Hot/Cold
ENERGY STAR USAGE (kWh/year)	58	438
Conventional (kWh/year)	106	799

High Efficiency:

Enhanced Case Usage	Cold Only	Hot/Cold
ENERGY STAR USAGE (kWh/year)	21	157
Conventional (kWh/year)	38	287

Energy Savings:

Energy Savings	Cold Only	Hot/Cold
ENERGY STAR USAGE (kWh/year)	37	281
Conventional (kWh/year)	68	512
Average Savings (kWh/year)	**53**	**397**

Energy Savings Assumptions:

It is assumed that half of all water coolers are Energy Star and half are not:

- 50% Energy Star
- 50% Conventional

It is assumed that half of all water coolers are cold only and half are hot + cold dispenser:

- 50% Cold Only
- 50% Hot + Cold

The energy savings figure will be based on the average of the above-mentioned percentages.

Persistence Factor = 90%

Energy Savings = 225 x 90% = 202.5 kWh/year

Demand Savings:

Taking a conservative approach, the demand savings will based on the following calculation and methodology:

Demand Savings = 225 kWh/year divided by 8760 hrs/year = 0.026 kW

Coincidence Factor = 75%

Note: Based on utilization of 3 of the 4 peak hours (6PM-9PM). 5PM-6PM is not counted since most offices close at 5PM and the timer should be set to turn off cooler 1 hour after office closes which is 6PM.

Coincidence Demand Savings = 0.026 kW x .75 = 0.020 kW

Persistence = 90% (10% of people will disconnect)

Peak Demand Savings = 0.020 kW x .90 = 0.018 kW

Savings Algorithms

Hours per Day	24
Days per year	365

Base Case Usage	Cold Only	Hot/Cold
ENERGY STAR USAGE (kWh/year)	58	438
Conventional (kWh/year)	106	799

Weekday OFF (Hour/Day)	12
Weekend OFF (Hour/Day)	24
Weekday (Day/week)	5
Weekend (Day/week)	2
Weekday (Week/year)	52
Weekend (Week/year)	52

Hours OFF	5616
Hours per Year	8760
Hours OFF (%)	64%
Hours ON (%)	36%

Enhanced Case Usage	Cold Only	Hot/Cold
ENERGY STAR USAGE (kWh/year)	21	157
Conventional (kWh/year)	38	287

Energy Savings	Cold Only	Hot/Cold
ENERGY STAR USAGE (kWh/year)	37	281
Conventional (kWh/year)	68	512
Average Savings (kWh/year)	**53**	**397**

Operating Hours

Weekday OFF (Hour/Day)	12
Weekend OFF (Hour/Day)	24
Weekday (Day/week)	5
Weekend (Day/week)	2
Weekday (Week/year)	52
Weekend (Week/year)	52

Hours OFF	5616
Hours per Year	8760
Hours OFF (%)	64%
Hours ON (%)	36%

Lifetime
5 years

13.10 High Efficiency Transformer

13.10.1 Transformer

Measure ID:

Version Date & Revision History:
Draft date: November 25, 2014

Referenced Documents:
- CEE – Commercial and Industrial Distribution Transformer Initiative (November 9, 2011)
- Average Marginal Cost data from survey of manufacturers' current products; price to channel. Energy performance data prepared by members of the CEE Distribution Transformers Committee assuming a constant, linear load at 35% of unit capacity.
- CEE Tier 1 criteria are identical to NEMA Premium voluntary standard levels and the US DOE Energy Efficiency Level 2 (Distribution Transformers Technical Support Document, 2011)
- CEE Tier 2 criteria are identical to US DOE Energy Efficiency Level 5 (Distribution Transformers Technical Support Document, 2011)
- Barnes, P. R., J. W. Van Dyke, B. W. McConnell, and S. Das, Determination Analysis of Energy Conservation Standards for Distribution Transformers, 1996, Oak Ridge National Laboratory. Oak Ridge, TN. Report No. ORNL-6847.
  Distribution Transformer Standards Rulemaking. Dry-type Distribution Transformers, Life Cycle Cost Analysis on Design Line 9. Prepared for: Building Technology Program Office of Energy Efficiency and Renewable Energy (US Department of Energy), October 4, 2002. LBNL.

TRM Review Actions:
- N/A

Major Changes:
- N/A

Measure Description:
Distribution transformers are used in commercial and industrial applications to step down power from distribution voltage to be used in HVAC or process loads (220V or 480V) or to serve plug loads (120V). They are made up of one or more cores (typically carbon steel), two sets of metal windings (copper or aluminum), an insulating material (oil or air), and a container shell. Distribution transformers have no moving parts.

Baseline Efficiencies:
- NEMA TP-1 (current federal minimum standard level)

High Efficiency:
- CEE Tier I (single phase)
- CEE Tier II (single or three phase)

Energy and Peak Demand Savings:
Transformer energy efficiency is the ratio of output power to distribution voltage input power. Between input and output the transformer experiences losses, generally characterized as core losses (or no-load losses) and winding losses (or load losses). Core losses occur in the core materials of the transformer and are constant whenever the transformer is energized, regardless of load. Winding losses occur in the transformer windings, and increase exponentially with load.

Total losses, energy and demand savings associated with CEE Tier 1 level for **single-phase** transformers:

KVA	Total Losses (kWh/yr)		Energy Savings vs. Baseline (kWh/yr)	Demand Savings vs. Baseline (kW)
	Baseline	Tier 1	Tier 1	Tier 1
15	1058	740	318	0.04
25	1533	1073	460	0.05
37.5	2070	1449	621	0.07
50	2606	1824	782	0.09
75	3449	2414	1035	0.12
100	4292	3005	1287	0.15
150	*6056*	*4239*	*1817*	*0.21*
167	6656	4659	1997	0.23
250	9198	6439	2759	0.31
333	11231	7862	3369	0.38

Total losses, energy and demand savings associated with CEE Tiers for **three-phase** equipment

KVA	Total Losses (kWh/yr)			Energy Savings vs. Baseline (kWh/yr)		Demand Savings vs. Baseline (kW)		Marginal Equipment Cost: Tier 1 vs. Baseline
	Baseline	Tier 1	Tier 2	Tier 1	Tier 2	Tier 1	Tier 2	
15	1380	966	736	414	644	0.05	0.07	$ 448
25	*1993*	*1395*	*1073*	*598*	*920*	*0.07*	*0.11*	*$ 687*
30	2300	1610	1242	690	1058	0.08	0.12	$ 807
45	3173	2221	1683	952	1490	0.11	0.17	$ 851
75	4599	3219	2460	1380	2139	0.16	0.24	$ 1,115
112.5	6209	4346	3346	1863	2863	0.21	0.33	$ 2,144
150	7818	5473	4139	2345	3679	0.27	0.42	$ 2,740
225	10348	7243	4139	3105	6209	0.35	0.71	$ 3,617
300	12877	9014	5151	3863	7726	0.44	0.88	$ 5,078
450	*18166*	*12716*	*6922*	*5450*	*11244*	*0.62*	*1.28*	*$ 4,881*
500	19929	13950	7512	5979	12417	0.68	1.42	$ 4,815

Operating Hours
24/7

Demand Coincidence Factor
TBD

Persistence
TBD

Lifetime
Measure life = **32 years** (Based on ORNL-6847, Determination Analysis of Energy Conservation Standards for Distribution Transformers)

Measure Costs and Incentive Levels

- Marginal (incremental) cost – see table above for 3-Phase.
- > 500 KVA (3-Phase) will be based on Custom Incentive Program
- > 333 KVA (Single Phase) will be based on Custom Incentive Program
- If a transformer size is not listed in table, we will apply the lower value
- Incentive level is based on the following table:

KVA	Energy Savings vs. Baseline (kWh/yr)		Inventives (total) $	
	Tier 1	Tier 2	Tier 1	Tier 2
Single-phase				
15	318		$ 80	
25	460		$ 115	
37.5	621		$ 155	
50	782		$ 195	
75	1035		$ 260	
100	1287		$ 320	
150	1817		$ 455	
167	1997		$ 500	
250	2759		$ 690	
333	3369		$ 840	
Three-phase				
15	414	644	$ 105	$160
25	598	920	$ 150	$230
30	690	1058	$ 175	$265
45	952	1490	$ 240	$375
75	1380	2139	$ 345	$535
112.5	1863	2863	$ 465	$715
150	2345	3679	$ 585	$920
225	3105	6209	$ 775	$1,550
300	3863	7726	$ 965	$1,930
450	5450	11244	$ 1,365	$2,810
500	5979	12417	$ 1,495	$3,100

14 Custom Business Energy Efficiency Measures (CBEEM)

14.1 Customized Project Measures

14.1.1 Customized Project Measures

Version Date & Revision History:
Draft date: March 4, 2016

Referenced Documents:
- n/a

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- 3/4/16 – Modified criteria for non-Energy Star, DLC, and Lighting Facts LED Lamps

Description: The Custom project measure is offered for energy efficiency projects involving complex site-specific applications that require detailed engineering analysis and/or projects which do not qualify for incentives under any of the prescriptive rebate offering. Projects offered through the custom approach must pass a cost-effectiveness test based on project-specific costs and savings.

Non-Lighting Measures:

Measure Life	Reduction in Energy Use Incentive	Evening Peak Demand Reduction (5:00 p.m. to 9:00 p.m. weekdays)	Day Peak Demand Reduction (HVAC only) (12:00 p.m. to 2:00 p.m. weekdays)	First Year Energy Savings (kWh)	Demand Savings (kW)
<= 5 years	$0.10 /kWh	$125 / kW	*$100 / kW		
> 5 years	$0.20 /kWh	$125 /kW	*$100 /kW		

Lighting Measures:

Measure Life	Reduction in Energy Use Incentive	Evening Peak Demand Reduction (5:00 p.m. to 9:00 p.m. weekdays)	First Year Energy Savings (kWh)	Demand Savings (kW)
<= 5 years	$0.10 /kWh	$125 / kW		
> 5 years	$0.15 /kWh	$125 /kW		

Program Requirements:
- Approval is required prior to the start of work on any customized project.
- Total resource benefit ratio is greater than or equal to 1.
- Incremental simple payback greater than one year or six months for lighting projects.

