4CSR 240-22.050

APPENDIX 5.D.2

Morgan Marketing Partners

Energy Conservation Measure Descriptions

4CSR 240-22.050 APPENDIX 5.D.2

This appendix describes the end-use energy conservation measures (ECM) that were evaluated for screening purposes and the estimates of energy savings that could be obtained by implementing the ECMs[1].

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[1] Additional information about the modeling and assumptions for weather sensitive HVAC measures can be found in the report, “Kansas City Power & Light C&I Energy Efficiency Programs Findings and Documentation”, dated January 04, 2008 by Morgan Marketing Partners, pages 33-61.

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SECTION 1: FES – L1 – REPLACE T12 OR T12HOS FIXTURES WITH T8 OR T8HO FIXTURES

Measure IDs: MMP 1 - 17

1.1 TECHNOLOGY DESCRIPTION

For this technology, we evaluated the replacement of energy efficient T12 lamps and T12 fixtures with magnetic ballasts with T8 lamps and T8 fixtures with electronic ballasts.

1.2 METHODOLOGY AND ASSUMPTIONS

A standard spreadsheet analysis was developed to evaluate the use of T8 lamps and fixtures with electronic ballasts versus the use of energy efficient T12 lamps and fixtures with magnetic ballasts. Also evaluated was the replacement of T12 HO lamps and fixtures with T8HO lamps and fixtures.

Key assumptions for both scenarios:

- Cost estimates include material costs only. Fixture replacement as well as fixture retrofit costs are provided. Installation costs and potential maintenance savings are not included.
- Secondary impacts for heating and cooling were not evaluated.
- Information regarding lamp and system wattages, lumens, and material pricing was developed from a combination of lighting suppliers and industrial supply houses.
- Potential lighting replacement scenarios were evaluated based on mean lumens. Lumen is the measure of the amount of light a lamp produces. Initial lumens are the lamps' approximate light output after 100 hours of operation, while mean lumens measures the light output at 40% of its rated life. A true measure of a lamps' efficacy is how well it maintains its' light output over time.

1.3 RESULTS SUMMARY

The results of the analysis are shown in FES – L1 T8 Replacement of T12s.

- Standard 2' T8 17 watt lamps with electronic ballasts can be used to replace standard 2' T12 20 watt lamps with magnetic ballasts on a one-for-one replacement schedule for 1, 2, 3 and 4 lamp configurations, with an average 10% increase in mean lumen output.

- Standard 3’ T8 25 watt lamps with electronic ballasts can be used to replace standard 3’ T12 30 watt lamps with magnetic ballasts on a one-for-one replacement schedule for 1, 2, 3 and 4 lamp configurations, with an average 3% increase in mean lumen output.

- Standard 4’ T12 34 watt lamps with magnetic ballasts can be replaced by 4’ T8 lamps with 28, 30, or 32 watt lamps with electronic ballasts on a one-for-one replacement schedule for 1, 2, 3 and 4 lamp configurations. Utilizing T8 28 watt lamps yield an average 13% increase in mean lumens output, the T8 30 watt lamps yield an average 16% increases in mean lumens output, while the T8 32 watt lamps yield an average 17% increase in mean lumens output.

- Standard 8’ T8 59 watt lamps with electronic ballasts can be used to replace standard 8’ T12 60 watt lamps with magnetic ballasts on a one-for-one replacement schedule for 1 and 2 lamp configurations, with an average 9% increase in mean lumen output. Although replacing T12 60W 8’ 1 and 2 lamp configurations with respective T8 59W 8’ 1 and 2 lamp configurations is an energy efficient solution, it isn’t very cost effective. A more cost effective option would be to replace T12 60W 8’ 1 lamp fixtures with T8 32 W 4’2 lamp fixtures and to replace T12 60W 8’ 2 lamp fixtures with T8 32 W 4’ 4 lamp fixtures. This option results in a 5% increase in mean lumen output.

- Standard 8’ T8 86 watt HO lamps with electronic ballasts can be used to replace standard 8’ T12 95 watt HO lamps with magnetic ballasts on a one-for-one replacement schedule for 1 and 2 lamp configurations, with an average 9% increase in mean lumen output.

- Standard 2’ T8 32W watt U-Bend lamps with electronic ballasts can be used to replace standard 2’ T12 34 watt U-Bend lamps with magnetic ballasts on a one-for-one replacement schedule for 1 and 2 lamp configurations, with an average 12% increase in mean lumen output.

1.4 MEASURE LIFE

Fixture and ballast life data range from 10 to 16 years, we recommend 10 years.

1.5 INITIAL ONE-TIME COSTS

A summary of costs are shown in FES – L1 T8 Replacement of T12s.

1.6 EXISTING ENERGY STANDARDS

There are currently no standards for this technology.

1.7 SOURCES OF INFORMATION

Center Point Energy lighting wattage table, manufacturer's data, and utility data.

1.8 ATTACHMENTS

FES – L1 T8 Replacement of T12s.

SECTION 2: FES – L2 REPLACE T12 OR T12HO FIXTURES WITH T5 OR T5HO FIXTURES

Measure IDs: MMP 18 - 25

2.1 TECHNOLOGY DESCRIPTION

For this technology, we evaluated the replacement of energy efficient T12 lamps and T12 fixtures with magnetic ballasts with T5 lamps and T5 fixtures with electronic ballasts.

2.2 METHODOLOGY AND ASSUMPTIONS

A standard spreadsheet analysis was developed to evaluate the use of T5 lamps and fixtures with electronic ballasts versus the use of energy efficient T12 lamps and fixtures with magnetic ballasts. Also evaluated was the replacement of T12 HO lamps and fixtures with T5HO lamps and fixtures.

Key assumptions for both scenarios:

- Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.
- Secondary impacts for heating and cooling were not evaluated.
- Information regarding lamp and system wattages, lumens, and material pricing was developed from a combination of lighting suppliers and industrial supply houses.
- Potential lighting replacement scenarios were evaluated based on mean lumens. Lumen is the measure of the amount of light a lamp produces. Initial lumens are the lamps' approximate light output after 100 hours of operation, while mean lumens measures the light output at 40% of its rated life.   A true measure of a lamps' efficacy is how well it maintains its' light output over time.

2.3 RESULTS SUMMARY

The results of the analysis are shown in FES – L2 T5s for T12s.

- Standard 4' T5 28 watt lamps with electronic ballasts can be used to replace standard 4' T12 34 watt lamps with magnetic ballasts on a one-for-one replacement schedule for 1, 2, 3 and 4 lamp configurations, with an average 20% <u>increase</u> in mean lumen output.

- T5 54W 4' 1 lamp HO fixture can be utilized to replace a T12 34W 4' 2 lamp fixture with a 3% increase in mean lumen output.

- T5 54W 4’ 2 lamp HO fixture can be utilized to replace a T12 60W 8’ 2 lamp fixture, but mean lumen output would decrease by 7%. The fixture can also be used to replace a T12 34W 4’ 4 lamp fixture with a 32% decrease in mean lumen output. Savings were determined for this fixture assuming an equal mix of these two replacements.

- T5 54W 4’ 3 lamp HO fixture can be utilized to replace a T12 95W 8’ 2 lamp HO fixture, with a 1% increase in mean lumen output.

- T5 54W 4’ 4 lamp HO fixture can be utilized to replace a T12 60W 8’ 4 lamp fixture, but mean lumen output would decrease by 6%. The fixture can also be used to replace a T12 95W 8’ 2 lamp HO or VHO fixture. Lumen output is 35% higher than the HO fixture and 28% lower than the VHO fixture. Savings were determined for this fixture assuming an equal mix of these three replacements.

Due to the high cost of the T5 fixtures, paybacks are generally not acceptable at lower operating hours. Some T5 options may be viable at higher operating hours, if substantial incentives are provided.

Due to the high lumen output, T5s may be too bright for low bay application and standard one-for-one T12 replacement. T5 technology may be better suited for high bay applications (ceiling heights > 15 feet) such as HID replacement.

2.4 MEASURE LIFE

Fixture and ballast life data range from 10 to 16 years, we recommend 10 years.

2.5 INITIAL ONE-TIME COSTS

A summary of costs are shown in FES – L2 T5s for T12s.

2.6 EXISTING ENERGY STANDARDS

There are currently no standards for this technology.

2.7 SOURCES OF INFORMATION

Center Point Energy lighting wattage table, manufacturer’s data, and utility data.

2.8 ATTACHMENTS

FES – L2 T5s for T12s.

SECTION 3: FES – L3 – HIGH BAY FLUORESCENTS AND PULSE-START HIDS

Measure IDs: MMP 26 - 35

3.1 TECHNOLOGY DESCRIPTION

In high bay lighting applications (ceiling heights > 15 feet), high intensity discharge (HID) fixtures are typically utilized due to their high lumen output. Although high pressure sodium fixtures are energy efficient, they do not provide good color rending. Probe-start metal halide fixtures are typically installed for high bay lighting applications because they deliver crisp white light, even though they are not very energy efficient.

Traditional probe-start metal halide lamps have an internal starting electrode, or probe, powered by a high open circuit voltage (600v peak voltage) from the ballast to initiate an arc. The ballast starts the lamps as well as regulates the current through the lamp. The necessity of the probe-start mechanism and its' high open circuit voltage requirement contributes to shorter ballast and lamp life, poor lumen maintenance, and poor lamp efficacy.

3.2 METHODOLOGY AND ASSUMPTIONS

The analysis for this technology was performed to evaluate the use of high bay fluorescents and pulse-start metal halides versus traditional probe-start metal halides in high bay applications.

Ten high bay applications were evaluated:

1. T5 fixtures utilizing 3, 4, 6, and 12, high output lamps (T5HO), replacing, 250W, 400W, and 1000W metal halide fixtures.

2. T8 fixtures utilizing 4, 6, 8, and 16, 32 watt lamps (F32T8), replacing, 250W, 400W, and 1000W metal halide fixtures.

3. Compact fluorescent fixture utilizing eight (8) 42 watt c.f. lamps – 8L42WCF replacing a 400W metal halide fixture.

4. Pulse-Start metal halides at various wattages replacing 400W probe start metal halides. Pulse-start metal halide fixtures have an igniter incorporated in the pulse-start ballast which delivers a high voltage pulse to start the pulse-start lamp. The pulse-start ballast has a lower open circuit voltage requirement which contributes to lower ballast operating temperatures, resulting in longer ballast and lamp life, great lumen maintenance and lamp efficacy. Pulse-start metal halide fixtures have faster warm up times and quicker re-strike times compared to traditional probe-start metal halide fixtures.

Key assumptions:

a. Base case probe-start metal halide fixture as summarized above
b. Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.
c. Information regarding lamp and system wattages, lumens, and material pricing was developed from a combination of lighting suppliers and industrial supply houses.
d. Secondary impacts for heating and cooling were not evaluated.
e. Potential lighting replacement scenarios were evaluated based on mean lumens. Lumen is the measure of the amount of light a lamp produces. Initial lumens is the lamps' approximate light output after 100 hours of operation, while mean lumens measures the light output at 40% of its rated life. A true measure of lamps' efficacy is how well it maintains its' light output over time.

3.3 RESULTS SUMMARY

The results of the analysis are shown in FES – L3 High Bay Fluorescents.
All T5HO fixtures are acceptable replacements for the metal halide fixtures they were compared to. Each result in a deviation in lumen output of 25% or less.

All F32T8 fixtures are acceptable replacements for the metal halide fixtures they were compared to. All but one result in a deviation in lumen output of 25% or less. The 2-8LT8 fixture replacement for a 1000W fixture results in a decrease in lumen output of 38%, but this is still a common fixture replacement.

The 8L42WCF fixtures may not be a cost effective option as cost is high compared to the above measures.
The 320WMH-PS fixtures deliver the same mean lumens as the standard system.

The 350WMH-PS fixtures result in a 12% increase in mean lumens, but have significantly lower savings.

The 400WMH-PS fixtures are not a cost effective option unless delamping scenarios are evaluated, as a one for one replacement results in savings.

3.4 MEASURE LIFE

Fixture and ballast life data range from 10 to 16 years, we recommend 10 years.

3.5 INITIAL ONE-TIME COSTS

A summary of costs are shown in FES – L3 High Bay Fluorescents.

3.6 EXISTING ENERGY STANDARDS

There are currently no standards for this technology.

3.7 SOURCES OF INFORMATION

Center Point Energy lighting wattage table, manufacturer's data, and utility data.

3.8 ATTACHMENTS:

- FES – L3 – High Bay Fluorescents

SECTION 4: FES-L6 – COMPACT FLUORESCENT LAMPS AND FIXTURES

Measure IDs: MMP 36 -37

4.1 TECHNOLOGY DESCRIPTION

Compact fluorescent lamps were evaluated for the replacement of incandescent lamps. Hard-wired compact fluorescent fixtures were also evaluated in installations in lieu of incandescent fixtures.

4.2 METHODOLOGY AND ASSUMPTIONS

A spreadsheet calculation was performed with standard lighting wattages. Savings for typical conversions were calculated. Replacements were chosen to provide equivalent lumen output.

Key assumptions:

- Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.
- Secondary impacts for heating and cooling were not evaluated.

4.2.1 ESTIMATED ENERGY SAVINGS – KWH

Screw based Compact Fluorescent Lamp annual savings 149 kWh/lamp. Assumes 1- 15W CFL replacing 60W incandescent lamp.

Compact Fluorescent Fixtures (hardwired) annual savings 308 kWh/fixture. Assumes 1 fixture with 2 -13W lamps (27W total) replacing 1 incandescent fixture with 2-60W lamps.

Assumptions include: 3,680 annual hours of operation (average of all commercial and industrial customers).

4.2.2 SUMMER PEAK SAVINGS

Screw based Compact Fluorescent Lamp – .0405 kW/lamp. Assumes 1- 15W CFL replacing 60W incandescent lamp.

Compact Fluorescent Fixtures (hardwired) - .0837 kW/fixture. Assumes 1 fixture with 2 -13W lamps (27W total) replacing 1 incandescent fixture with 2-60W lamps.

Assumes 90% of lighting is on during peak times.

4.2.3 MEASURE LIFE

Screw in Compact Fluorescent lamps 2 years (available with average rated life of 6,000 to 10,000 hours. Assumed mean life would be 8,000 hours for CFLs.)

Hardwired Compact Fluorescent fixtures: 12 years. Source: California Public Utilities Commission

4.3 INITIAL ONE-TIME COST

Screw in CFLs range in price from less than $3.00/lamp for shorter lifetime mainstream wattage lamps to over $20.00/lamp for specialty CFLs such as dimmable ballast reflector floods and other decorative styles.

Compact Fluorescent Fixtures are available for as little as $15.00/fixture for simple single lamp indoor or outdoor fixtures with magnetic ballasts, and over $200.00/fixture for commercial grade decorative fixtures with multiple lamps and electronic ballast. Median price range is $35.00-85.00/fixture for most common configurations.

4.4 ANY RECURRING COSTS

Lamps will require replacement approximately every 2.5 years in a commercial building due to assumed average rated lamp life of 8,000 hours.

4.5 REQUIREMENTS FOR APPLICATION

Compact fluorescent lamps must be replacing incandescent lamps. CFL fixtures should contain pin based lamps and be a hardwired installation. CFLs specified should be approximately ¼ of the wattage of the incandescent they are replacing.

4.6 EXISTING ENERGY STANDARDS

Energy Star standards are available for both technologies for residential use. Considerations include rated lamp life, flicker free lamps, and descriptive information on packaging. Many commercial fixtures have not been evaluated for Energy Star residential list, but are appropriate replacements for incandescent and should not be excluded.

4.7 SOURCES OF INFORMATION

Energy Star, Center Point Energy Lighting Wattage Table, lightsearch.com.

4.8 ATTACHMENTS

FES-L6 – Compact Fluorescent Lamps

SECTION 5: FES-L5 – LED EXIT SIGNS

Measure ID: MMP 38

5.1 TECHNOLOGY DESCRIPTION

Exit signs that have earned the ENERGY STAR label operate on five watts or less per sign, compared to standard signs, which use as much as 40 watts per sign.

5.2 ENERGY SAVINGS – KWH AND SUMMER PEAK SAVINGS

ENERGY STAR lists typical savings of 149 kWh and 31W. This assumes two CFL lamps in the base unit. As many existing fixtures have incandescent lamps these values are conservative.

5.3 MEASURE LIFE

15 years

5.4 INITIAL ONE-TIME COST

Material costs are found in the range of $20 - $40.

5.5 REQUIREMENTS

There are ENERGY STAR program requirements for LED Exit Signs. Signals must be less than 5W and have power factors above 0.7.

5.6 EXISTING ENERGY STANDARDS

ENERGY STAR

5.7 SOURCE OF INFO

ENERGY STAR website. Manufacturer's website.

SECTION 6: FES-L7 – OCCUPANCY SENSORS

Measure IDs: MMP 39 -40

6.1 TECHNOLOGY

Occupancy sensors represent an energy-efficient way to control lighting use in low occupancy areas such as halls, storage rooms, and restrooms. Instead of relying on people to remember to switch lights off when they leave a space, occupancy sensors perform this task. They measure the movement of people within a space. When movement is detected, the lights turn on automatically; they then shut off when they no longer sense movement. Each unit's shut-off time can be preset, given the needs of the space being controlled.

6.2 ESTIMATED ENERGY SAVINGS – KWH

Savings estimates vary by type of space and connected load. We are suggesting a two tier incentive based on square footage controlled. Larger square footages controlled will likely result in higher costs for multiple sensors, additional wiring, etc. We are not specifying savings or incentives by type of space assuming a natural mix in actual applications.

Industry Estimates of potential energy savings for occupancy sensors (%)

Space Type	CEC	Esource	EPRI	Novitas	Watt Stopper
Private office	25-50	13-50	30	40-55	15-70
Open office	20-25	20-28	15	30-35	5-25
Classroom	-	40-46	20-35	30-40	10-75
Conference	45-65	22-65	35	45-65	20-65
Restroom	30-75	30-90	40	45-65	30-75
Warehouses	50-75	-	55	70-90	50-75
Storage	45-65	45-80	-	-	45-65

Assumed 3,680 annual hours of operation (average of all commercial and industrial customers), a 30% reduction in operating hours and 1.2 watts/square foot of lighting controlled.

Under 500 ft^2 $\frac{300\ ft^2 \text{ average} \times 1.2\ watt/ft^2 \times 3680 \text{ hours} \times 30\%}{1000 \text{ watts/kWh}} = 397$ kWh

Over 500 ft^2 $\frac{750\ ft^2 \text{ average} \times 1.2\ watt/ft^2 \times 3680 \text{ hours} \times 30\%}{1000 \text{ watts/kWh}} = 994$ kWh

6.3 SUMMER PEAK SAVINGS

None – occupancy sensors may reduce load at peak but not for many applications. Average demand savings are 0.11 kW and 0.27 kW.

6.4 MEASURE LIFE

8-15 years listed in programs reviewed, DEER list 8 years, we recommend 8 years.

6.5 INITIAL ONE-TIME COST

Prices vary depending on sensor capability. Range from approximately $40 for low end or residential model to $200, not including installation. Assume $100 to $400/unit installed.

6.6 ANY RECURRING COSTS: NONE

6.7 REQUIREMENTS FOR APPLICATION

Care should be taken when specifying occupancy sensors to ensure occupant satisfaction. Two main technologies used for occupancy sensors are passive infrared (PIR) and ultrasonic. PIR sensors react to body heat and sense occupancy by detecting the difference in heat from a body and the background. Ultrasonic sensors use volumetric detectors and broadcast sounds above the range of human hearing, then measure the time it takes the waves to return and can detect persons behind obstructions.

Both types of sensors feature a delay adjustment which sets the time that lights are on after no occupancy is detected and a sensitivity adjustment which makes the unit either more or less sensitive to motion. Delays should not be set for less than 10 minutes so that lamp life is not affected or make sure that programmed start ballasts are specified with fluorescent lamps.

Ultrasonic sensors are sensitive to air movement from HVAC diffusers and should be adjusted to a point at which they are not sensing air movement.

6.8 EXISTING ENERGY STANDARDS

There are currently no Energy Star standards for this technology.

6.9 SOURCE OF INFO

FEMP, LRC; Green Seal Report, manufacturer's web sites Novitas, Leviton, Watt Stopper, Pass & Seymour Legrand

SECTION 7: FES-L8 – LED TRAFFIC LIGHTS

Measure IDs: MMP 41 - 42

7.1 TECHNOLOGY DESCRIPTION

ENERGY STAR labeled signals perform better than incandescent models and are a better value. Compared to standard incandescent, ENERGY STAR labeled traffic signals use 80 - 90% less energy, and have lower maintenance costs because they need to be replaced less frequently.

7.2 ENERGY SAVINGS – KWH

The energy savings varies for red, green and yellow signals. Savings also varies for round lamps, arrows and pedestrian signals. Reviewing details on California, Wisconsin and Texan programs, the savings below are typical.

In general savings are greater on car traffic signals and costs for the lamps are generally less than for pedestrian signals. The recommendations include a breakdown between the two types of signals.

Traffic signal (per lamp average)	275 kWh
Pedestrian signal	150 kWh

7.3 SUMMER PEAK SAVINGS

Traffic signal (per lamp average)	0.085 KW
Pedestrian signal	0.044 KW

7.4 MEASURE LIFE

Lamps rated for 30,000 to 40,000 hours which would provide for a 10 to 15 year life on traffic signal lights. We have seen municipalities plan for a 5 to 7 year change out schedule. Assume 6 to 8 years.

7.5 INITIAL ONE-TIME COST

Lamp costs vary significantly. Green generally cost 50% more than yellow or red. Pedestrian lamps generally 50% to 100% more expansive than traffic lamps.

Traffic Signals	$50/lamp
Pedestrian	$100/lamp

7.6 REQUIREMENTS

There are Energy Star Program Requirements for LED Traffic Signals. Signals must be connected to a metered electric service. Some utilities charge municipalities per fixture or per intersection for traffic lights.

7.7 EXISTING ENERGY STANDARDS

Energy Star

7.8 SOURCE OF INFO

LED Traffic signal programs from Texas, California and Wisconsin. Energy Star website. Manufacturer's website.

SECTION 8: FES-L9 – LIGHT TUBE COMMERCIAL SKYLIGHT

Measure ID: MMP 43

TECHNOLOGY DESCRIPTION

This technology is essentially a 10” to 21” diameter skylight with a prismatic or translucent lens that reflects light captured from a roof opening through a highly specular reflective tube down to the mounted fixture height. When in use, a light tube fixture resembles a metal halide fixture. Uses include grocery, school, retail and other single story commercial buildings.