Requirements for Non ENERGY STAR®, DLC or Lighting Facts LED Lamps

For LED products that do not fall into one of the existing DLC product categories, we will accept products that meet all of the following criteria:

- UL Listed
- LM79 and LM80 tests
- Five year manufacturer warranty

Category of Measure and Total Resource Cost

Custom Measures under 5 years

1. Lighting
    - TRC = $600,000

Custom Measure over 5 years

1. Lighting (LED & Non-LED)
    - TRC = $5,200,000

2. Mixed
    - TRC = $1,724,000

Energy and Demand Savings:

All assumptions, data and formulas used in the calculations must be clearly documented. Standard engineering principles must be applied, and all references cited. Energy saving calculations shall also reflect the interactive effects of other simultaneous technologies to prevent the overstatement of the actual savings. Proposed base and enhanced cases must be performed by a qualified person or firm. In some cases, a professional engineer may be required to provide verification of the analysis.

Savings Algorithms

Gross energy and demand savings estimates for custom projects are calculated using engineering analysis and project-specific details. Custom analyses typically include a weather dependent load bin analysis, whole building energy model simulation, or other engineering analysis and include estimates of savings, costs, and an evaluation of the project's cost-effectiveness.

Baseline Efficiency

The baseline efficiency case assumes compliance with the efficiency requirements as mandated by the Hawaii State Energy Code or industry accepted standard practice.

High Efficiency

The high efficiency scenario is specific to the custom project and may include one or more energy efficiency measures. Energy and demand savings calculations are based on projected changes in equipment efficiencies and operating characteristics and are determined on a case-by-case basis. The project must be proven cost-effective and pass total resource benefit and have a payback greater than or equal to 1.

Persistance Factor
PF = 1 since all custom projects require verification of equipment installation.

Incentives

- Incentives is limited to 50% of incremental costs.
- Installations are subject to inspection for up to 5 years. Removal will be cause for incentive forfeiture.

14.1.2 Efficiency Project Auction

Version Date & Revision History:
Draft date: June 20, 2014

Referenced Documents:
- n/a

TRM Review Actions:
- Currently under review

Major Changes:
- New measure

Description:
Hawaii Energy will issue a call for projects for innovative energy efficiency programs from third parties. Eligible projects in this auction are any new technology, marketing approach or customer segment not already offered or served Hawaii Energy PY14 programs. Projects may include new technologies if it can be demonstrated that the technology is commercially available and any performance issues have been investigated and resolved. A ceiling price and evaluation methods will be defined in the call for projects.

Energy Savings:
The Custom project measure is offered for energy efficiency projects involving complex site-specific applications that require detailed engineering analysis and/or projects which do not qualify for incentives under any of the prescriptive rebate offering. Projects offered through the custom approach must pass a cost-effectiveness test based on project-specific costs and savings.

Life:
DEER

Energy Savings:
Based on Pre/Post data logging

Demand Savings:
Based on Peak 5PM-9PM

15 Business Energy Services and Maintenance (BESM)

15.1 Business Direct Installation

15.1.1 Small Business Direct Lighting Retrofits

Version Date & Revision History:
Draft date: Marcy 4, 2016

Referenced Documents:
- n/a

TRM Review Actions:
- 10/5/11 – Currently Under Review.
- 3/4/16 – Added language to include restaurants in program requirements to reflect current practices

Major Changes:
- n/a

Measure Description:
The program targets customers within the small business market. Typically this market has limited time and expertise within their organizations to research lighting technology options, obtain financing and contract with lighting contractors to replace their older less efficient lighting technologies. The Small Business Lighting Retrofit provides a "Turnkey" program consisting of audits, fixed pricing, installation by participating Hawaii Energy contractors and 4 month financing of lighting retrofits.

Baseline Efficiency:
The baseline efficiency for this measure is the actual existing lighting at the small business and their actual estimated annual hours of operation.

Program Requirements:
Small Business Customers receiving eclectic power under a Schedule "G" rate, or are similar to Schedule "G" but are under master-metered accounts, are eligible under this program. In addition to schedule G accounts, all restaurants are eligible given the historically hard-to-reach nature of this sector.

Savings Algorithms

Small Business Direct Install Lighting Retrofit Pilot Program
Summary Sheet

Business Name:	
Contact Name:	
Address:	
Phone:	
Fax:	
Email:	

Contractor Name:	
Auditor Name:	
Address:	
Phone:	
Fax:	
Email:	

Total Watts Saved	Energy Savings	Energy Cost Savings	Hawaii Energy Participating Contractor NTE Pricing	Hawaii Energy Cash Incentive	Net Customer Cost	Simple Payback	4 Month Monthly Payment	Monthly Savings % of Payment
1,323 W	3,324 kWh/yr.	$ 776 / yr.	$ 2,300	$ 833	1,467	23	367	18%

Step 1	
f2	
Oahu	Island of Project Location
$ 0.234 /kWh	2010 "G" Marginal Cost of Electricity

Measure Code	Existing Technology	New Technology	Step 2 Total Units (each)	Step 3 M-F Hours per Day	Sat. Hours per Day	Sun. Hours per Day	Annual Hours of Operation (hrs/year)	Step 4 Wkdays Hours on between 5 and 9 p.m. (hrs)	On-Peak Fraction (%)	Total Watts Saved (Watts)	Energy Savings (kWh/Year)	Energy Cost Savings ($/year)	Hawaii Energy Participating Contractor NTE Pricing ($)	Hawaii Energy Cash Incentive ($)	Net Customer Cost ($)	Simple Payback (Months)	6 Month Monthly Payment ($/month)	Monthly Savings % of Payment (%)
			a	b1a	b1b	b2a	b3 = b1*b2*(365/7)	c	c2 =c / 4	d = a x o	e = b x (d/1000)	f = e x f2	g = a x p	h = a x q	i = a x (p-q)	j = (i/f) x 12	k = i /6	l = (f/12)/k
8L1-4L2	8 ft. 1 Lamp F96	4 ft. 2 lamp F25/28 N	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 75	$ 62	$ 13	6	$ 2.24	100%
8L2-4L2	8 ft. 2 Lamp F96	4 ft. 2 lamp F25/28 H	1	8	8	0	2,503	-	0%	57	143	$ 33	$ 84	$ 53	$ 31	11	$ 5.17	54%
8L2HO-4L2R	8 ft. 2 Lamp F96 HO	4 ft. 2 lamp F25/28 N, Reflct.	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 85	$ 27	$ 58	26	$ 9.67	23%
8L2HO-4L4	8 ft. 2 Lamp F96 HO	4 ft. 4 lamp F25/28 N	1	8	8	0	2,503	-	0%	92	230	$ 54	$ 138	$ 53	$ 85	19	$ 14.17	32%
4L4-4L4	4 ft. 4 Lamp F40	4 ft. 4 lamp F25/28 N	1	8	8	0	2,503	-	0%	92	230	$ 54	$ 83	$ 51	$ 32	7	$ 5.33	84%
4L4-4L2R	4 ft. 4 lamp F40	4 ft. 2 lamp F25/28 N, Reflct.	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 65	$ 27	$ 38	17	$ 6.33	35%
4L3-4L3	4 ft. 3 lamp F40	4 ft. 3 lamp F25/28 N, Reflct.	1	8	8	0	2,503	-	0%	69	173	$ 40	$ 74	$ 38	$ 36	11	$ 6.00	56%
4L3-4L2R	4 ft. 3 lamp F40	4 ft. 2 lamp F25/28 N, Reflct.	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 65	$ 27	$ 38	17	$ 6.33	35%
4L2-4L2	4 ft. 2 lamp F40	4 ft. 2 lamp F25/28 N	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 35	$ 27	$ 8	4	$ 1.33	168%
4L1-4L1	4 ft. 1 lamp F40	4 ft. 1 lamp F25/28 N	1	8	8	0	2,503	-	0%	23	58	$ 13	$ 30	$ 14	$ 16	14	$ 2.67	42%
4L4-4L4	4 ft. 4 lamp F32	4 ft. 4 lamp F25/28 N	1	8	8	0	2,503	-	0%	92	230	$ 54	$ 83	$ 34	$ 49	11	$ 8.17	55%
4L4-4L2	4 ft. 4 lamp F32	4 ft. 2 lamp F25/28 N	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 65	$ 53	$ 12	5	$ 2.00	112%
4L3-4L3	4 ft. 3 lamp F32	4 ft. 3 lamp F25/28 N	1	8	8	0	2,503	-	0%	69	173	$ 40	$ 74	$ 26	$ 48	14	$ 8.00	42%
4L3-4L2	4 ft. 3 lamp F32	4 ft. 2 lamp F25/28 N	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 65	$ 25	$ 40	18	$ 6.67	34%
4L2-4L2	4 ft. 2 lamp F32	4 ft. 2 lamp F25/28 N	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 35	$ 27	$ 8	4	$ 1.33	168%
4L1-4L1	4 ft. 1 lamp F32	4 ft. 1 lamp F25/28 N	1	8	8	0	2,503	-	0%	23	58	$ 13	$ 35	$ 9	$ 26	23	$ 4.33	26%
1L400-4L6	HID Pendant 1 lamp 400W	4 foot 6 lamp F25/T8 N	1	8	8	0	2,503	-	0%	138	345	$ 81	$ 360	$ 76	$ 284	42	$ 47.33	14%
1L250-4L4	HID Pendant 1 lamp 250W	4 foot 4 lamp F25/T8 N	1	8	8	0	2,503	-	0%	92	230	$ 54	$ 330	$ 51	$ 279	62	$ 46.50	10%
1L175-4L4	HID Pendant 1 lamp 175W	4 foot 4 lamp F25/T8 N	1	8	8	0	2,503	-	0%	92	230	$ 54	$ 330	$ 51	$ 279	62	$ 46.50	10%
UBL2-2L2	4 ft. U-Bend 2 lamp FB40	2 ft. 2 lamp F17 N	1	8	8	0	2,503	-	0%	32	80	$ 19	$ 40	$ 22	$ 18	12	$ 3.00	52%
UBL2-2L2R	4 ft. U-Bend 2 lamp FB40	2 ft. 2 lamp F17 L, Reflector	1	8	8	0	2,503	-	0%	27	68	$ 16	$ 50	$ 30	$ 20	15	$ 3.33	39%
100-23	100 Watt Incandescent	23 Watt CFL	1	8	8	0	2,503	-	0%	23	58	$ 13	$ 10	$ 4	$ 6	5	$ 1.00	112%
75-19	75 Watt Incandescent	19 Watt CFL	1	8	8	0	2,503	-	0%	19	48	$ 11	$ 8	$ 4	$ 4	4	$ 0.67	139%
60-13	60 Watt Incandescent	13 Watt CFL	1	8	8	0	2,503	-	0%	13	33	$ 8	$ 6	$ 4	$ 2	3	$ 0.33	190%
Exit	40W Incandecent	2 Watt LED	1	24	24	24	8,760	-	0%	2	18	$ 4	$ 75	$ 38	$ 37	109	$ 6.17	6%
OverHeight	Cost Adder for Fixtures above or out of the reach of a 10' Ladd		0										$ -		$ -			
										1,323 W	3,324 kWh/yr.	$ 776 / yr.	$ 2,300	$ 833	$ 1,467	23	$ 366.86	18%