ESTIMATED ENERGY SAVINGS – KWH

As noted on the following table, the average savings is calculated to be 361 kWh. Please note, this assumes only 21” and 14” installations.

Brand/size	Lumen Output	Equivalent	KW	kWh
Solatube 21”	13,500-20,500	2-3LF32T8 172W	0.172	481.6
14”	6000-9100	1-3LF32T8	0.086	240.8
10”	3000-4600	3-18W quad	0.054	151.2
		AVERAGE	0.129	361.2

2800 hours per year used for savings calculations. Manufacturers maintain that light overcast conditions still allow for adequate output to offset electric light use.

8.1 SUMMER PEAK SAVINGS

There would be a fairly high correlation between sunlight available for the light tube and summer peak demand. Using 90% of the 0.129 KW average shown above results in a demand reduction estimate of 0.116 KW.

8.2 MEASURE LIFE

Warranty is 10 years. We have assumed a 14 year average life.

8.3 INITIAL ONE-TIME COST

Do it yourself kits range in price from approximately $300 to $500. Labor to install varies (approx. $200-$400) based on the type of roof deck. Average cost assumed to be on the low end, $500. Unless installations are easy and straightforward we don't feel many customers will utilize this technology. New construction installations are less expensive, and likely more viable.

8.4 ANY RECURRING COSTS

Flashing may need occasional maintenance and lens many need cleaning.

8.5 REQUIREMENTS

Commercial and Industrial interior spaces that would otherwise require electric lighting between 1-4PM on weekdays during the summer to reduce peak demand.

8.6 EXISTING ENERGY STANDARDS

There are currently no standards for this technology.

8.7 SOURCE OF INFO

California Energy Commission website www.energy.ca.gov, www.evsolar.com/daylighting.htm, www.elitesolarsystems.com, www.Solatube.com/solamaster.htm , www.dayliteco.com, PG&E Daylighting McDonald's case study, manufacturer's web sites,

SECTION 9: FES-L10 – CENTRALIZED LIGHTING CONTROL

Measure ID: MMP 44

9.1 TECHNOLOGY DESCRIPTION

Allow automated control of lighting systems. Included in this technology are simple time clocks, package programmable relay panels, and complete building automation systems. This type of control is most often used with programming schedules to light only areas that are occupied based on typical occupant schedules and utilize wall switches or occupancy sensors to determine when occupants are in a space at a non-typical time and allow adjustments to the lighting accordingly. Increased savings are possible by incorporating photo sensors with a centralized lighting control system to indicate when it is appropriate to decrease the lighting level in perimeter building areas. Energy savings are maximized by integrating other systems such as security systems that detect employee keycards and can turn on or off lighting in office areas accordingly. Limitations include high initial and maintenance costs and compatibility of components. This technology is easiest to implement in new construction, however retrofit is a possibility.

9.2 ESTIMATED ENERGY SAVINGS – KWH

Timers 10-20% of lighting energy, Building Automation systems with photoelectric controls 20-30%

Assumptions include: Lights on for an average of 3,680 hours, even though 3,956 annual hours of operation (average of all commercial and industrial customers). 1.25 Watts per square foot, average lighting level in space to be controlled, 15% savings on simple timer systems and 25% on more sophisticated building automation and controls. Estimated savings averages 1.15 kWh per square foot per year.

(1.25 W/SF / 1000W/kW) x (25% savings) x 3,680 hrs = 1.15 kWh/SF/yr

9.3 SUMMER PEAK SAVINGS

Assumes at least 90% of lighting on during peak times. Assume peak savings is negligible. Average demand savings is 3.12 kW/10,000 SF.

9.4 MEASURE LIFE

DEER lists 16 years, programs reviewed show 10-15 years, and we recommend 12 years.

9.5 INITIAL ONE-TIME COST

Simple time clocks are available for as little as $49.00 for an electronic 20A programmable 7 day timer. Building automation systems can be in the hundred thousands of dollars. The simple time clock installed for $100 in a 150 square foot office will only cost about $0.67/square foot. Large systems could cost several dollars per square foot. This analysis assumes can average cost of $0.90 per square foot.

9.6 ANY RECURRING COSTS

Requires regular maintenance and adjustments in scheduling due to changes in usage by occupants.

9.7 REQUIREMENTS

System should be automated and must consider occupant schedules and override for safety.

9.8 EXISTING ENERGY STANDARDS

There are currently no standards for this technology.

9.9 SOURCE OF INFO

Lighting Research center –"Controlling lighting with building automation systems", ACEEE Guide to Energy Efficient Commercial Equipment, FEMP, DEER

SECTION 10: FES-L11 – MULTILEVEL LIGHTING CONTROL

Measure ID: MMP 45

10.1 TECHNOLOGY DESCRIPTION

Systems allow occupants or building control systems the ability to vary the amount of lighting in a space using multilevel switching to create different lighting schemes based on the task illumination requirements. Examples are: Conference rooms, auditoriums, classrooms and other multipurpose rooms where lighting needs may be at different levels for meetings, presentations, etc. Fluorescent fixtures with 3 lamps may be containing 2 ballasts to control inboard and outboard lamps to vary the amount of illumination generated by the fixture. Occupants can operate fixtures at 3 levels – 1 lamp, 2 lamps or all 3 lamps. Other examples are multiple fixture types, such as in a conference or multimedia room where occupants may choose to operate perimeter lights, accent lights or task lights separately from ambient lighting for multiple levels of lighting.

Another area where multilevel lighting might be used is in warehouse areas that are frequently unoccupied or are illuminated by skylights. In this situation, lighting with multilevel (high/low) capability can be switched to low output based on input from an occupancy or daylight sensor. A consideration for multilevel HID is that in many cases, the lamp loses efficacy at reduced power – for example at the high setting a 400W MH is operating at 100% input wattage and 100% lamp lumens, but at 50% power the lamp lumens are at approximately 23-30%. An option to operate lamps at 50% light level is also available, but the energy savings are not as great (approx 30% energy reduction).

10.2 ESTIMATED ENERGY SAVINGS – KWH

Savings varies by application and user preferences. Classrooms can take advantage of available daylight and switch lighting rows next to windows off to achieve savings (approx. 20-30% at perimeter). Savings for HID bi-level can be estimated at approximately 24% compared to single level HID fixtures. These savings are likely optimistic compared to the universe of potential applications. Average savings is estimated at 15-20%. Based on 3,680 burn hours per year savings should be about 0.8 kWh per square foot.

(1.25 W/SF / 1000W/kW) x (17.5% savings) x 3,680 hrs = 0.80 kWh/SF/yr

10.3 SUMMER PEAK SAVINGS

Assume peak demand impact is negligible. Average demand savings is 2.2 kW/10,000 SF.

10.4 MEASURE LIFE

DEER lists 16 years, programs reviewed show 10-15 years, and we recommend 12 years.

10.5 INITIAL ONE-TIME COST

One time cost on new construction can be fairly minimal. Costs on retrofit will vary significantly with sophistication of the project. Assume $1/square foot for lack of substantial detail.

10.6 ANY RECURRING COSTS

Commissioning to ensure proper performance of sensors if used.

10.7 REQUIREMENTS

Should be used with daylight or occupancy sensors to automate and maximize savings.

10.8 EXISTING ENERGY STANDARDS

There are currently no Energy Star standards for this technology.

10.9 SOURCE OF INFO

PG&E, LRC, manufacturer websites.

SECTION 11: FES-L12 – DAYLIGHT SENSOR LIGHTING CONTROL

Measure ID: MMP 46

11.1 TECHNOLOGY DESCRIPTION

Systems use photoelectric controls to take advantage of available daylight in perimeter building spaces (open spaces within 10' to 15' of windows) or other areas that have access to daylight infiltration. Photoelectric controls can be used to turn lights on or off, stepped dimming (high/low or inboard/outboard), or continuous dimming based on light level from available daylight. Especially useful in common spaces where task lighting is not critical (malls, warehouses, atriums, etc.).

11.2 ESTIMATED ENERGY SAVINGS – KWH

20-30+% for perimeter office and open spaces, up to 40% for sky lit common spaces.

Assumptions include lighting on 3,680 hours per year. Assumes 1.3 watts per square foot, 30% savings in exterior (sun lit) spaces. Assume savings averages 1.43 kWh per square foot per year.

(1.3 W/SF / 1000W/kW) x (30% savings) x 3,680 hrs = 1.43 kWh/SF/yr

11.3 SUMMER PEAK SAVINGS

The bulk of savings will occur during peak hours because this is exactly the time that maximum daylight is available.

1.3 watts/square foot x 1 square foot x .35 x 0.9 DF = 0.41 watts/ft2

= .00041 KW/ft2 or 4.1 KW/10,000ft2

11.4 MEASURE LIFE

DEER lists 16 years, programs reviewed show 10-15 years, and we recommend 12 years.

11.5 INITIAL ONE-TIME COST

Estimate $1/square foot. Less expensive, and less refined, with multilevel lighting versus dimmable ballasts.

11.6 ANY RECURRING COSTS

Occasional re-commissioning & adjustments, service calls due to occupant complaints.

11.7 REQUIREMENTS

Requires commissioning to calibrate sensors and ensure that energy savings and occupant comfort are realized. Incentive only for space with reasonable sun light exposure.

11.8 EXISTING ENERGY STANDARDS

There are currently no standards for this technology.

11.9 SOURCE OF INFO

FEMP, ACEEE, Heschong Mahone Group, manufacturer websites, DEER.

SECTION 12: FES-H1 – ENERGY STAR ROOM AIR CONDITIONERS

Measure IDs: MMP 47 - 48

12.1 TECHNOLOGY DESCRIPTION

Energy Star Room Air Conditioners were evaluated for the replacement of non-Energy Star Rated units. Savings will be evaluated on units with rated capacities over 14,000 Btu/h and under 14,000 Btu/h.

12.2 METHODOLOGY AND ASSUMPTIONS

A spreadsheet calculation was performed using average federal standard EER ratings for all of the available models along with the actual EER ratings for the Energy Star rated units. Savings for typical conversions were calculated. Full load cooling hours assumed was based on information from ARI Unitary Directory, August 1, 1992 - January 31, 1993 for Kansas City, MO.

Key assumptions:

- Full load cooling hours = 1,032 hours/year
- Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.
- *Information regarding EER and rated capacities of specified equipment was gathered from data taken by DOE 2005 and EPA 2006.*

12.3 ESTIMATED ENERGY SAVINGS – KWH

<14,000 Btu/h Room AC annual savings: 70 kWh per unit

>14,000 Btu/h Room AC annual savings: 170 kWh per unit

12.4 SUMMER PEAK SAVINGS

<14,000 Btu/h Room AC annual savings: 0.07 kW per unit

>14,000 Btu/h Room AC annual savings: 0.16 kW per unit

Assumes air conditioners are 20% oversized for the design cooling load they have to satisfy.

12.5 MEASURE LIFE

Room Air Conditioners have an average lifetime of 13 years. Source: EPA 2006

12.6 INITIAL ONE-TIME COST

Room Air Conditioners have an average one time initial product cost of ~$300, as specified on Energy Star's website according to Industry Data from 2006. The average incremental cost to upgrade to an Energy Star rated unit for all available models is roughly $30/unit.

12.7 ANY RECURRING COSTS

There should be no recurring costs for room air conditioners apart from the annual maintenance requirements for the units such as cleaning/replacement of the air filters.

12.8 REQUIREMENTS FOR APPLICATION

Must be Energy Star rated room air conditioner that meets strict energy efficiency guidelines set by the U.S. Environmental Protection Agency and the U.S. Department of Energy

12.9 EXISTING ENERGY STANDARDS

The National Appliance Energy Conservation Act (NAECA) dictates minimum standards for energy consumption in room air conditioners. The standard varies depending on the size and configuration of the air conditioner. The baseline EER rating used in the engineering calc was an average of the minimum standard energy consumption required for all of the air conditioners in the data source.

12.10 SOURCES OF INFORMATION

Energy Star, ARI Unitary Directory, DOE, EPA, NAECA (National Appliance Energy Conservation Act

12.11 ATTACHMENTS

FES-H1 – Room AC

SECTION 13: FES-H2B – COMMERCIAL/INDUSTRIAL HEAT PUMP WATER HEATERS

Measure IDs: MMP 49 - 51

13.1 TECHNOLOGY DESCRIPTION

Heat Pump Water Heaters (air source) were evaluated for replacement of commercial electric water heaters. This is a mature technology that has been on the market for almost 20 years. They are available in capacities ranging from 10,000 Btu/h to almost 800,000 Btu/h.

13.2 METHODOLOGY AND ASSUMPTIONS

A spreadsheet calculation was performed using average performance data from a number of manufacturer websites, and savings numbers were tiered based on the amount of hot water the business customer goes through in a typical day. The size of the storage tank selected and the heating capacity of the water heater will correlate with the amount of hot water used in a given day.

Key assumptions:

- COP of a standard commercial water heater: 0.9
- COP of an air source heat pump water heater: 3.5
- Cost estimates include installation.
- 80°F temperature difference from make up water to hot water supply

13.3 ESTIMATED ENERGY SAVINGS – KWH

500 gal/day average use: 22,299 kWh

1,000 gal/day average use: 44,599 kWh

1,500 gal/day average use: 66,898 kWh

13.4 SUMMER PEAK SAVINGS - KW

500 gal/day average use: 6 kW

1,000 gal/day average use: 12.1 kW

1,500 gal/day average use: 18.1 kW

13.5 MEASURE LIFE

15 years; according to study done by US Department of Energy

13.6 INITIAL ONE-TIME COST

$4,000-$18,000. Cost can be higher if added tank capacity is needed to support more hourly hot water demand.

13.7 ANY RECURRING COSTS

Annual maintenance costs range from $0-$1000 annually depending on the size of the HPWH. Maintenance requirements for air source heat pumps are similar to those for air conditioners. The evaporator air filters require periodic replacement or cleaning; especially where the evaporator is located to cool a kitchen or other room where there is a concentration of airborne contaminants. Where heavy concentrations of dust or grease are present, the evaporator coils should be cleaned regularly. On the condenser side of the system, concentrations of calcium carbonate and other minerals in the water can produce scale inside the condenser tubes, and this reduces the heat transfer to the circulating water. Maintenance to remove scale may be required in locations where hard water is present and a water softener is not used upstream of an HPWH evaporator.

13.8 REQUIREMENTS FOR APPLICATION

Must have heating COP of 3.0 or greater

13.9 EXISTING ENERGY STANDARDS

It is highly recommended that this incentive only be available for replacement of a conventional electric water heater, as KCPL is not a natural gas utility and the life cycle cost analysis is much more favorable with replacement of an electric water heater.

13.10 SOURCES OF INFORMATION

Colmac Coil Manufacturing Inc., US Department of Energy

13.11 ATTACHMENTS

FES-H2B CI Heat Pump Water Heaters

SECTION 14: FES-M1 – PREMIUM EFFICIENCY MOTORS

Measure IDs: MMP 52 - 55

14.1 TECHNOLOGY DESCRIPTION

Considerable efficiency gains can be made by selecting NEMA Premium Efficiency motors over standard EPACT efficiency motors.

14.2 METHODOLOGY AND ASSUMPTIONS

The attached spreadsheet compares the efficiency gains from EPACT to NEMA Premium Efficiency for 6 of the more common motors from 1 to 300 HP. The motor types selected were ODP and TEFC in 1200, 1800, and 3600 RPM. (60 Hz 1, 2, and 3 poles)

Key assumptions:

- Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.
- Energy savings are for new motors

14.3 ESTIMATED ENERGY SAVINGS

Size Category	kW	kWh
1-5 HP	0.03	110
7.5-20 HP	0.08	294
25-100 HP	0.29	1,067
125-250 HP	0.66	2,429

Assumptions include: 3,680 annual hours of operation (average of all commercial and industrial customers).

14.4 MEASURE LIFE

NEMA premium efficiency motors have a life of 15 years.

14.5 REQUIREMENTS FOR APPLICATION

Copies of invoices that clearly show that the new motor is NEMA premium efficiency and the motor's size.

14.6 <u>CROSS REFERENCE FOR ENERGY CALCULATIONS</u>

Estimated Savings for Motors are within 8.5% of deemed savings by the Focus On Energy program.

14.7 <u>EXISTING ENERGY STANDARDS</u>

NEMA Premium Efficiency, Epact 1992, Pre 1997

14.8 <u>SOURCES OF INFORMATION</u>

EERE Industrial Technologies Program

14.9 <u>ATTACHMENTS</u>

FES-M1 – Premium Efficiency Motors

SECTION 15: FES-M2 – VFD'S ON PUMPS

MEASURE IDS: MMP 56 - 67

15.1 TECHNOLOGY DESCRIPTION

Variable frequency drives physically slow the motors driving pumps in order to achieve reduced flow rates at considerable energy savings. Traditionally flow rates have been reduced by increasing the head and riding the pump curve back to a new flow rate (throttling control). Alternately some systems have bypasses that divert a portion of the flow back to the pump inlet to reduce system flow (bypass control).

15.2 METHODOLOGY AND ASSUMPTIONS

The attached spreadsheet analyzes three common load profiles utilizing data collected from simple VFD models. Since throttling valve control is more efficient than bypass control it was selected as the base case.

Key assumptions:

- Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.
- Typical load profiles were assumed.

15.3 ESTIMATED ENERGY SAVINGS

0.26 kW/HP
957 kWh/HP

Assumptions include: 3,680 annual hours of operation (average of all commercial and industrial customers).

15.4 MEASURE LIFE

Variable Speed Drives have a life of 10 years.

15.5 SUGGESTED INCENTIVE

We recommend an incentive of $40 - $50/HP.

15.6 REQUIREMENTS FOR APPLICATION

Copies of invoices that clearly show that the new motor is NEMA premium efficiency and the motor's size.

15.7 CROSS REFERENCE FOR ENERGY CALCULATIONS

Focus on Energy offers a hybrid rebate a prescriptive incentive of $50/hp that needs custom calculations to determine savings.

15.8 EXISTING ENERGY STANDARDS

None

15.9 SOURCES OF INFORMATION

EERE Industrial Technologies Program

15.10 ATTACHMENTS

FES-M2 – VFDs

SECTION 16: FES-M3 – HIGH EFFICIENCY PUMPS

MEASURE IDS: MMP 68 - 75

16.1 TECHNOLOGY DESCRIPTION

Choosing the correct pump for the process can have a large impact on energy consumption. System efficiencies can be increased by 20% or more depending on pump selection. High efficiency pumps reach efficiencies of 75% or greater on the pump curve at the dominant operating conditions.

16.2 METHODOLOGY AND ASSUMPTIONS

A spreadsheet analysis was performed for the operation of a set of pumps from Bell-Gosset. For five flow increments and five pressure increments, pumps that could meet the operating conditions were compared. The savings listed are the average savings on a kilowatt per horsepower basis of high efficiency pumps over other pumps that could meet the load.

Key assumptions:

- Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.
- New installations such that motor speed and impeller size could vary

16.3 ESTIMATED ENERGY SAVINGS – KWH

The high efficiency pumps are shown to save 236 kWh per year per horsepower of the pump.

Assumptions include: 3,680 annual hours of operation (average of all commercial and industrial customers).

16.4 SUMMER PEAK SAVINGS

The high efficiency pumps are shown to save .064 kW per horsepower of the pump.

Assumptions include: The average loading of the pumps analyzed was 76%. Pumps with varying loads should also be equipped a variable speed drive to ensure optimal performance.

16.5 MEASURE LIFE

Pumping systems are common listed with life spans of 15 years.

16.6 REQUIREMENTS FOR APPLICATION

Submittals for incentive should include a pump performance curve demonstrating that a pump efficiency of 75% or greater for the dominant operating conditions.

16.7 EXISTING ENERGY STANDARDS

A premium quality pump can have a poor efficiency if it is not matched with the proper load. The best indicator of pump performance is the pump curve.

16.8 SOURCES OF INFORMATION

EERE Industrial Technologies Program

16.9 ATTACHMENTS

FES-M3 – HE Pumps

SECTION 17: FES-C1 – ENERGY STAR COMMERCIAL CLOTHES WASHERS, (WASHERS ONLY)

MEASURE ID:MMP 76

17.1 TECHNOLOGY DESCRIPTION

ENERGY STAR qualified commercial clothes washers wash more clothes per load than standard clothes washers and use less water and energy to do so. This calculation is comparing the annual energy savings resulting from purchasing an ENERGY STAR qualified clothes washer over a standard clothes washer that is DOE 2007 compliant. This calculation is for the clothes washer only and does not take into account the dryer savings resulting from lower moisture levels per load. The hot water energy savings are assuming the water is heated with an electric water heater.

17.2 METHODOLOGY AND ASSUMPTIONS

A spreadsheet calculation was performed using industry data put together by the US Department of Energy and Energy Star.

Key assumptions:

- Annual cycles per washer per year = 950 cycles
- Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.
- Dryer energy savings as a result of lower moisture levels were not included.

17.3 ESTIMATED ENERGY SAVINGS – KWH

Energy Star qualified Commercial Clothes Washer: 380 kWh/yr

17.4 SUMMER PEAK SAVINGS

Energy Star qualified Commercial Clothes Washer: 0.019 kW

(only accounts for machine energy savings)

17.5 MEASURE LIFE

10-12 years

17.6 INITIAL ONE-TIME COST

US Department of Energy quoted the average retail price of a conventional clothes washer at $750, not including installation/labor costs. It quoted the average retail price of an ENERGY STAR qualified clothes washer at $1,077, not including installation/labor costs. These numbers were based on 2006 industry data gathered from across the country. ENERGY STAR's savings calculator had a conventional unit at $350, while it had an average ENERGY STAR qualified clothes washer at $500. The average incremental cost between these two comparisons is roughly $240.

17.7 ANY RECURRING COSTS

none

17.8 REQUIREMENTS FOR APPLICATION

ENERGY STAR qualified commercial clothes washers must have a Modified Energy Factor (MEF) of 1.72 or higher.

17.9 EXISTING ENERGY STANDARDS

US Department of Energy standard for commercial clothes washers is an MEF of 1.26 or better.

17.10 SOURCES OF INFORMATION

Energy Star, US Department of Energy, Multihousing Laundry Assn

17.11 ATTACHMENTS

FES-C1 Energy Star Commercial Clothes Washers

SECTION 18: FES-C2 – PLUG LOAD OCCUPANCY SENSORS FOR DOCUMENT STATIONS

MEASURE ID: MMP 77

18.1 TECHNOLOGY DESCRIPTION

Occupancy sensors that control ‘document stations’, i.e., fax machines, copiers, scanners, etc reduce the idling runtime of these machines when no one is using them or is around them.