WORKBOOK INPUTS

Measure Code	Existing per Unit Watts	Unit New Watts	Unit Watts Saved	Hawaii Energy Participating Contractor Pricing	Hawaii Energy Cash Incentive	Public Benefit Fee Investment
	(Watt/unit)	(Watt/unit)	(Watt/unit)	($/unit)	($)	($/kWh)
	m	n	o = m-n	p	q	r
8L1-4L2	85	46	39	$ 75	$ 62	$ 0.53
8L2-4L2	142	57	85	$ 84	$ 53	$ 0.37
8L2HO-4L2R	170	46	124	$ 85	$ 27	$ 0.23
8L2HO-4L4	170	92	78	$ 138	$ 53	$ 0.23
4L4-4L4	168	92	76	$ 83	$ 51	$ 0.22
4L4-4L2R	168	46	122	$ 65	$ 27	$ 0.23
4L3-4L3	126	69	57	$ 74	$ 38	$ 0.22
4L3-4L2R	126	46	80	$ 65	$ 27	$ 0.23
4L2-4L2	84	46	38	$ 35	$ 27	$ 0.23
4L1-4L1	42	23	19	$ 30	$ 14	$ 0.24
4L4-4L4	112	92	20	$ 83	$ 34	$ 0.15
4L4-4L2	112	46	66	$ 65	$ 53	$ 0.46
4L3-4L3	84	69	15	$ 74	$ 26	$ 0.15
4L3-4L2	84	46	38	$ 65	$ 25	$ 0.22
4L2-4L2	56	46	10	$ 35	$ 27	$ 0.23
4L1-4L1	28	23	5	$ 35	$ 9	$ 0.16
1L400-4L6	475	138	337	$ 360	$ 76	$ 0.22
1L250-4L4	300	92	208	$ 330	$ 51	$ 0.22
1L175-4L4	225	92	133	$ 330	$ 51	$ 0.22
UBL2-2L2	84	32	52	$ 40	$ 22	$ 0.27
UBL2-2L2R	84	27	57	$ 50	$ 30	$ 0.44
100-23	100	23	77	$ 10	$ 4	$ 0.07
75-19	75	19	56	$ 8	$ 4	$ 0.08
60-13	60	13	47	$ 6	$ 4	$ 0.12
Exit	40	2	38	$ 75	$ 38	$ 2.17
OverHeight				$ 8		
						0

15.2 Business Design, Audits and Commissioning

15.2.1 Benchmark Metering

Version Date & Revision History:
Draft date: March 2, 2011

Referenced Documents:
- n/a

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- n/a

Description:
The Benchmark Metering incentive is designed to encourage business customers to install a central chiller plant metering and data logging system that will provide real-time data and trend data. This data reflects actual tons of cooling and measured efficiency in KW per ton. The new equipment will make it possible for the customer to set meaningful energy efficiency goals and track progress towards those goals. With the Hawaii Energy incentive, there is no cost to the customer for the metering equipment or installation (up to $100,000).

Procedure:

Customer:
1. Have a central chiller plant (or a central chiller plant project in the planning phase) with a total building electrical energy consumption of at least 3 million kWh per year.
2. Complete and submit Central Chiller Plant Benchmarking Application
3. The Hawaii Energy monitoring and data acquisition server shall be located at the customer's site and connected to the internet via customer's connection.
4. Submit to Hawaii Energy all payee information and the IRS Form W-9 at the beginning of every calendar year for processing of the IRS Form 1099. It is understood that Hawaii Energy will forward a copy of the IRS Form 1099 to the payee at the end of the calendar year.
5. Agree to inspection of project for up to 5 years after completion

Industry Partners:
1. Assist customer in submission of application, savings estimate worksheet, and project proposal.
2. Provide quotations for metering installation at customer's location. Only firm/fixed cost quotes will be accepted by Hawaii Energy.
3. Provide supporting documentation to support information submitted on Worksheet. Information may include drawings, vendor cut sheets, energy savings estimates (methodology and calculations).
4. Install approved measures and required metering/monitoring equipment

Hawaii Energy:

1. Review application, worksheet, and proposal to determine if proposed project meets the intent of the program.
2. Perform post installation inspection to ensure all measures/equipment are properly install and operational.
3. Process approved incentive payments (to customer or authorized third party) based on validated savings calculations
4. Prepare and file close out report documenting actual savings achieved and incentives paid.

15.2.2 Energy Study

Version Date & Revision History:
Draft date: September 20, 2011

Referenced Documents:
- n/a

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- n/a

Description: The Energy Study is an indirect impact product that offers Hawaii businesses with analysis services to identify energy saving opportunities. The goal of the energy study is to provide a method for commercial and industrial customers to learn how their business uses energy today and to identify measures that will help them save energy and reduce operating costs in the future. The focus is on a customer's core energy efficiency opportunities.

Program Requirements:
- Program approval is required prior to the start of work on the energy study
- The program reserves the right to review all materials that result from a program-supported study including, but not limited to, final reports, consultant recommendations, and metered data
- The study must be performed by a qualified person or firm. A brief summary of the consultant's qualifications should be submitted with the application. In some cases, a professional engineer may be required to provide verification of the analysis
- At any time, customers may contact program staff to discuss a project, get assistance in preparing an application, or with any program-related questions

Energy and Demand Savings:

All assumptions, data and formulas used in energy efficiency calculations must be clearly documented. Standard engineering principles must be applied, and all references cited. Energy saving calculations shall also reflect the interactive effects of other simultaneous technologies to prevent the overstatement of the actual savings.

Savings Algorithms

Gross energy and demand savings estimates for energy studies are calculated using engineering analysis and project-specific details. Energy study analyses typically include estimates of savings, costs, and an evaluation of the cost-effectiveness of potential projects/upgrades.

Energy Study

The Energy Study shall include the following information and be presented in the following format:

1) Executive Summary
    a) Energy Conservation Measures (ECMs) Proposed
    b) Summary of Baseline and Enhanced Case Assumptions
    c) Actionable Recommendations in "loading order."
2) Technical Information and Analysis
    a) Energy Consumption Analysis
        i) Two years of billing data (weatherized and compared to some pertinent operating metric)
    b) Description of the project
    c) Proposed Energy Conservation Measures (ECM)
        i) Descriptive Name
        ii) Schematic System Drawing
        iii) Current Peak Demand (kW), Energy Usage (kWh), Effective Full Load Run Hours
        iv) Proposed Peak Demand (kW), Energy Usage (kWh), Effective Full Load Run Hours
        v) % Change for above
        vi) Estimated Installation Cost
        vii) Project timeline
        viii) Measure Life
        ix) Simple Payback
    d) Base case information
        i) Short term/spot baseline thermal, fluid, and electrical measurements for major equipment to be changed with ECMs
        ii) Permanent metering data (This metering will qualify for additional cost assistance)
        iii) Sizing/Performance Reviews (Pump Curves, Cooling Bin Data etc.)
    e) Enhanced case information
        i) How will performance be measured in the future.
        ii) Description of where energy savings occurs (lower run time, more efficient operations etc.)
    f) Estimated energy and demand savings associated with your proposed project
        i) Applicable figures and tables
        ii) Simple payback period and/or life cycle costs
    g) Estimated costs including design, materials, and installation
3) Appendix
    a) Raw and Analyzed Data (Cooling Models, Field Data, Pictures, Metering Data etc.)
    b) Building Plans (Mechanical, Electrical Schedules, Layouts etc.)

Incentives

- Incentives are limited to 50% of the cost of the study up to $15,000

15.2.3 Design Assistance

Measure ID:

Version Date & Revision History:
Draft date: September 20, 2011

Referenced Documents:
- n/a

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- 12/22/11 – Program requirement changed to require project be in planning or initial design phase.

Description: Design Assistance is available to building owners and their design teams to encourage the implementation of energy efficient building systems. Considering energy efficiency during the initial phases of planning and design greatly increase the feasibility of implementation. Incentives for energy efficiency are project-specific and offered as upfront assistance for additional costs incurred during the design phase. The long-term benefits include energy use reduction for the state of Hawaii and a reduction in operating costs, equipment lifecycle improvement for building owners, and improved comfort for building users.

Program Requirements:
- Application with written pre-approval from Hawaii Energy
- Project in planning or initial design phase
- Total resource benefit ratio greater than or equal to 1

Energy and Demand Savings:
A base case and enhanced case model must be produced with a clear comparison. All assumptions, data, and formulas used in energy efficiency calculations must be clearly documented. Standard engineering principles must be applied, and all references cited. Energy saving calculations shall also reflect the interactive effects of other simultaneous technologies to prevent the overstatement of actual savings. Proposed base and enhanced cases must be performed by a qualified person or firm. In some cases, a professional engineer may be required to provide verification of the analysis.

Savings Algorithms
Gross energy and demand savings estimates for design assistance are calculated using engineering analysis and project-specific details. Custom analyses typically include a weather dependent load bin analysis, whole building energy model simulation, or other engineering analysis and include estimates of savings, costs, and an evaluation of the project's cost-effectiveness.

Baseline Efficiency
The baseline efficiency case assumes compliance with the efficiency requirements as mandated by the Hawaii State Energy Code or industry accepted standard practice.

High Efficiency

The high efficiency scenario is specific to each project and may include one or more energy efficiency measures. Energy and demand savings calculations are based on comparing a base case analysis and enhanced cased analysis on equipment efficiencies and operating characteristics and are determined on a case-by-case basis. The energy efficiency measures must be proven cost-effective, pass total resource benefit, and have a payback greater than or equal to 1.

Persistence Factor

PF = 1 since all custom projects require verification of equipment installation.

Incentives

- Incentive applications are processed on a first-come, first-serve basis
- Incentives are 50% limited to a maximum of $15,000

16 Business Hard to Reach (BHTR)

16.1 Energy Efficiency Equipment Grants

16.1.1 Small Business Direct Installation - Demand Control Kitchen Ventilation (DCKV)

Version Date & Revision History:

Referenced Documents:
- Detailed Energy Savings Report, Melink Corporation, http://www.melinkcorp.com/Intellihood/Energy_Analysis.pdf

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- n/a

Measure Description:
Kitchen ventilation with DCKV hood exhaust. Demand ventilation uses temperature and/or smoke sensing to adjust ventilation rates. This saves energy comparing with the traditional 100% on/off kitchen ventilation system.

Baseline Efficiencies:
Kitchen ventilation without DCKV. Usage per HP:

Basecase = (HP x .746 KW/HP x Hours per Year)/efficiency

Basecase fan motor usage per HP (kWh/year)	4827
Basecase fan motor demand (kW)	0.83

High Efficiency:

Usage per HP:

Enhanced case fan motor usage per HP (kWh/year)	2194
Enhanced case fan motor demand (kW)	0.38

Energy Savings:
The demand control kitchen ventilation savings were determined using the method described in the Melink Detailed Energy Savings Report.

Energy Savings from fan motor per HP (kWh/year)	2633
Demand Savings from fan motor per HP (kW)	0.45

Savings Algorithms

% Rated RPM	% Run Time	Time HRS/YR	Output KW/HP	System Efficiency	Input KW/HP	KWH/HP/YR
H	I	J=GXI	K	L	M=K/L	N=JXM
100	5%	291.2	0.746	0.9	0.829	241
90	20%	1164.8	0.544	0.9	0.604	704
80	25%	1456	0.382	0.9	0.424	618
70	25%	1456	0.256	0.9	0.284	414
60	15%	873.6	0.161	0.9	0.179	156
50	10%	582.4	0.093	0.9	0.103	60
40	0%	0	0.048	0.9	0.053	0
30	0%	0	0.02	0.9	0.022	0
20	0%	0	0.015	0.9	0.017	0
10	0%	0	0.01	0.9	0.011	0
Total kWh/HP/YR						**2194**

Basecase = (HP x .746 KW/HP x Hours per Year)/efficiency

Basecase fan motor usage per HP (kWh/year)	4827
Basecase fan motor demand (kW)	0.83

Enhanced case fan motor usage per HP (kWh/year)	2194
Enhanced case fan motor demand (kW)	0.38

Energy Savings from fan motor per HP (kWh/year)	2633
Demand Savings from fan motor per HP (kW)	0.45

Operating Schedule	
16	HR/DAY
7	DAY/WK
52	WK/YR
5824	

Demand Coincidence Factor
TBD

Persistence
TBD

Lifetime
15 Years (Hawaii Energy assumption)

Measure Costs
Measure Cost: $1,200 - $1,700 per HP based on business vertical and site complications (provided my Melink)

16.1.2 Low Flow Spray Nozzles for Food Service (Retrofit)

Version Date & Revision History:
Draft date:

Referenced Documents:
- Evergreen TRM Review – 1/15/14

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- n/a

Measure Description:
All pre-rinse valves use a spray of water to remove food waste from dishes prior to cleaning in a dishwasher. They reduce water consumption, water heating cost, and waste water (sewer) charges. Pre-rinse spray valves include a nozzle, squeeze lever, and dish guard bumper. Energy savings depend on the facility's method of water heating (electric resistance or heat pump). If the facility does not have electric water heating (i.e. gas or propane), there are no electric savings for this measure. The spray valves usually have a clip to lock the handle in the "on" position. Pre-rinse valves are inexpensive and easily interchangeable with different manufacturers' assemblies.

Baseline Efficiencies:
The baseline equipment is assumed to be a spray valve with a flow rate of 2.25 gallons per minute.

High Efficiency:
The efficient equipment is assumed to be a pre-rinse spray valve with a flow rate of 1.28 gallons per minute.

Energy Savings:

$$\Delta kWh = \Delta Water \times HOT_{\%} \times 8.33 \times (\Delta T) \times (1/EFF^{*}) / 3413$$

ΔWater = Water savings (gallons)
$HOT_{\%}$ = The percentage of water used by the pre-rinse spray valve that is heated = 69%
8.33 = The energy content of heated water (Btu/gallon/°F)
ΔT = Temperature rise through water heater (°F) = 65°F
*EFF1 = Water heater thermal efficiency (electric resistance) = 0.98
*EFF2 = Water heater thermal efficiency (heat pump) = 3.0
3413 = Factor to convert Btu to kWh

Building Type	Operating Schedule (Day/year)	kW Savings	Electric Resistance (kWh/yr) Savings	Heat Pump (kWh/yr) Savings
Restaurants/Institutions	365	1.03	4,753	1,553
Dormitories	274	0.9	3,568	1,165
K-12 Schools	200	0.79	2,604	851

Demand Coincidence Factor
TBD

Persistence
TBD

Lifetime
5 years

Measure Costs and Incentive Levels
The actual measure installation cost should be used (including material and labor).

16.1.3 Commercial Ice Makers

Version Date & Revision History:
Draft date:

Referenced Documents:
- PG&E Work Paper PGECOFST108 Commercial Ice Machines Revision 3 – May 30, 2012

TRM Review Actions:
- Currently Under Review.

Major Changes:
- New measure

Measure Description:
This measure applies to Energy Efficient air-cooled commercial ice makers in retrofit and new construction applications installed in conditioned spaces. Commercial ice makers are classified into three equipment types; ice-making heads (IMHs), remote condensing units (RCUs) and self-contained units (SCUs). The measure described here applies to ice makers that use a batch process to make cubed ice.

The industry standard for energy use and performance of commercial ice machines is AHRI Standard 810. Key parameters reported for ice makers include the Equipment Type, Harvest Rate (lbs of ice/24hrs) and Energy Consumption Rate. The AHRI Directory of Certified Equipment150 lists these values by equipment manufacturer and model number.

Baseline and Efficiency Standard:
The Energy Efficient criteria for ice makers define efficiency requirements for both energy and potable water use.

Market Applicability
Hospitals account for 39.4 percent of all commercial icemaker purchases, followed by hotels (22.3 percent), restaurants (13.8 percent), retail outlets (8.5 percent), schools (8.5 percent), offices (4.3 percent), and grocery stores (3.2 percent).

Measure Savings Calculations:
Annual electric savings can be calculated by determining the energy consumed for baseline ice makers compared against ENERGY STAR performance requirements using the harvest rate of the more efficient unit. Peak demand savings can then be derived from the electric savings.

$$\Delta kWh = (kWh_{\boldsymbol{base,per100lb}} - kWh_{\boldsymbol{ee,per100lb}})/100 \times DC \times H \times 365$$

$$\Delta kW = \Delta kWh / HRS$$

Where:

- 100 = conversion factor to convert kWh***base,per100lb*** and kWh***ee,per100lb*** into maximum kWh consumption per pound of ice.
- DC = Duty Cycle of the ice maker representing the percentage of time the ice machine is making ice
- H = Harvest Rate (lbs of ice made per day)
- 365 = days per year
- kWh = Annual energy savings
- HRS = Annual operating hours
- CF = 1.0

The baseline and energy efficient energy usage per 100lbs of ice produced is dependent on the category of ice maker, as well as the capacity of the energy efficient ice maker. The equations used to determine the energy per 100lbs of ice produced can be seen below.

This incentive applies towards the purchase of new or replacement energy efficient Air-cooled ice machines. Used or rebuilt equipment is not eligible. Customers must provide proof that the appliance meets the energy efficiency specifications listed in Table below.

This specification covers machines generating 60 grams (2 oz.) or lighter ice cubes, as well as flaked, crushed, or fragmented ice machines that meet the Energy Efficiency thresholds by Ice harvest (IHR) rate listed below. Only air cooled machines (icemaker heads, self-contained unites, and remote condensing units) are eligible for incentives. Performance data is based on ARI Standard 810.

Energy Efficiency Requirements

Equipment Type	Ice Harvest Rate Range (lbs of ice/24 hrs)	Energy Effficient Ice Makers		Federal Minimum Standard Energy Consumption Rate (kWh/100 lbs ice) (H = Harvest Rate)
		Energy Consumption Rate (kWh/100 lbs ice) (H = Harvest Rate)	Potable Water Use Limit (gal/100 lbs ice)	
Ice Making Heads	<450	≤ 8.72 - 0.0073H	≤ 20	10.26 - 0.0086H
	≥ 450	≤ 5.86 - 0.0009H	≤ 20	6.89 - 0.0011H
Remote Condensing Units	< 1,000	≤ 7.52 - 0.0032H	≤ 20	8.85 - 0.0038H
	≥ 1,000	≤ 4.34	≤ 20	5.10
Remote Condensing Units	< 934	≤ 7.52 - 0.0032H	≤ 20	8.85 - 0.0038H
	≥ 934	≤ 4.51	≤ 20	5.30
Self-Contained Units	< 175	≤ 15.3 - 0.0399H	≤ 30	18.0 - 0.069H
	≥ 175	≤ 8.33	≤ 30	9.80

Example Savings Calculations

Savings calculation for varying Harvest Rates (H) can be seen below:

Performance	IHR	IHR	IHR	IHR	IHR
Ice Harvest Rate (IHR) (lbs per 24 hrs.)	101-300	301-500	501-1,000	1,001-1,500	> 1,500
Average IHR Used in Energy Calculations (lbs/day)	200	400	750	1,250	1,750
Baseline Model Energy Usage (kWh/100 lbs)	9.8	6.82	6.07	5.1	5.1
Energy Efficient Model Energy Usage (kWh/100 lbs)	8.33	5.8	5.19	4.34	4.34
Baseline Model Daily Energy Consumption (kWh)	14.7	20.5	34.1	47.8	66.9
Energy Efficient Model Daily Energy Consumption (kWh)	12.5	17.4	29.2	40.7	57
Baseline Model Average Demand (kW)	0.613	0.853	1.421	1.992	2.789
Energy Efficient Model Average Demand (kW)	0.521	0.725	1.215	1.695	2.373
Estimated Demand Reduction (kW)	0.092	0.128	0.206	0.297	0.416
Baseline Model Annual Energy Consumption (kWh/yr)	5,366	7,468	12,452	17,452	24,432
Energy Efficient Model Annual Energy Consumption (kWh/yr)	4,561	6,351	10,645	14,851	20,791
Estimated Annual Energy Savings (kWh/yr)	805	1,117	1,807	2,601	3,641
Electric Cost ($/kWh)	$0.25	$0.25	$0.25	$0.25	$0.25
Baseline Model Annual Energy Cost ($/yr)	$1,342	$1,867	$3,113	$4,363	$6,108
Energy Efficient Model Annual Energy Cost ($/yr)	$1,140	$1,588	$2,661	$3,713	$5,198
Estimated Annual Energy Cost Savings ($/yr)	$201	$279	$452	$650	$910
Estimated Incremental Cost	$306	$266	$249	$589	$939
Estimated Useful Life (EUL)	12	12	12	12	12

Demand Coincidence Factor
CF = 1.0

Lifetime
12 years

16.1.4 Food Service – Commercial Electric Steam Cooker

Version Date & Revision History:
Draft date:

Referenced Documents:
- ENERGY STAR Commercial Kitchen Equipment Savings Calculator: Steam Cooker Calcs.
- PG&E Work Paper PGECOFST104 Commercial Steam Cooker Revision #4 (5/22/12)

TRM Review Actions:
- Currently Under Review.