18.2 METHODOLOGY AND ASSUMPTIONS

A spreadsheet calculation was performed with standard equipment wattages, both idle wattages and continuous use wattages. Savings for typical conversions were calculated. A 25% savings factor was assumed.

Key assumptions:

- Savings factor during a typical 10 hour business day = 25%
- Idle wattage of laser printer = 50W
- Idle wattage of fax machine, scanner, etc = 50W
- Idle wattage of copier = 120W

18.3 ESTIMATED ENERGY SAVINGS – KWH

Plug Load Occupancy Sensor for Document Station = 803 kWh

18.4 SUMMER PEAK SAVINGS

Plug Load Occupancy Sensor for Document Station = 0.055 kW

18.5 MEASURE LIFE

5 years

18.6 INITIAL ONE-TIME COST

Cost estimates are variable and can range from $80 to $400+. Assume average cost of $150.

18.7 ANY RECURRING COSTS

none

It’s possible that document station can be controlled by a single power strip with sensor at a cost of $80 to $100 which would result in a high percentage incentive.

18.8 REQUIREMENTS FOR APPLICATION

Must control at least 3 devices in central document station

18.9 EXISTING ENERGY STANDARDS

none

18.10 SOURCES OF INFORMATION

June 2000 ASHRAE Journal Study, 2001 ASHRAE Fundamentals, manufacturers websites

18.11 ATTACHMENTS

FES-C2 Plug Load Occupancy Sensors for Document Stations

SECTION 19: FES-C3 – COLD BEVERAGE VENDING MACHINE CONTROLLERS

MEASURE ID: MMP 78

19.1 TECHNOLOGY DESCRIPTION

Cold beverage vending machine controls reduce energy consumption between 30% and 50% on average by controlling the machine's lights and optimizing refrigeration to reduce energy while maintaining product quality. Additional yearly savings in maintenance can also be realized due to reduced running time of vendor components. The most prevalent and available control is Bayview Technologies' (owned by US Technologies, Inc) VendingMiser.

19.2 METHODOLOGY AND ASSUMPTIONS

Typical vending equipment consumes 7-14 kWh/day depending on size. VendingMiser claims savings range is from 30%-50%. Potential annual energy saving calculate between 766.5 and 2,555 kWh per unit/year.
Tufts Climate initiative estimated 1752 kWh/year savings based on a very limited study. The Database for Energy Efficiency Resources (DEER) claims 1,612 kWh in annual savings.

19.3 ESTIMATED ENERGY SAVINGS – KWH

We have had experience with the installation of thousands of these units on programs over the last couple of years. We feel the units are effective in some applications but misapplications and persistency lead us to savings on the low end of expectations. We recommend a savings level of 800 kWh/year.

19.4 SUMMER PEAK SAVINGS

Typical peak use for a cold beverage machine: 700W – 1200 W. Assuming a 30% runtime reduction: 0.7 kW x 30% = 0.21 kW

19.5 MEASURE LIFE

Questions about persistence have been raised because the units are easily accessed and removed or unplugged. Position of sensor is also important for optimum performance. Although the quality of the product will allow for a longer life, we have assumed 5 years, as with other plug load technologies, analyzed, due to the persistency issue.

19.6 INITIAL ONE-TIME COST

Prices vary primarily due to institutional rates that are available to Utility and Government conservation programs. Identified costs vary from $140 to $180 per unit. Assume an average cost of $160/unit.

19.7 ANY RECURRING COSTS

None.

19.8 REQUIREMENTS FOR APPLICATION

May need to move equipment away from the wall to access the outlet. Should follow placement of sensor directions closely

19.9 EXISTING ENERGY STANDARDS

None for the controls. However, ENERGY STAR does have requirements for existing vending machines/rebuilt vending machines to be ENERGY STAR qualified. One of the methods of achieving the ENERGY STAR status is to install a vending machine controller to the existing machine.

19.10 SOURCES OF INFORMATION

USA Technologies (usatech.com); EPA Energy Star; multiple utility/government program sites; Tufts University, E-Source, DEER database

19.11 ATTACHMENTS

None.

SECTION 20: FES-C4 – WINDOW FILM

MEASURE ID: MMP 79

20.1 TECHNOLOGY DESCRIPTION

Window films block up to 76% of solar heat gain through the glass and also improve energy efficiency and reduce ultraviolet radiation.

20.2 METHODOLOGY AND ASSUMPTIONS

The benefit of, and motivation for, providing incentives on window films varies considerably depending on region and perspective regarding heating and cooling. Since KCPL is an electric only provider, we strictly looked at the benefits to reducing the cooling load. With this perspective the key window film characteristic becomes the solar heat gain coefficient (SHGC). The lower the factor, the lower the heat gain, the greater the air conditioning savings. The coefficient is a number from 0 to 1 that basically corresponds to the percentage of heat that is allowed into the conditioned space. California DSM Programs specify energy savings to be between 12-15 kWh/sq ft annually.

20.3 ESTIMATED ENERGY SAVINGS – KWH

Window Film   12 kWh/square foot/year

20.4 SUMMER PEAK SAVINGS

None.

20.5 MEASURE LIFE

Window Film = 10 years. New windows should conservatively last 20 to 30 years. The life of window films is assumed to be less because post manufacturing installations of coatings may not last as long and they are generally installed on older, existing windows that would inherently have a shorter remaining life than a new window.

20.6 INITIAL ONE-TIME COST

Window films – costs are in the $3 to $9 per square foot range. Analysis assumed $6 per square foot.

20.7 ANY RECURRING COSTS

None.

20.8 REQUIREMENTS FOR APPLICATION

A maximum SHGC of .40 after window film application. Application must improve overall SHGC by at least .10.

20.9 EXISTING ENERGY STANDARDS

No meaningful standard. The variability of window location, orientation to the sun, U-factors, SHGC, Visible Transmittance and other variables make establishing a standard very difficult.

20.10 SOURCES OF INFORMATION

Efficient Windows Collaborative, California DSM Programs, various manufacturer websites and utility websites

20.11 ATTACHMENTS

None.

SECTION 21: FES-C5 – 80 PLUS DESKTOP AND SERVER UNITS

Measure ID: MMP 80 - 81

21.1 TECHNOLOGY DESCRIPTION

80 PLUS is an electric utility-funded incentive program to integrate more energy-efficient power supplies into desktop computers and servers. It is designed to address plug loads, primarily in the commercial sector, because this end-use category consumes more than 7% electricity in commercial buildings..

21.2 METHODOLOGY AND ASSUMPTIONS

This 85 kWh per unit savings estimate is considered conservative since many computers on the market do not currently meet the Intel required specification. The unit savings estimate is the difference in consumption between the Intel required and the minimum qualifying 80 PLUS power supply (i.e., one that is precisely 80% efficient at all load levels). The demand reduction for using an 80 PLUS computer is 16 watts for a commercial application. The demand reduction was determined by calculating the average active wattage for the base case (74 watts) and the 80 PLUS computer (58 watts) and dividing by the total number of hours that the computer operates during those load states.

The server base case power supply units consume between 491 and 613 kWh per year, while the 80 PLUS units consume between 211 and 263 kWh per year. This translates into an annual savings between 280 and 350 kWh per year, with the 80 PLUS program assuming a melded average of 301 kWh per year. The demand savings for servers are based on data provided by the “80 PLUS and ENERGY STAR Program Work Paper, October 2007”

21.3 ESTIMATED ENERGY SAVINGS – KWH

80 PLUS Desktop Computer: 85 kWh/yr

80 PLUS Server Unit: 301 kWh/yr

21.4 SUMMER PEAK SAVINGS

80 PLUS Desktop Computer: 0.016 kW

80 PLUS Server Unit: 0.034 kW

21.5 MEASURE LIFE

4 years. A measure life of four years has been established for the desktop computers and desktop-derived servers included in this project. Utilities, project sponsors and evaluators have consistently agreed that this estimate is either reasonable or conservative. Additionally, the IRS assumes a five-year depreciation schedule for computer equipment.

21.6 INITIAL ONE-TIME COST

Incremental costs for 80 PLUS desktop computers vs. standard units range all over the board from $9-$20 per unit. Most of the time this added cost does get passed onto the consumer.

Incremental costs for 80 PLUS servers vs. standard units usually range anywhere from $15-$40 per unit.

21.7 ANY RECURRING COSTS

None.

21.8 REQUIREMENTS FOR APPLICATION

Meet 80 PLUS qualifications

21.9 EXISTING ENERGY STANDARDS

80 PLUS used the Intel 2005 “required” efficiency levels as the baseline as defined in the ATX12V Power Supply Design Guide v2.01.

21.10 SOURCES OF INFORMATION

”80 PLUS and ENERGY STAR Program Work Paper, October 2007”,

21.11 ATTACHMENTS

“FES-C5 80Plus Desktop and Server Units.pdf”

SECTION 22: FES-G1 – MULTIPLEX COMPRESSORS

Measure ID: not assigned

22.1 TECHNOLOGY DESCRIPTION

A system serviced with several compressors that operate independently of each other has several inefficiencies. Each compressor is typically oversized to the load it is connected to with little ability to match varying loads. A multiplexed system uses multiple compressors controlled together to optimize operation and match loads. This method eliminates some of the excess capacity and can operate in part load conditions more efficiently. This measure also includes high-efficiency features of sub-cooling and floating head pressure controls to encompass an overall efficient system option.

This analysis is based on information extracted from documents describing past California DSM programs. These are complex technologies based on many assumptions. California DSM documents report an estimated savings of 1761 kWh/ton-yr.

22.2 METHODOLOGY AND ASSUMPTIONS

Data extrapolated from a computer model was used to test the California results.

Assumptions:
- System Capacity: 40 Tons with full load (peak) kW per ton at 105°F saturated condensing temp of 2.3 kW/ton.

- Existing system is single compressors. Average kW/ton of 1.98 assumed. Data from the computer model indicated that an average kW/ton for a rack system without additional energy savings features was around 1.93 kW/ton. Single compressors would operate at an overall higher average efficiency. A 3-4% decrease in efficiency was selected.

- Proposed system has floating head, sub-cooling with multiple compressors to better match load. Assumed average kW/ton is 1.83, based efficiency of a rack system with floating head pressure. The improved peak kW/ton of 2.0 is based on a study completed of 11 Wisconsin supermarkets that evaluated sub-cooling and indicated a range of 2 to 26% savings. Including improvement for load matching, a 13% improvement in peak kW/ton results in 2.0. No demand reduction claimed for the floating head pressure portion of savings.

- Average annual loads based on output data from computer modeling of similar compressors.

22.3 ESTIMATED ENERGY SAVINGS – KWH

1761 kWh per ton of refrigeration capacity.

Extrapolation of computer model energy usage and efficiencies into a simplified calculation results in 1719 kWh savings.

22.4 SUMMER PEAK SAVINGS

0.29 kW per ton of refrigeration capacity

22.5 MEASURE LIFE

The DEER database uses a 15-year life.

22.6 INITIAL ONE-TIME COST

$1187 per ton of refrigeration capacity based on a study completed for Oregon's EnergySmart Grocer. California's DEER database indicates between $2500 and $3000 per ton.