Major Changes:
- New measure

Measure Description:
The installation of a qualified ENERGY STAR commercial steam cooker. ENERGY STAR steam cookers save energy during cooling and idle times due to improved cooking efficiency and idle energy rates.

Baseline Efficiencies:
The Baseline Efficiency case is a conventional electric steam cooker with a cooking energy efficiency of 30%, pan production of 23.3 pounds per hour, and an idle energy rate of 1.2 kW.

High Efficiency:
The High Efficiency case is an ENERGY STAR electric steam cooker with a cooking energy efficiency of 50%, pan production capacity of 16.7 pounds per hour, and an idle energy rate of 0.4 kW.

Energy Savings:
Unit savings are deemed based on study results:

ΔkWh/year = 3,258 kWh/pan
ΔkW = 2.23 kW

Savings Algorithms

Steam Cooker Calculations for the ENERGY STAR Commercial Kitchen Equipment Calculato

Inputs

	USER ENTRY	
	Electric	
Average daily operation	12	hours
Annual days of operation	365	days
Food cooked per day	100	pounds
Number of pans per unit	3	
Incremental cost	$2,000	

Assumptions

	Electric		
	Conventional	ENERGY STAR	
Type	steam generator	boilerless	
Water Use	40	3	gallons/hour
Time in constant steam mode	40%	40%	
Cooking energy efficiency	30%	50%	
Production capacity per pan	23.3	16.7	pounds/hour
Number of preheats per day	1	1	
Preheat length	15	15	minutes
Preheat energy rate	6,000	6,000	W
Idle energy rate	1,200	400	W
ASTM energy to food	30.8		Wh/pound
Equipment lifetime	12		years

Calculations

	Electric		
	Conventional	ENERGY STAR	
Annual operation	4,380		hours
Daily preheat energy	1,500	1,500	Wh
Daily cooking energy	10,267	6,160	Wh
Daily idle time	10.32	9.75	hour
Daily idle energy	37,052	14,382	Wh
Total daily energy	48,819	22,042	Wh

Annual energy consumption per steam cooker

	Conventional	ENERGY STAR	Savings (3 Pan)	Savings per Pan
Electric Usage (kWh/year)	17,819	8,045	9,774	3258

Operating Hours
The average steam cooker is assumed to operate 4,380 hours per year.

Demand Coincidence Factor
CF = 1.0

Persistence
100% persistence factor

Lifetime
12 years

Measure Costs
Incremental cost = $2,000

16.1.5 Food Service – Commercial Electric Griddle

Version Date & Revision History:
Draft date:

Referenced Documents:

- The industry standard for energy use and cooking performance of griddles are ASTM F1275-03: Standard Test
- Method for the Performance of Griddles and ASTM F1605-01: Standard Test Method for the Performance of Double-Sided Griddles
- ENERGY STAR Commercial Griddles Program Requirements Version 1.1, effective May 2009 for gas griddles and effective January 1, 2011 for electric.
- Database for Energy Efficient Resources, 2008, http://www.deeresources.com/deer0911planning/downloads/EUL_Summary_10-1-08.xls
- Assumptions based on PG&E Commercial Griddles Work Paper developed by FSTC, May 22, 2012.

TRM Review Actions:

- Currently Under Review.

Major Changes:

- New measure

Measure Description:
This measure applies to ENERGY STAR or equivalent electric commercial griddles in retrofit and new construction applications. This appliance is designed for cooking food in oil or its own juices by direct contact with either a flat, smooth, hot surface or a hot channeled cooking surface where plate temperature is thermostatically controlled.

Energy-efficient commercial electric griddles reduce energy consumption primarily through the application of advanced controls and improved temperature uniformity.

Baseline and Efficiency Standard
Key parameters for defining griddle efficiency are Heavy Load Cooking Energy Efficiency and Idle Energy Rate. There are currently no federal minimum standards for Commercial Griddles, however, the American Society of Testing and Materials (ASTM) publishes Test Methods155 that allow uniform procedures to be applied to each commercial cooking appliance for a fair comparison of performance results.

ENERGY STAR efficiency requirements apply to single and double sided griddles. The ENERGY STAR criteria should be reviewed on an annual basis to reflect the latest requirements.

ENERGY STAR Criteria for Electric Single and Double Sided Griddles

Performance Parameters	Electric Griddles
Heavy-Load Cooking Energy Efficiency	>= 70%
Idle Energy Rate	<= 320 watts per ft²

Energy Savings:
Annual savings can be calculated by determining the energy consumed by a standard efficiency griddle as compared with an ENERGY STAR rated griddle.

ΔkWh = kWh(base) – kWh(eff)

ΔkWh(base or eff) = kWh(cooking) + kWh(idle) + kWh(preheat)

kWh(cooking) = [LB(food) x E(food)/Cook(eff)] x Days

kWh(idle) = IdleEnergy x [DailyHrs – LB(food)/Capacity – PreheatTime/60] x Days

kWh(preheat) = PreheatEnergy x Days

Parameter	Description	Value	Source
Daily Hrs	Daily Operating Hours	12 hours	FSTC
Preheat Time	Time to Preheat (min)	15 min	FSTC
E(food)	ASTM defined Energy to Food	0.139 kWh/lb	FSTC
Days	Number of days of operation	365 days	FSTC
CookEff	Cooking energy efficiency (%)	See Table below	FSTC, ENERGY STAR
IdleEnergy	Idle energy rate (kW)		
Capacity	Production capacity (lbs/hr)		FSTC
Preheat Energy	kWh/day		FSTC
LB(food)	Food cooked per day (lb/day)		FSTC

General assumptions used for deriving deemed electric savings are values taken from the Food Service Technology Center (FSTC) work papers. These deemed values assume that the griddles are 3 x 2 feet in size. Parameters in the table are per linear foot, with an assumed depth of 2 feet.

Baseline and Efficient Assumptions for Electric Griddles

Parameter	Baseline Electric Griddles	Efficient Electric Griddles
Preheat Energy (kWh/ft)	1.33	0.67
Idle Energy Rate (kW/ft)	0.80	0.64
Cooking Energy Efficiency (%)	65%	70%
Production Capacity (lbs/h/ft)	11.7	16.33
Lbs of food cooked/day/ft	33.33	33.33

Base (kWh/year) per linear foot	
Cooking	2602
Idle	2599
Preheat	485
Total Base Energy Usage (kWh)	**5686**
Demand (kW)	**1.30**

Efficient (kWh/year) per linear foot	
Cooking	2416
Idle	2268
Preheat	245
Total Efficient Energy Usage (kWh)	**4928**
Demand (kW)	**1.13**

Energy Savings (kWh/year) per linear foot	**758**
Demand Savings (kW)	**0.17**

Operating Hours
The average steam cooker is assumed to operate 4,380 hours per year.

Demand Coincidence Factor
Coincidence factor is 1.0 because the cooking equipment is assumed to operate throughout the on-peak demand periods (5PM – 9PM).

Persistence
100% persistence factor

Lifetime
12 years – DEER (2008)

Measure Costs and Incentive Levels
Incremental cost = $774
(Assumptions based on PG&E Commercial Griddles Work Paper developed by FSTC, May 22, 2012).

16.1.6 Food Service – Commercial Fryer

Version Date & Revision History:
Draft date:
Effective date: July 1, 2015
End date: June 30, 2015

Referenced Documents:

- The industry standards for energy use and cooking performance of fryers are ASTM Standard Test Method for the Performance of Open Deep Fat Fryers (F1361) and ASTM Standard Test Method for the Performance of Large Vat Fryers (FF2144).
- ENERGY STAR Version 2.0, effective April 22, 2011
- Assumptions based on PG&E Commercial Fryers Work Paper developed by FSTC, June 13, 2012

TRM Review Actions:

- Currently Under Review.

Major Changes:

- New measure

Measure Description:
This measure applies to ENERGY STAR or its equivalent electric commercial open-deep fat fryers in retrofit and new construction applications. Commercial fryers consist of a reservoir of cooking oil that allows food to be fully submerged without touching the bottom of the vessel. Electric fryers use a heating element immersed in the cooking oil. High efficiency standard and large vat fryers offer shorter cook times and higher production rates through the use of heat exchanger design. Standby losses are reduced in more efficient models through the use of fry pot insulation.

Baseline and Efficiency Standard
Key parameters for defining fryer efficiency are Heavy Load Cooking Energy Efficiency and Idle Energy Rate. ENERGY STAR requirements apply to a standard fryer and a large vat fryer. A standard fryer measures 14 to 18 inches wide with a vat capacity from 25 to 60 pounds. A large vat fryer measures 18 inches to 24 inches wide with a vat capacity greater than 50 pounds. The ENERGY STAR criteria should be reviewed on an annual basis to reflect the latest requirements.

There are currently no federal minimum standards for Commercial Fryers, however, the American Society of Testing and Materials (ASTM) publishes Test Methods183 that allow uniform procedures to be applied to each commercial cooking appliance for a fair comparison of performance results.

ENERGY STAR Criteria and FSTC Baseline for Open Deep-Fat Electric Fryers

Performance Parameters	ENERGY STAR Electric Fryer Criteria	
	Standard Fryers	Large Vat Fryers
Heavy-Load Cooking Energy Efficiency	>= 80%	>= 80%
Idle Energy Rate	<+ 1.0 kW	<= 1.1 kW

Energy Savings:

Annual savings can be calculated by determining the energy consumed by a standard efficiency fryer as compared with an ENERGY STAR rated fryer.

∆kWh	= kWh(base) – kWh(eff)
∆kWh(base or eff)	= kWh(cooking) + kWh(idle) + kWh(preheat)
kWh(cooking)	= [LB(food) x E(food)/Cook(eff)] x Days
kWh(idle)	= IdleEnergy x [DailyHrs – LB(food)/Capacity – PreheatTime/60] x Days
kWh(preheat)	= PreheatEnergy x Days

Parameter	Description	Value	Source
Daily Hrs	Daily Operating Hours	12 hours	FSTC
Preheat Time	Time to Preheat (min)	15 min	FSTC
E(food)	ASTM defined Energy to Food	0.167 kWh/lb	FSTC
Days	Number of days of operation	365 days	FSTC
CookEff	Cooking energy efficiency (%)	See Table below	FSTC, ENERGY STAR
IdleEnergy	Idle energy rate (kW)		
Capacity	Production capacity (lbs/hr)		FSTC
Preheat Energy	kWh/day		FSTC
LB(food)	Food cooked per day (lb/day)		FSTC

General assumptions used for deriving deemed electric savings are values taken from the Food Service Technology Center (FSTC) work papers.

Baseline and Efficient Assumptions for Electric Standard and Large Vat Fryers

Parameter	Baseline Electric Fryers		Efficient Electric Fryers	
	Standard	Large Vat	Standard	Large Vat
Preheat Energy (kWh/ft)	2.3	2.5	1.7	2.1
Idle Energy Rate (kW/ft)	1.05	1.35	1.00	1.1
Cooking Energy Efficiency (%)	75%	70%	80%	80%
Production Capacity (lbs/h/ft)	65	100	70	110
Lbs of food cooked/day/ft	150	150	150	150

Baseline Electric Fryers	Standard	Large Vat
Cooking	12191	13062
Idle	3619	5051
Preheat	840	913
Total Energy Usage (kWh/year) per Vat	16649	19025
Demand	3.80	4.34

Efficient Electric Fryers	Standard	Large Vat
Cooking	11429	11429
Idle	3507	4170
Preheat	621	767
Total Energy Usage (kWh/year) per Vat	15556	16366
Demand	3.55	3.74

Savings	Standard	Large Vat
Energy Savings (kWh/year) per Vat	1093	2659
Demand Savings (kW)	0.25	0.61

Operating Hours
The average steam cooker is assumed to operate 4,380 hours per year.

Demand Coincidence Factor
Coincidence factor is 1.0 because the cooking equipment is assumed to operate throughout the on-peak demand periods (5PM – 9PM).

Persistence
100% persistence factor

Lifetime
12 years – DEER (2008)

Measure Costs and Incentive Levels
Incremental cost = $769
(Assumptions based on PG&E Commercial Fryers Work Paper developed by FSTC, May 22, 2012).

16.1.7 Hot Food Holding Cabinet

Version Date & Revision History:
Draft date:
Effective date: July 1, 2015
End date: June 30, 2015

Referenced Documents:
- PG&E Work Paper PGEFST105 (Revision 3) – June 8, 2012

TRM Review Actions:
- Currently Under Review.

Major Changes:
- New measure

Measure Description:
Commercial insulated hot food holding cabinet models that meet program requirements incorporate better insulation, reducing heat loss, and may also offer additional energy saving devices such as magnetic door electric gaskets, auto-door closures, or dutch doors. The insulation of the cabinet also offers better temperature uniformity within the cabinet from top to bottom. This means that qualified hot food holding cabinets are more efficient at maintaining food temperature while using less energy.

- **<u>Full-size holding cabinets</u>** are defined as any holding cabinet with an internal measured volume of greater than or equal to 15 cubic feet (≥15 ft.3). This measure does not include cook-and-hold equipment. All measures must be electric hot food holding cabinets that are fully insulated and have doors. Qualifying cabinets must not exceed the maximum idle energy rate of 20 Watts per cubic foot in accordance with the ASTM Standard test method.

- **<u>Half-size holding cabinets</u>** are defined as any holding cabinet with an internal measured volume of less than 15 cubic feet (<15 ft.3). This measure does not include cook-and-hold or retherm equipment. All measures must be electric hot food holding cabinets that are fully insulated and have doors. Qualifying cabinets must not exceed the maximum idle energy rate of 20 Watts per cubic foot in accordance with the ASTM Standard test method.

Baseline Efficiency:
The baseline equipment is assumed to be a standard hot food holding cabinet with an idle energy rate of 40 watts per cubic foot.

High Efficiency:
The efficient equipment is assumed to be an ENERGY STAR qualified hot food holding cabinet with an idle energy rate of 20 watts per cubic foot.

Energy Savings:
Energy usage calculations are based on 15 hours a day, 365 days per year operation at a typical temperature setting of 150°F. The different sizes for the holding cabinets (half size and full size) have proportional operating energy rates. Operating energy rate for the full size holding cabinets was obtained in accordance with the ASTM Standard.

The energy savings calculations listed in the following tables use Title 20 (California) as the baseline for potential energy savings requiring all hot food holding cabinets sold in California to meet a normalized idle energy rate of 40 Watts/ft³.

Insulated Hot Food Holding Cabinet - Full Size

Performance	Baseline	High Efficiency Qualifying Model
Demand (kW)	1	0.28
Annual Energy Use (kWh/year)	5475	1533
Estimated Demand Reduction (kW)	-	0.72
Annual Energy Savings (kWh/year)	-	3942
Incremental Measure Cost ($)		2336
Estimated Useful Life (years)	12	12

Insulated Hot Food Holding Cabinet - Half Size

Performance	Baseline	High Efficiency Qualifying Model
Demand (kW)	0.38	0.05
Annual Energy Use (kWh/year)	2081	274
Estimated Demand Reduction (kW)	-	0.33
Annual Energy Savings (kWh/year)	-	1807
Incremental Measure Cost ($)		381
Estimated Useful Life (years)	12	12

The demand reduction estimation is based on measured data for standard efficiency insulated holding cabinets and for high-efficiency insulated holding cabinets. The measured data are derived from tests conducted under ASTM Standard Test Method for the Performance of Hot Food Holding Cabinets.

Measure ASTM test results for Hot Food Holding Cabinets

Cabinet Size	Cabinet Volume (ft³)	Normalized Idle Energy Rate (W/ft³)	Total Cabinet Idle Energy Rate (W)
Full-Size	25	11.3	0.28
Half-Size	10	5.7	0.05

Operating Hours

15 hr/day, 365 day/year = 5,475 hours/year

Demand Coincidence Factor
CF = 1.0

Lifetime
12 years

Measure Costs
The incremental cost for ENERGY STAR hot food holding cabinet is $2,336 (full size) & $381 (half size)

16.1.8 Commercial Kitchen Combination Ovens

Version Date & Revision History:
Draft date:
Effective date: July 1, 2015
End date: June 30, 2015

Referenced Documents:

- U.S. Department of Energy, Energy Star website: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COO
- Energy Star Commercial Kitchen Equipment Savings Calculator
- PG&E Work Paper PGEFST105 (Revision 3) – June 8, 2012
- Arkansas TRM Version 2.0 Volume 2
- KEMA report titled "Business Programs: Deemed Savings Parameter Development", November 2009 - Coincidence factor for food service building type listed as 0.84

TRM Review Actions:

- Currently Under Review.

Major Changes:

- New measure

Measure Description:
Commercial combination ovens offer the ability to steam food in the oven cavity. These oven are capable of steaming, proofing and reheating various food products in addition to the normal functions of baking and roasting. Foods can be cooked in a variety of ways: in a convection oven dry heat only mode, a steam only mode, and a combination of dry heat and steam modes. Food to be cooked partially in one mode at a certain temperature and then finished in another mode and at a separate temperature by utilizing the programmability of combination ovens. Combination ovens range in size from 6 pan countertop models up to 40 pan stand-alone models.

Baseline Efficiency:

Parameter	< 15 Pans	15-28 Pans	> 28 Pans
Assumptions			
% Time in Steam Mode	50%	50%	50%
Preheat Energy (kWh/day)	3.0	3.75	5.63
Convection Idle Energy Rate (kW)	1.5	3.75	5.25
Steam Idle Energy Rate (kW)	10.0	12.5	18.0
Convection Cooking Energy Efficiency (%)	65%	65%	65%
Steam Cooking Energy Efficiency (%)	40%	40%	40%
Convection Production Capacity (lbs/hour)	80	100	275
Steam Production Capacity (lbs/hour)	100	150	350
Lbs of Food Cooked/day	200	250	400
Total Energy			
Annual Energy Consumption (kWh)	35,263	48,004	74,448
Demand (kW)	6.8	9.2	14.3

High Efficiency:

Parameter	< 15 Pans	15-28 Pans	> 28 Pans
Assumptions			
% Time in Steam Mode	50%	50%	50%
Preheat Energy (kWh/day)	1.5	2.0	3.0
Convection Idle Energy Rate (kW)	1.0	2.5	4.0
Steam Idle Energy Rate (kW)	5.0	6.0	9.0
Convection Cooking Energy Efficiency (%)	70%	70%	70%
Steam Cooking Energy Efficiency (%)	50%	50%	50%
Convection Production Capacity (lbs/hour)	100	152	325
Steam Production Capacity (lbs/hour)	120	200	400
Lbs of Food Cooked/day	200	250	400
Total Energy			
Annual Energy Consumption (kWh)	23,658	32,001	50,692
Demand (kW)	4.5	6.1	9.7

Energy Savings

Energy usage calculations are based on 12 hours a day, 365 days per year (4,380 hours/year). The different sizes for the combination ovens (< 15 pans, 15-28 pans, and > 28 pans) have proportional operating energy rates.