22.7 REQUIREMENTS FOR APPLICATION

Must replace a single compressor per line-up system with a multiplex (parallel) system. System must include floating head pressure control and mechanical sub-cooling and is applicable for retrofit situations only. System must serve a specific suction group (ie. low temp, medium temp) with each system serving multiple line-ups of similar suction groups. Incentive is based on the tons of multiplex refrigeration capacity installed. Capacity calculated at customer specific design conditions.

22.8 EXISTING ENERGY STANDARDS

None

22.9 SOURCES OF INFORMATION

California DSM programs, CDH Energy Study, Oregon report for EnergySmart Grocer project.

Attachments

FES-G1 – Multiplex Compressors

SECTION 23: FES-G2 – ANTI-SWEAT HEATER CONTROLS

Measure IDs: MMP 83

23.1 TECHNOLOGY DESCRIPTION

Glass doors on refrigerator and freezer cases can have anti-sweat or anti-condensate heaters in the frames and mullions of the case. These heaters operate continuously in order to prevent condensation/frosting on the glass and frame that occurs when the surface temperature is below the dew point of the surrounding air. Anti-sweat heater controls control the operation of these heaters so that they do not run continuously when not needed (lower dew point in the air as typically occurs in winter). Anti-sweat heaters are only required to operate at full capacity when the space humidity is 55%. This results in energy savings due to reduce operation of the heater elements.

23.2 METHODOLOGY AND ASSUMPTIONS

Savings numbers were derived from a collection of supermarket studies identifying anti-sweat heaters as a potential energy efficiency measure. The study was completed by CDH Energy using the Supermarket Simulation Tool (SST) that they developed for the Electric Power Research Institute (EPRI).

The study simulated the potential impact of cycling anti-sweat heaters based on store humidity at eleven Wisconsin supermarkets. The control scheme assumes the heaters are on 100% of the time at store (indoor) relative humidity levels of 55%. The runtime drops linearly until the heaters are off at a store (indoor) humidity level of 22%. The savings determined is the average per door of the locations studied.

The savings at each store is driven by the hours at each humidity level – therefore the dryer the store the more savings. In addition, a reduction in refrigeration load due to less heat gain to the system from the heater operation is factored into the savings – therefore the less efficient the refrigeration system the more savings. Store humidity levels are dependent on outdoor humidity and the ventilation rate of the store.

Key assumptions:

- Average power per door – 250 watts
- 3% savings in runtime of heater for a 1% drop in store (indoor) relative humidity.
- Low temp rack efficiency of 1.8 kW/ton
- 75% of anti-sweat heater load contributes to total case load.

23.3 ESTIMATED ENERGY SAVINGS – KWH

1489 kWh savings per door.

23.4 SUMMER PEAK SAVINGS

No summer peak savings is claimed since the heaters typically must operate continuously through the summer in climates where summers are humid.

23.5 MEASURE LIFE

We recommend a 10 year life. This is consistent with what other programs use for other types of controls.

23.6 INITIAL ONE-TIME COST

The cost of controls can vary significantly per door depending on control type installed. One controller can operate as few as 1 door (when control is at the case) or an entire supermarket of doors when control is integrated into existing refrigeration control system. From our current observations of projects completed the average is $85 per door. A typical control is ~$250 to operate an average of 3 doors.

23.7 REQUIREMENTS FOR APPLICATION

Equipment must sense the relative humidity or dew point in the air outside of the display case and reduces or turns off the glass door (if applicable) and frame anti-sweat heaters at low humidity conditions. Measure not applicable for low or zero energy doors where there are no anti-sweat heaters. Incentive based on total number of doors and capped at 50% of project cost. New or retrofit applications are eligible.

23.8 EXISTING ENERGY STANDARDS

None

23.9 SOURCES OF INFORMATION

CDH Energy study, Other Efficiency Program Websites

23.10 ATTACHMENTS

None

SECTION 24: FES-G3 – EFFICIENT REFRIGERATION CONDENSER

Measure IDs: MMP 84

24.1 TECHNOLOGY DESCRIPTION

This analysis evaluates the installation of oversized condensers for refrigeration systems. Increasing condenser size allows for reduced system head pressures. Reducing head pressure reduces the power consumption at the compressor.

Typical condenser designs provide for approaches (difference between entering air dry bulb temperature and refrigerant condensing temperature) as below:

Medium Temperature System = 15°F design approach
Low Temperature System = 10°F design approach

Reducing the approach lowers the head pressure and conserves compressor horsepower. Previous new construction programs in California offered prescriptive incentives that were based on the improvement in approach temperatures over those listed above.

24.2 METHODOLOGY AND ASSUMPTIONS

Averages of load and operating efficiency from an outside computer model are used in the calculation for energy savings.

- System capacity: 40 tons with full load kW/ton of 2.3 at 105°F saturated condensing temp.
- For the base, extrapolated from a computer model completed by an outside engineering firm, a system without efficient (oversized) condensers (10°F condenser approach) operating based on 82F ambient had an ave. load of 82% and ave. kW/ton of 1.92 and a similar system operating based on 70F ambient had an ave. load of 79% and ave. kW/ton of 1.85.
- For the proposed, extrapolated from the same computer model, a system with efficient (oversized) condensers (7°F condenser approach) operating based on 82F ambient had an ave. load of 83% and ave. kW/ton of 1.86 and a similar system operating based on 70F ambient had an ave. load of 80% and ave. kW/ton of 1.78. Peak kW/ton of the proposed in the model was 2.18 kW/ton.
- Due to savings for this measure occurring only in the warmer months, 4380 hours was used (1/2 a year).

24.3 ESTIMATED ENERGY SAVINGS – KWH

120 kWh per ton of refrigeration capacity

24.4 SUMMER PEAK SAVINGS

0.118 kW per ton of refrigeration capacity

24.5 MEASURE LIFE

Connecticut Light & Power uses a 15 year life. The DEER database indicates between 10 and 16 years.

24.6 INITIAL ONE-TIME COST

Per internet research, more recent analysis from projects completed in Oregon and California indicate $35 per ton of refrigeration cost for incremental. A new condenser when existing not failed would result in $350 per ton cost.

24.7 REQUIREMENTS FOR APPLICATION

Oversized Condenser Approach Requirements: Air cooled low temp 8°F, air cooled medium temp 13°F, evaporative-cooled 18°F. Condenser design temperature approach must be at or below the following parameters: Air-cooled condensers (exiting refrigerant vs. ambient dry bulb temperature): low temperature systems (8°F) and medium temperature systems (13°F). Evaporative-cooled condensers (exiting refrigerant vs. ambient wet bulb temperature: 18°F. Incentive is based on tons of refrigeration capacity of the system being affected. Capacity calculated at customer specific design conditions.

24.8 EXISTING ENERGY STANDARDS

None

24.9 SOURCES OF INFORMATION

California DSM programs, Connecticut Power & Light programs, Oregon Energy Smart Grocer project report

24.10 ATTACHMENTS

FES-G3 – Efficient Condensers

SECTION 25: FES-G4 – NIGHT COVERS

Measure ID: MMP 85

25.1 TECHNOLOGY DESCRIPTION

Open refrigerated display cases in supermarkets have a continuous heat load due to losses to the surrounding environment. When store operations are not 24 hours per day, night covers (a film type perforated cover) can be utilized on the cases to minimize the losses to the ambient space during periods when the store is closed. The analysis is based on information extracted from documents describing past California utilities refrigeration efficiency improvement programs. This analysis relies on the assumptions from the California programs.

Thermal radiation and infiltration of warm air into cold, open display cases account for most of the refrigeration load for the displays. For supermarkets that do not operate for 24 hours, there is an energy reduction opportunity to cover the opening. The literature restricts its analysis to a case with a minimum of 6 hours per day of non-operating hours. It is recommended that the covers be perforated to decrease moisture buildup.

Test results reported by the SDG&E indicate a 9% reduction is compressor power during a 6 hour period with night covers in place. The uncovered usage reported by the California programs is 1168 kWh per linear foot.

25.2 METHODOLOGY AND ASSUMPTIONS

The analysis for this technology consists of simply clarifying the results of the test reports from the California utilities. Inherent in the acceptance of their energy estimates is acceptance of their testing and assumptions..

25.3 ESTIMATED ENERGY SAVINGS – KWH

KWh Savings = 1168 kWh/lineal foot x 9% = 105 per lineal foot

25.4 SUMMER PEAK SAVINGS

No summer peak savings due to covers installed at night. Average night demand savings based on 3500 hours of night application would be 0.03 kW.

25.5 MEASURE LIFE

The DEER database indicates a 5 year life for night covers. It does indicate a 16-year life for night shields – the savings would be the same for these but the likelihood of installation is low due to the covers being easier to use.

25.6 INITIAL ONE-TIME COST

Per internet research, more recent analysis from projects completed in Oregon indicate $35 per lineal foot cost.

25.7 REQUIREMENTS FOR APPLICATION

Store operation must allow covers to be covering cases at least 6 hours per 24 hour period.

25.8 EXISTING ENERGY STANDARDS

None

25.9 SOURCES OF INFORMATION

California DSM programs

25.10 ATTACHMENTS

None

SECTION 26: FES-G5 – HEAD PRESSURE CONTROL

Measure ID: MMP 86

26.1 TECHNOLOGY DESCRIPTION

Reducing the compressor discharge pressure reduces the pressure ratio across the compressor and improves the operating efficiency. Many systems have controls that maintain a minimum condensing pressure to ensure proper operation of all components. By letting the condensing pressure drop down at lower ambient temperatures with head pressure controls, energy savings can be achieved. The typical design target for refrigeration systems for head pressure is the equivalent of 100F to 105F saturated condensing temperature.

Previous programs in California offered prescriptive incentives that were based on ambient temperatures for the estimated savings as listed below:

82°F = Base – No incentive
70°F = 6% Savings
60°F = 9.5% Savings
50°F = 13% Savings

26.2 METHODOLOGY AND ASSUMPTIONS

Averages of load and operating efficiency from an outside computer model are used in the calculation for energy savings. The analysis is based on the estimated energy consumption of a low temperature system (-25°F) operating 8760 hours per year. The base system is assumed to limit the condensing pressure to that corresponding to 82°F ambient. The floating head pressure system is assumed to allow the equivalent condensing pressure to drop to a pressure corresponding 60°F ambient. The average base load extrapolated from the model to be 82% with an average of 1.92 kW/ton operation. The proposed operation as extrapolated from the model is 78% with an average of 1.83 kW/ton.

26.3 ESTIMATED ENERGY SAVINGS – KWH

1264 per ton of refrigeration (based on original model output).

The calculation based on extrapolated data results in 1288 kWh/ton. A program simulation completed in Wisconsin of eleven stores demonstrated an average of 1226 kWh per ton.

26.4 SUMMER PEAK SAVINGS

Because the savings opportunity is based on colder ambient temperatures, there is no predictable demand savings for this technology.

26.5 MEASURE LIFE

The DEER database 2005 indicates a 16 year life

26.6 INITIAL ONE-TIME COST

Per internet research, more recent analysis from projects completed in Oregon indicated $80 per ton (mostly labor). The DEER database from California indicates between $30 & $50 per ton (mostly labor).

26.7 SUGGESTED INCENTIVE

$60 per ton of refrigeration

26.8 REQUIREMENTS FOR APPLICATION

Controls must be installed that vary head pressure based on outdoor air temperature. At least a 20° minimum variance below design head pressure should be achieved during milder weather conditions. Qualifying systems use variable set-point floating head controls to adjust condensing temperatures in relation to outdoor air temperature. Incentive only available to assist with the purchase of hardware needed to achieve lowered head pressure (70F is a typical value). . Incentive is based on tons of refrigeration capacity that the control is applied to and is capped at 50% of project cost. Capacity calculated at customer specific design conditions.

26.9 EXISTING ENERGY STANDARDS

None

26.10 SOURCES OF INFORMATION

California DSM programs, CDH Energy Simulation report on Floating Head Pressure for 11 Wisconsin supermarkets

26.11 ATTACHMENTS

FES-G5 – Head Pressure Control

SECTION 27: FES-G6 – ENERGY STAR COMMERCIAL SOLID DOOR REFRIGERATORS AND FREEZERS

Measure IDs: MMP 87 – 92

27.1 TECHNOLOGY DESCRIPTION

ENERGY STAR Commercial Solid Door Refrigerators and Freezers were evaluated in comparison to base models of comparable units.

27.2 METHODOLOGY AND ASSUMPTIONS

A spreadsheet calculation was performed comparing an equation for the base equipment energy usage (dependent on unit volume) to the ENERGY STAR specification (dependent on unit volume). Average sizes in three different size ranges were evaluated.

Key assumptions:

- Sizes Used for each range of unit is the average size of all units qualifying for ENERGY STAR in the size range.
- The energy per day for the existing unit is based on the equation 0.125*Volume+2.76 for refrigerators and 0.398*Volume+2.28 for freezers. (per Food Service Technology Center - pre-1996 standard)
- The energy per day for ENERGY STAR units is based on the qualifying specification 0.1*Volume+2.04 for refrigerators and 0.4*Volume+1.38 for freezers.
- The demand is assumed to be the average demand. (per Food Service Technology Center)
- Unit run continuously year round = 8760 hours/year
- Cost estimates are incremental based on data provided by the Food Service Technology Center.
- Secondary impacts for heating and cooling were not evaluated.

27.3 ESTIMATED ENERGY SAVINGS – KWH

(Based on using Food Service Technolgy Center Life Cycle Cost Calculator)

Refrigerators <20 ft^3 - 371 kWh/unit. Assumes 12 ft^3 average.

Refrigerators 20-48 ft^3 - 544 kWh/unit. Assumes 30 ft^3 average.

Refrigerators >48 ft^3 - 832 kWh/unit. Assumes 62 ft^3 average.

Freezers <20 ft^3 - 320 kWh/unit. Assumes 12 ft^3 average.

Freezers 20-48 ft^3 - 307 kWh/unit. Assumes 30 ft^3 average.

Freezers >48 ft^3 - 282 kWh/unit. Assumes 63 ft^3 average.

27.4 SUMMER PEAK SAVINGS

(Based on using Food Service Technolgy Center Life Cycle Cost Calculator)

Refrigerators <20 ft^3 - 0.042 kW/unit. Assumes 12 ft^3 average.

Refrigerators 20-48 ft^3 - 0.062 kW/unit. Assumes 30 ft^3 average.

Refrigerators >48 ft^3 - 0.095 kW/unit. Assumes 62 ft^3 average.

Freezers <20 ft^3 - 0.037 kW/unit. Assumes 12 ft^3 average.

Freezers 20-48 ft^3 - 0.035 kW/unit. Assumes 30 ft^3 average.

Freezers >48 ft^3 - 0.032 kW/unit. Assumes 63 ft^3 average.

27.5 MEASURE LIFE

The DEER database from California indicates a 12 year useful life.

27.6 INITIAL ONE-TIME COST

For qualifying refrigerators, research from the Food Service Technology Center indicates incremental costs of $250, $500 and $900 corresponding to the size ranges recommended from smallest to largest.

For qualifying freezers, research from the Food Service Technology Center indicates incremental costs of $150, $400 and $700 corresponding to the size ranges recommended from smallest to largest.

27.7 REQUIREMENTS FOR APPLICATION

New units must be ENERGY STAR.

27.8 EXISTING ENERGY STANDARDS

ENERGY STAR is the energy standard applicable to these units. The Consortium for Energy Efficiency also has more efficient tiers included in their specification.

27.9 SOURCES OF INFORMATION

ENERGY STAR, Food Service Technology Center, Program websites for Efficiency Vermont and Rochester Public Utilities

27.10 ATTACHMENTS

FES-G6 – ENERGY STAR Commercial Solid Door Refrigerators and Freezers

SECTION 28: FES-G7 – ICE MACHINES

Measure IDs: MMP 93 -95

28.1 TECHNOLOGY DESCRIPTION

Ice machines (both air- and water-cooled) that are cube making machines were evaluated. These machines may be either an ice making head, remote condensing (air-cooled only) or a self-contained unit.

28.2 METHODOLOGY AND ASSUMPTIONS

A spreadsheet analysis of all equipment in the Air-conditioning & Refrigeration Institute (ARI) directory (the regulating agency that provides the testing standard for ice machines) was completed.

Data from the ARI directory (Ice Harvest Rate – lbs/24 hrs; Energy Consumption Rate – kWh/100 lbs) was separated into the categories used by the Consortium for Energy Efficiency (CEE) for their specification: air-cooled ice making head, air-cooled remote condensing unit, air-cooled self-contained unit, water-cooled ice making head and water-cooled self-contained unit.

Within each of these categories, an X-Y scatter diagram of energy vs harvest rate was created and a trend line was determined for the equipment that did not meet the CEE Tier 1 specification in order to set the base line for savings. (Note: the ARI directory only includes equipment currently available for sale) Savings (kWh/year) for each piece of qualifying equipment was calculated as compared to the base line determined for its category & size.

Calculation for kWh/year:

Annual kWh Savings per Unit =

$$\left(\frac{\text{kWh base}}{\text{100 lbs}} - \frac{\text{kWh prop}}{\text{100 lbs}}\right) \times \frac{\text{lbs/24 hrs}}{\text{100 lbs}} \times \text{365 days} \times \text{Load Factor}$$

Demand Savings = Annual kWh Savings per Unit / 3000 Equiv. Full Load Hours

All qualifying equipment was then grouped back together and sorted by size. This list was separated by size category (increments of 100 lbs of ice production per day). Total savings per year with a load factor was calculated as well as an estimated demand for each piece of equipment and the average in each size range was determined. After analyzing the different size categories it was determined that the equipment could be put into the larger groupings of <500 lbs, 500-1000 lbs and >1000 lbs.

Key assumptions:

- 75% load factor
- Estimated 3000 hours per year equivalent full load.

28.3 ESTIMATED ENERGY SAVINGS – KWH

Ice Production <500 lbs/24 hrs - 1200 kWh/unit.

Ice Production 500-1000 lbs/24 hrs - 1750 kWh/unit.

Ice Production >1000 lbs/24 hrs - 4870 kWh/unit.

28.4 SUMMER PEAK SAVINGS

Ice Production <500 lbs/24 hrs – 0.32 kW/unit.

Ice Production 500-1000 lbs/24 hrs – 0.48 kW/unit.

Ice Production >1000 lbs/24 hrs – 1.28 kW/unit.

28.5 MEASURE LIFE

California's Southern California Edison program indicates a 12 year useful life for ice machines.

28.6 INITIAL ONE-TIME COST

The incremental cost was found in research completed by the Food Service Technology Center. Ice Production <500 lbs/24 hrs - $600; Ice Production 500-1000 lbs/24 hrs - $1500; Ice Production >1000 lbs/24 hrs - $2000

28.7 REQUIREMENTS FOR APPLICATION

New units must meet Consortium for Energy Efficiency's Tier 1 ice machine specification. Flake and nugget machines are not included.

28.8 EXISTING ENERGY STANDARDS

Consortium for Energy Efficiency (CEE) Tier 1 is the standard. CEE also has more efficient tiers included in their specification.

28.9 SOURCES OF INFORMATION

ARI, Consortium for Energy Efficiency, Food Service Technology Center working with the California DSM Programs, ASHRAE

28.10 ATTACHMENTS

None

SECTION 29: FES-I1 – ENGINEERED NOZZLES

MEASURE ID: MMP 96

29.1 TECHNOLOGY DESCRIPTION

Engineered nozzles reduce the amount of air required to blow off parts or for drying. These nozzles utilize the coanda effect to pull in free air to accomplish tasks for up to 70% less compressed air. Engineered nozzles often replace simple copper tubes. Engineered nozzles have the added benefits of noise reduction and improved safety in systems with greater than 30 psig.

29.2 METHODOLOGY AND ASSUMPTIONS

Energy efficiency information from the Compressed Air Challenge was used to estimate compressor efficiency. Standard open pipe leak rates were obtained as well as typical nozzle flow rates.

Key assumptions:

- Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.

29.3 ESTIMATED ENERGY SAVINGS

3.68 kW, 7343 kWh

29.4 MEASURE LIFE

NEMA premium efficiency motors have a life of 15 years.

29.5 REQUIREMENTS FOR APPLICATION

Ratings for engineered nozzle. Verify that usage is 2000 hours or greater.

29.6 SOURCES OF INFORMATION

The Compressed Air Challenge: Fundamentals of Compressed Air Systems

29.7 ATTACHMENTS

FES-I1 – Engineered Nozzles

SECTION 30: FES-I2 – BARREL WRAPS FOR INJECTION MOLDERS & EXTRUDERS

MEASURE ID: MMP 97

30.1 TECHNOLOGY DESCRIPTION

Removable insulated blankets enclose the cylindrical barrels of an injection molder or extruder. Surface temperatures of the barrels range from 300°F to 600°F, depending on the resins processed. Barrels are heated either with electric resistance band heaters or by friction from the mechanical screw which forces resin through the barrel. Insulated blankets minimize the use of resistance heating without affecting temperature control of the molded or extruded resin.

Barrel wraps are held in place by straps. The only cost is for the equipment, there is no installation cost. Blankets are available either in standard sizes or can be custom manufactured.

30.2 METHODOLOGY AND ASSUMPTIONS

Manufacturer data was analyzed from 10 case studies over a range of injection molder sizes (55 – 1000 tons)

(http://www.unitherm.com/information/kwhstudies/index.htm).

Data from Unitherm was selected because at the time of the analysis they supplied the most information on their web site.

It is not known how they compiled their data, but it appears to be direct power logging before and after installation of the blankets. As the savings appear to be reasonable and consistent with claims from other manufacturers and what would be expected from this type of measure, no additional engineering analysis was warranted.

30.3 ESTIMATED ENERGY SAVINGS – KWH

Average energy savings are approximately 75 kWh/ton for the case studies analyzed. Savings are going to vary dependant upon machine size and operating parameters. In order to be conservative, we will claim 50 kWh/ton.

30.4 SUMMER PEAK SAVINGS

Peak savings will be dependant upon production schedules and equipment size. Using 50 kWh as the energy savings, and 5000 hours as the typical annual hours of operation, the peak demand savings calculates to 0.01 kW.

30.5 MEASURE LIFE

It is unknown what the typical product life is. With proper care it would be expected that the blankets could last up to 10 years. In dirty or severe environments the life may only be a couple of years. For conservancy sake, it is estimated that 5 years is an appropriate measure life.

30.6 INITIAL ONE-TIME COST

Average unit cost is approximately $1/sq. in. It is difficult to relate this cost into a per ton basis, as that is dependant upon the various dimensions for individual molders. It appears that in most manufacturer claims, payback is one year or less.