Performance	< 15 Pans	15-28 Pans	> 28 Pans
Annual Energy Savings (kWh)	11,604	16,003	23,756
Estimated Demand Reduction (kW)	2.6	3.7	5.4

Operating Hours
12 hr/day, 365 day/year = 4,380 hours/year

Demand Coincidence Factor
CF = 0.84

Lifetime
12 years

16.1.9 Commercial Kitchen Convection Ovens

Version Date & Revision History:
Draft date:

Referenced Documents:
- U.S. Department of Energy, Energy Star website: http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&pgw_code=COO
- Energy Star Commercial Kitchen Equipment Savings Calculator
- PG&E Work Paper PGEFST105 (Revision 3) – June 8, 2012
- Arkansas TRM Version 2.0 Volume 2
- KEMA report titled "Business Programs: Deemed Savings Parameter Development", November 2009 - Coincidence factor for food service building type listed as 0.84

TRM Review Actions:
- Currently Under Review.

Major Changes:
- New measure

Measure Description:
Commercial convection ovens are widely used in the foodservice industry and have a wide variety of uses from baking and roasting to warming and reheating. Convection ovens are also used for nearly all types of food preparation, including foods typically prepared using other types of appliances (e.g., griddles, fryers, etc.). ENERGY STAR commercial ovens are about 20 percent more energy efficient than standard models.

- **Full-size electric convection ovens** are defined by the ability to accept a minimum of five (5) standard full-size sheet pans (18 in. x 26 in. x 1 in.). Qualifying ovens must meet Energy Star requirements by having a tested heavy-load (potato) cooking efficiency in accordance with ASTM F1496. Cooking energy efficiency must be greater than or equal to 70 percent (≥70%) and must not exceed the maximum idle energy rate of 1.6 kW (≤ 1.6kW).

- **Half-size electric convection ovens** are defined by the ability to accept a minimum of five (5) sheet pans measuring (18 in. x 13 in. x 1 in.). Qualifying ovens must meet Energy Star requirements by having a tested heavy-load (potato) cooking efficiency in accordance with ASTM F1496. Cooking energy efficiency must be greater than or equal to 70 percent (≥70%) and must not exceed the maximum idle energy rate of 1.0 kW (≤ 1.0kW).

Baseline Efficiency:

Parameter	Half Size	Full Size
Assumptions		
Preheat Energy (kWh/day)	1.0	1.5
Idle Energy Rate (kW)	1.5	2.0
Cooking Energy Efficiency (%)	65%	65%
Production Capacity (lbs/hour)	45	70
Lbs of food cooked/day	100	100
Energy per pound of food (kWh/lb)	0.0732	0.0732
Total Energy		
Annual Energy Consumption (kWh)	9,692	12,193
Demand (kW)	1.86	2.34

High Efficiency:

Parameter	Half Size	Full Size
Assumptions		
Preheat Energy (kWh/day)	0.9	1.0
Idle Energy Rate (kW)	1.0	1.6
Cooking Energy Efficiency (%)	70%	70%
Production Capacity (lbs/hour)	50	80
Lbs of food cooked/day	100	100
Energy per pound of food (kWh/lb)	0.0732	0.0732
Total Energy		
Annual Energy Consumption (kWh)	7,704	10,314
Demand (kW)	1.48	1.98

Energy Savings
Energy usage calculations are based on 12 hours a day, 365 days per year. The different sizes for the holding cabinets (half size and full size) have proportional operating energy rates.

Performance	Half Size	Full Size
Annual Energy Savings (kWh)	1,988	1,879
Estimated Demand Reduction (kW)	0.38	0.36

Operating Hours
12 hr/day, 365 day/year = 4,380 hours/year

Demand Coincidence Factor
CF = 0.84

Lifetime
12 years

16.1.10 Commercial Solid Door Refrigerators & Freezers

Version Date & Revision History
Draft date:

Referenced Documents:

- Southern California Edison Work Paper SCE13CC001 Commercial Reach-In Refrigerators and Freezers – April 6, 2012

TRM Review Actions:

- 10/5/11 – Currently Under Review.

Major Changes:

- New measure

Measure Description:
This measure relates to the installation of a new reach-in commercial refrigerator or freezer meeting ENERGY STAR efficiency standards. ENERGY STAR labeled commercial refrigerators and freezers are more energy efficient because they are designed with components such as ECM evaporator and condenser fan motors, hot gas anti-sweat heaters, or high-efficiency compressors, which will significantly reduce energy consumption. This measure could relate to the replacing of an existing unit at the end of its useful life, or the installation of a new system in a new or existing building.

Baseline Efficiencies:
In order for this characterization to apply, the baseline equipment is assumed to be a solid or glass door refrigerator or freezer meeting the minimum federal manufacturing standards. It is assumed that the volume for baseline is the average of the range. For example if range is 0 to 15, the average volume is 7.5.

High Efficiency:
In order for this characterization to apply, the efficient equipment is assumed to be a solid or glass door refrigerator or freezer meeting the minimum ENERGY STAR efficiency level standards.

Energy and Demand Savings:

Annual Energy Savings (kWh/year) = (kWh_{base} – kWh_{ee}) * 365

Demand Savings = Annual Energy Savings / Hours * CF

Operating Hours
8760 hours/year

Demand Coincidence Factor
CF = 1.0

Lifetime
12 years

Volume (cubic feet)	Typical Volume (cubic feet)	Volumetric Factor (kWh/ft3)	Fixed Energy Usage (kWh)	Enhanced Case (kWh/day)
Solid-door Reach-in Refrigerator				
0 < V < 15	7.5	0.089	1.411	2.08
15 ≤ V < 30	22.5	0.037	2.200	3.03
30 ≤ V < 50	40	0.056	1.635	3.88
50 ≤ V	60	0.060	1.416	5.02
Solid-Door Reach-In Freezer				
0 < V < 15	7.5	0.250	1.250	3.13
15 ≤ V < 30	22.5	0.400	-1.000	8.00
30 ≤ V < 50	40	0.163	6.125	12.65
50 ≤ V	60	0.158	6.333	15.81
Glass-door Reach-in Refrigerator				
0 < V < 15	7.5	0.118	1.382	2.27
15 ≤ V < 30	22.5	0.140	1.050	4.20
30 ≤ V < 50	40	0.089	2.625	6.18
50 ≤ V	60	0.110	1.500	8.10
Glass-Door Reach-In Freezer				
0 < V < 15	7.5	0.607	0.893	5.45
15 ≤ V < 30	22.5	0.733	-1.000	15.49
30 ≤ V < 50	40	0.250	13.500	23.50
50 ≤ V	60	0.450	3.500	30.50

Volume (cubic feet)	Typical Volume (cubic feet)	Volumetric Factor (kWh/ft3)	Fixed Energy Usage (kWh)	Base Case (kWh/day)
Solid-door Reach-in Refrigerator				
0 < V < 15	7.5	0.10	2.04	2.79
15 ≤ V < 30	22.5	0.10	2.04	4.29
30 ≤ V < 50	40	0.10	2.04	6.04
50 ≤ V	60	0.10	2.04	8.04
Solid-Door Reach-In Freezer				
0 < V < 15	7.5	0.40	1.38	4.38
15 ≤ V < 30	22.5	0.40	1.38	10.38
30 ≤ V < 50	40	0.40	1.38	17.38
50 ≤ V	60	0.40	1.38	25.38
Glass-door Reach-in Refrigerator				
0 < V < 15	7.5	0.12	3.34	4.24
15 ≤ V < 30	22.5	0.12	3.34	6.04
30 ≤ V < 50	40	0.12	3.34	8.14
50 ≤ V	60	0.12	3.34	10.54
Glass-Door Reach-In Freezer				
0 < V < 15	7.5	0.75	4.10	9.73
15 ≤ V < 30	22.5	0.75	4.10	20.98
30 ≤ V < 50	40	0.75	4.10	34.1
50 ≤ V	60	0.75	4.10	49.1

Volume (cubic feet)	Typical Volume (cubic feet)	Base Case (kWh/day)	Enhanced Case (kWh/day)	Energy Savings (kWh/day)	Energy Savings (kWh/year)	Demand Savings (kW)
Solid-door Reach-in Refrigerator						
0 < V < 15	7.5	2.79	2.08	0.71	259.15	0.030
15 ≤ V < 30	22.5	4.29	3.03	1.26	459.90	0.053
30 ≤ V < 50	40	6.04	3.88	2.16	788.40	0.090
50 ≤ V	60	8.04	5.02	3.02	1102.30	0.126
Solid-Door Reach-In Freezer						
0 < V < 15	7.5	4.38	3.13	1.25	456.25	0.052
15 ≤ V < 30	22.5	10.38	8.00	2.38	868.70	0.099
30 ≤ V < 50	40	17.38	12.65	4.73	1726.45	0.197
50 ≤ V	60	25.38	15.81	9.57	3493.05	0.399
Glass-door Reach-in Refrigerator						
0 < V < 15	7.5	4.24	2.27	1.97	719.05	0.082
15 ≤ V < 30	22.5	6.04	4.20	1.84	671.60	0.077
30 ≤ V < 50	40	8.14	6.18	1.96	715.40	0.082
50 ≤ V	60	10.54	8.10	2.44	890.60	0.102
Glass-Door Reach-In Freezer						
0 < V < 15	7.5	9.73	5.45	4.28	1562.20	0.178
15 ≤ V < 30	22.5	20.98	15.49	5.49	2003.85	0.229
30 ≤ V < 50	40	34.1	23.50	10.60	3869.00	0.442
50 ≤ V	60	49.1	30.50	18.60	6789.00	0.775

Measure Costs and Incentive Levels

Incremental Measure Refrigerator and Freezer Costs

Description	Under-Counter	Single-Door	Double-Door	Triple-Door
Nominal Size	1 door	1 door	2 doors	3 doors
Nominal Volume Range (cubic feet)	0 ≤ V < 15	15 ≤ V < 30	30 ≤ V 50	50 ≤ V
Solid-Door Reach-In Refrigerators Incremental Cost	$1,092.00	$ 1,410.73	$ 1,968.70	$2,723.28
Solid-Door Reach-In Freezers Incremental Cost	$ 257.60	$ 1,363.18	$15,556.71	$1,968.03
Glass-Door Reach-In Refrigerators Incremental Cost	$ 103.60	$ 863.80	$ 1,076.11	$1,548.96
Glass-Door Reach-In Freezers Incremental Cost	$ 25.48	$ 124.04	$ 214.20	$ 899.30

16.1.11 Small Business Direct Restaurant Lighting Retrofits

Version Date & Revision History:
Draft date:

Referenced Documents:
- n/a

TRM Review Actions:
- 10/5/11 – Currently Under Review.

Major Changes:
- n/a

Measure Description:
The program targets customers within the small business market. Typically this market has limited time and expertise within their organizations to research lighting technology options, obtain financing and contract with lighting contractors to replace their older less efficient lighting technologies. The Small Business Lighting Retrofit provides a "Turnkey" program consisting of audits, fixed pricing, installation by participating Hawaii Energy contractors and 4 month financing of lighting retrofits.

Program Requirements:
Small Business Restaurant Customers - TBD

Savings Algorithms

Small Business Direct Install Lighting Retrofit Pilot Program
Summary Sheet

Business Name:	
Contact Name:	
Address:	
Phone:	
Fax:	
Email:	

Contractor Name:	
Auditor Name:	
Address:	
Phone:	
Fax:	
Email:	

Total Watts Saved	Energy Savings	Energy Cost Savings	Hawaii Energy Participating Contractor NTE Pricing	Hawaii Energy Cash Incentive	Net Customer Cost	Simple Payback	4 Month Monthly Payment	Monthly Savings % of Payment
1,323 W	3,324 kWh/yr.	$ 776 / yr.	$ 2,300	$ 833	1,467	23	367	18%

Step 1	
f2	
Oahu	Island of Project Location
$ 0.234 /kWh	2010 "G" Marginal Cost of Electricity

Measure Code	Existing Technology		New Technology		Total Units (each) a	M-F Hours per Day b1a	Sat. Hours per Day b1b	Sun. Hours per Day b2a	Annual Hours of Operation (hrs/year) b3 = b1*b2*(365/7)	Wkdays Hours on between 5 and 9 p.m. (hrs) c	On-Peak Fraction (%) c2 = c / 4	Total Watts Saved (Watts) d = a x o	Energy Savings (kWh/Year) e = b x (d/1000)	Energy Cost Savings ($/year) f = e x f2	Hawaii Energy Participating Contractor NTE Pricing ($) g = a x p	Hawaii Energy Cash Incentive ($) h = a x q	Net Customer Cost ($) i = a x (p-q)	Simple Payback (Months) j = (i/f) x 12	6 Month Monthly Payment ($/month) k = i /6	Monthly Savings % of Payment (%) l = (f/12)/k
					Step 2	Step 3				Step 4										
8L1-4L2	8 ft.	1 Lamp F96	4 ft.	2 lamp F25/28 N	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 75	$ 62	$ 13	6	$ 2.24	100%
8L2-4L2	8 ft.	2 Lamp F96	4 ft.	2 lamp F25/28 H	1	8	8	0	2,503	-	0%	57	143	$ 33	$ 84	$ 53	$ 31	11	$ 5.17	54%
8L2HO-4L2R	8 ft.	2 Lamp F96 HO	4 ft.	2 lamp F25/28 N, Reflct.	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 85	$ 27	$ 58	26	$ 9.67	23%
8L2HO-4L4	8 ft.	2 Lamp F96 HO	4 ft.	4 lamp F25/28 N	1	8	8	0	2,503	-	0%	92	230	$ 54	$ 138	$ 53	$ 85	19	$ 14.17	32%
4L4-4L4	4 ft.	4 Lamp F40	4 ft.	4 lamp F25/28 N	1	8	8	0	2,503	-	0%	92	230	$ 54	$ 83	$ 51	$ 32	7	$ 5.33	84%
4L4-4L2R	4 ft.	4 lamp F40	4 ft.	2 lamp F25/28 N, Reflct.	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 65	$ 27	$ 38	17	$ 6.33	35%
4L3-4L3	4 ft.	3 lamp F40	4 ft.	3 lamp F25/28 N, Reflct.	1	8	8	0	2,503	-	0%	69	173	$ 40	$ 74	$ 38	$ 36	11	$ 6.00	56%
4L3-4L2R	4 ft.	3 lamp F40	4 ft.	2 lamp F25/28 N, Reflct.	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 65	$ 27	$ 38	17	$ 6.33	35%
4L2-4L2	4 ft.	2 lamp F40	4 ft.	2 lamp F25/28 N	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 35	$ 27	$ 8	4	$ 1.33	168%
4L1-4L1	4 ft.	1 lamp F40	4 ft.	1 lamp F25/28 N	1	8	8	0	2,503	-	0%	23	58	$ 13	$ 30	$ 14	$ 16	14	$ 2.67	42%
4L4-4L4	4 ft.	4 lamp F32	4 ft.	4 lamp F25/28 N	1	8	8	0	2,503	-	0%	92	230	$ 54	$ 83	$ 34	$ 49	11	$ 8.17	55%
4L4-4L2	4 ft.	4 lamp F32	4 ft.	2 lamp F25/28 N	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 65	$ 53	$ 12	5	$ 2.00	112%
4L3-4L3	4 ft.	3 lamp F32	4 ft.	3 lamp F25/28 N	1	8	8	0	2,503	-	0%	69	173	$ 40	$ 74	$ 26	$ 48	14	$ 8.00	42%
4L3-4L2	4 ft.	3 lamp F32	4 ft.	2 lamp F25/28 N	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 65	$ 25	$ 40	18	$ 6.67	34%
4L2-4L2	4 ft.	2 lamp F32	4 ft.	2 lamp F25/28 N	1	8	8	0	2,503	-	0%	46	115	$ 27	$ 35	$ 27	$ 8	4	$ 1.33	168%
4L1-4L1	4 ft.	1 lamp F32	4 ft.	1 lamp F25/28 N	1	8	8	0	2,503	-	0%	23	58	$ 13	$ 35	$ 9	$ 26	23	$ 4.33	26%
1L400-4L6	HID Pendant	1 lamp 400W	4 foot	6 lamp F25/T8 N	1	8	8	0	2,503	-	0%	138	345	$ 81	$ 360	$ 76	$ 284	42	$ 47.33	14%
1L250-4L4	HID Pendant	1 lamp 250W	4 foot	4 lamp F25/T8 N	1	8	8	0	2,503	-	0%	92	230	$ 54	$ 330	$ 51	$ 279	62	$ 46.50	10%
1L175-4L4	HID Pendant	1 lamp 175W	4 foot	4 lamp F25/T8 N	1	8	8	0	2,503	-	0%	92	230	$ 54	$ 330	$ 51	$ 279	62	$ 46.50	10%
UBL2-2L2	4 ft. U-Bend	2 lamp FB40	2 ft.	2 lamp F17 N	1	8	8	0	2,503	-	0%	32	80	$ 19	$ 40	$ 22	$ 18	12	$ 3.00	52%
UBL2-2L2R	4 ft. U-Bend	2 lamp FB40	2 ft.	2 lamp F17 L, Reflector	1	8	8	0	2,503	-	0%	27	68	$ 16	$ 50	$ 30	$ 20	15	$ 3.33	39%
100-23	100 Watt Incandescent		23 Watt	CFL	1	8	8	0	2,503	-	0%	23	58	$ 13	$ 10	$ 4	$ 6	5	$ 1.00	112%
75-19	75 Watt Incandescent		19 Watt	CFL	1	8	8	0	2,503	-	0%	19	48	$ 11	$ 8	$ 4	$ 4	4	$ 0.67	139%
60-13	60 Watt Incandescent		13 Watt	CFL	1	8	8	0	2,503	-	0%	13	33	$ 8	$ 6	$ 4	$ 2	3	$ 0.33	190%
Exit	40W Incandecent		2 Watt	LED	1	24	24	24	8,760	-	0%	2	18	$ 4	$ 75	$ 38	$ 37	109	$ 6.17	6%
OverHeight	Cost Adder for Fixtures above or out of the reach of a 10' Ladd				0										$ -		$ -			
												1,323 W	3,324 kWh/yr.	$ 776 / yr.	$ 2,300	$ 833	$ 1,467	23	$ 366.86	18%

WORKBOOK INPUTS

Measure Code	Existing per Unit Watts (Watt/unit) m	Unit New Watts (Watt/unit) n	Unit Watts Saved (Watt/unit) o = m-n	Hawaii Energy Participating Contractor Pricing ($/unit) p	Hawaii Energy Cash Incentive ($) q	Public Benefit Fee Investment ($/kWh) r
8L1-4L2	85	46	39	$ 75	$ 62	$ 0.53
8L2-4L2	142	57	85	$ 84	$ 53	$ 0.37
8L2HO-4L2R	170	46	124	$ 85	$ 27	$ 0.23
8L2HO-4L4	170	92	78	$ 138	$ 53	$ 0.23
4L4-4L4	168	92	76	$ 83	$ 51	$ 0.22
4L4-4L2R	168	46	122	$ 65	$ 27	$ 0.23
4L3-4L3	126	69	57	$ 74	$ 38	$ 0.22
4L3-4L2R	126	46	80	$ 65	$ 27	$ 0.23
4L2-4L2	84	46	38	$ 35	$ 27	$ 0.23
4L1-4L1	42	23	19	$ 30	$ 14	$ 0.24
4L4-4L4	112	92	20	$ 83	$ 34	$ 0.15
4L4-4L2	112	46	66	$ 65	$ 53	$ 0.46
4L3-4L3	84	69	15	$ 74	$ 26	$ 0.15
4L3-4L2	84	46	38	$ 65	$ 25	$ 0.22
4L2-4L2	56	46	10	$ 35	$ 27	$ 0.23
4L1-4L1	28	23	5	$ 35	$ 9	$ 0.16
1L400-4L6	475	138	337	$ 360	$ 76	$ 0.22
1L250-4L4	300	92	208	$ 330	$ 51	$ 0.22
1L175-4L4	225	92	133	$ 330	$ 51	$ 0.22
UBL2-2L2	84	32	52	$ 40	$ 22	$ 0.27
UBL2-2L2R	84	27	57	$ 50	$ 30	$ 0.44
100-23	100	23	77	$ 10	$ 4	$ 0.07
75-19	75	19	56	$ 8	$ 4	$ 0.08
60-13	60	13	47	$ 6	$ 4	$ 0.12
Exit	40	2	38	$ 75	$ 38	$ 2.17
OverHeight				$ 8		
						0