30.7 ANY RECURRING COSTS

No additional recurring costs.

30.8 REQUIREMENTS FOR APPLICATION

Blankets must be installed on equipment that previously has not had insulation. Also, blankets must be used in applications recommended by the blanket manufacturer.

One concern is that as these are not permanent, it is possible that the blankets might be removed for a number of reasons then not replaced.

30.9 EXISTING ENERGY STANDARDS

No standards exist.

30.10 SOURCES OF INFORMATION

Unitherm - www.unitherm.com/information/kwhstudies/index.htm.
Uni-Vest - www.imscompany.com
Jeda Equipment Services, Inc.

30.11 <u>ATTACHMENTS</u>

FES-I2 – Barrel Wraps Savings Analysis

SECTION 31: FES-I3 – INSULATED PELLET DRYER DUCTS

MEASURE IDS: MMP 98 - 102

31.1 TECHNOLOGY DESCRIPTION

Resin pellets used in injection molders and extruders are typically dried using electrically heated and desiccant dried air. Flexible ducts in the 3" to 8" diameter size range circulate the drying air. Air temperatures usually range from 160°F to 200°F. Uninsulated duct heat loss must be replaced by electric resistance heaters. Most facilities have pellet dryers running constantly to maintain pellet dryness at all times.

31.2 METHODOLOGY AND ASSUMPTIONS

Analysis results are shown in Table FES-I3. The analysis is shown for a range of duct diameters from 3" to 8", air temperatures from 160°F to 200°F, and for 2000 to 8760 operating hours per year.

The secondary impacts of heat loss into the space are not included. Reduced heat loss helps during the cooling season, but adds to winter space heating loads.

31.3 ESTIMATED ENERGY SAVINGS – KWH

Estimated energy savings can be found for various duct diameters, operating temperatures, and run times in Table FES-I3..

31.4 SUMMER PEAK SAVINGS

Peak savings will be dependant upon production schedules and equipment size. Table FES-I3 list demand reduction on a kW/ft basis for various temperatures and duct diameters.

31.5 MEASURE LIFE

It is unknown what the typical product life is. With proper care it would be expected that the insulation could last up to 10 years. In dirty or severe environments the life may only be a couple of years. For conservancy sake, it is estimated that 5 years is an appropriate measure life.

31.6 INITIAL ONE-TIME COST

Costs are estimated in Table FES-I3. Installation cost is assumed to be negligible as it is expected that maintenance will be installing the ducting.

31.7 ANY RECURRING COSTS

No additional recurring costs.

31.8 REQUIREMENTS FOR APPLICATION

Ducting must be installed on equipment that previously has not had insulation. Installation should only be on centralized, recirculating hoppers, not transportable drums. Incentives should be for applicable products, i.e. the ducting must be capable of steady-state temperatures of 200F, and most standard HVAC insulation is only rated to 140F..

31.9 EXISTING ENERGY STANDARDS

No standards exist.

31.10 SOURCES OF INFORMATION

Bradflo - http://www.bradflo.com/index.htm

31.11 ATTACHMENTS

FES-I3 – Pellet Dryer Duct Insulation

SECTION 32: ADDITIONAL END-USE MEASURES

32.1 WATER LOOP HEAT PUMP BASELINE AND MEASURE ASSUMPTIONS:

MEASURE IDS: MMP 103 - 105

The water lop heat pump analysis assumed a water loop heat pump system is installed in the base case, with an incremental improvement in the heat pump efficiency as the measure. The baseline efficiency is defined from ASHRAE 90.1-2004. The baseline and measure efficiency assumptions are shown below:

Equipment Category	Capacity Range Btu/hr	Baseline Efficiency		Source	Measure Efficiency	
		Value	Units		Value	Units
Water Source Heat Pump	<17,000	11.2	EER	ASHRAE 90.1-2004	11.5	EER
Water Source Heat Pump	17,000 - 65,000	12	EER	ASHRAE 90.1-2004	12.3	EER
Water Source Heat Pump	65,000 - 135,000	12	EER	ASHRAE 90.1-2004	12.3	EER

A water loop heat pump system utilizes a network of packaged single zone air to water heat pumps connected to a common water loop. Units in heating mode take heat from the loop, while units in cooling mode reject heat to the loop. A boiler is used to maintain a minimum loop temperature if there is a net heat removal from the loop, and a heat rejection device is used to maintain a maximum loop temperature if there is a net heat rejection to the loop.

32.2 SETBACK THERMOSTAT ASSUMPTIONS:

Measure ID: MMP 106

The thermostat must meet Energy Star qualifications.

1. 7am – 11pm Monday-Friday occupancy
2. 10°F setback during unoccupied times
3. Economizer cycle available
4. AHU fan shutdown when space satisfied during unoccupied times
5. Single zone constant volume AHUs
6. Typical commercial building construction with one (1) outside wall for space analyzed

32.3 GROUND SOURCE HEAT PUMP BASELINE AND MEASURE ASSUMPTIONS:

Measure ID: MMP 107

The ground source heat pump analysis assumed a ground source heat pump system is installed in the base case, with an incremental improvement in the heat pump efficiency as the measure. The baseline efficiency is defined from ASHRAE 90.1-2004. The baseline and measure efficiency assumptions are shown below:

Equipment Category	Capacity Range Btu/hr	Baseline Efficiency		Source	Measure Efficiency	
		Value	Units		Value	Units
Ground Source HP Closed Loop	<135,000 & 59 F EWT	16.2	EER	ASHRAE 90.1-2004	16.5	EER
Ground Source HP Closed Loop	<135,000 & 77 F EWT	13.4	EER	ASHRAE 90.1-2004	13.7	EER

32.4 WEATHER SENSITIVE/ HVAC MEASURES

Measure IDs: MMP 103 – 134

Study Methodology

HVAC measure energy and demand savings were established by using a set of prototypical building models developed for the DOE-2.2 building energy simulation program. Prototype models were developed for small retail, big-box retail, small office, large office, fast food restaurant, full service restaurant, school, assembly and light industrial buildings. These buildings represent the types of customers that are expected to participate in the program. The prototypes are based on the models used in the California DEER study, with appropriate modifications to adapt these models to local design practices and climate. Energy savings estimates were developed from the prototype models for entry into the DSMore cost-effectiveness tool.

The HVAC measures for small commercial buildings include single package rooftop air conditioners and heat pumps, split system air conditioners and heat pumps, packaged terminal air conditioners and heat pumps, and ground source and water loop heat pumps. The HVAC measures for the large office building include air cooled chillers, water cooled chillers, variable frequency drives (VFD) applied to fans and pumps, and chilled water temperature reset controls. The program baseline is defined by the National Appliance Energy Conservation Act (NAECA) minimum efficiency for single phase equipment and ASHRAE 90.1 – 2004 minimum efficiency for three phase equipment. HVAC measures cover the upgrade of standard efficiency packaged HVAC systems with high efficiency versions of the same equipment. The calculations do not address HVAC system type changes (e.g. the energy savings from changing from a rooftop AC system to a ground-source heat pump system).

MEASURE EFFICIENCY ASSUMPTIONS

The equipment covered, the size ranges, and the program baseline and measure efficiency assumptions are shown in Table 1. Additional information about the modeling methodology and assumptions can be found in the report, "Kansas City Power & Light C&I Energy Efficiency Programs Findings and Documentation", dated October 12, 2007 by Morgan Marketing Partners, on page 35.

TABLE 1. HVAC Equipment Efficiency Assumptions

Equipment Category	Capacity Range Btu/hr	Baseline Efficiency		Source	Measure Efficiency	
		Value	Units		Value	Units
Packaged Terminal A/C	All	8.9	EER	ASHRAE 90.1-2004	9.2	EER
Packaged Terminal HP	All	8.7	EER	ASHRAE 90.1-2004	9	EER
Rooftop A/C (1) phase	<65,000 1 Ph	13	SEER	NAECA	14	SEER
Rooftop A/C (3) phase	<65,000 3 Ph	12	SEER	ASHRAE 90.1-2004	13	SEER
Rooftop A/C (3) phase	65,000 - 135,000	10.1	EER	ASHRAE 90.1-2004	11	EER
Rooftop A/C (3) phase	135,000 - 240,000	9.5	EER	ASHRAE 90.1-2004	11	EER
Rooftop A/C (3) phase	240,000 - 760,000	9.3	EER	ASHRAE 90.1-2004	10	EER
Rooftop A/C (3) phase	>760,000	9	EER	ASHRAE 90.1-2004	10	EER
Rooftop HP (1) phase	<65,000 1 Ph	13	SEER	NAECA	14	SEER
Rooftop HP (3) phase	<65,000 3 Ph	12	SEER	ASHRAE 90.1-2004	13	SEER
Rooftop HP (3) phase	65,000 - 135,000	9.9	EER	ASHRAE 90.1-2004	11	EER
Rooftop HP (3) phase	135,000 - 240,000	9.1	EER	ASHRAE 90.1-2004	10	EER
Rooftop HP (3) phase	>240,000	8.8	EER	ASHRAE 90.1-2004	10	EER
Ground Source HP Closed Loop	<135,000 & 59 F EWT	16.2	EER	ASHRAE 90.1-2004	16.5	EER
Ground Source HP Closed Loop	<135,000 & 77 F EWT	13.4	EER	ASHRAE 90.1-2004	13.7	EER
Water Source Heat Pump	<17,000	11.2	EER	ASHRAE 90.1-2004	11.5	EER
Water Source Heat Pump	17,000 - 65,000	12	EER	ASHRAE 90.1-2004	12.3	EER
Water Source Heat Pump	65,000 - 135,000	12	EER	ASHRAE 90.1-2004	12.3	EER
Air Cooled Chillers	All	1.33	kW/ton	ASHRAE 90.1-2004	1.16	kW/ton
Water Cooled Chillers	< 150 ton	0.835	kW/ton	ASHRAE 90.1-2004	0.78	kW/ton
Water Cooled Chillers	150 - 300 ton	0.74	kW/ton	ASHRAE 90.1-2004	0.56	kW/ton
Water Cooled Chillers	> 300 ton	0.69	kW/ton	ASHRAE 90.1-2004	0.54	kW/ton

SECTION 33: ADDITIONAL RESIDENTIAL SECTOR, ENERGY CONSERVATION MEASURES

33.1 RESIDENTIAL CENTRAL AIR-CONDITIONING SYSTEM, REPLACEMENT UPON FAILURE

Measure IDs: KCP&L 1-3

33.2 TECHNOLOGY DESCRIPTION

Residential central air-conditioning systems were evaluated for the replacement of a failed system with a unit having a Seasonal Energy Efficiency Rating (SEER) above 13.

33.3 METHODOLOGY AND ASSUMPTIONS

A spreadsheet calculation was performed using an minimum required SEER rating of 13 for a new unit with the SEER rating for the more efficient units. SEER ratings were converted to equivalent Energy Efficiency Ratings (EER95) Savings at 12,000 BTU per Ton. Full load cooling hours assumed was based on information from ARI Unitary Directory, August 1, 1992 - January 31, 1993 for Kansas City, MO.

Key assumptions:

- Full load cooling hours = 1,050 hours/year
- Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.

33.4 ESTIMATED ENERGY SAVINGS – KWH

Install AC SEER = 14 vs 13 SEER: 238 kWh per unit
Install AC SEER = 15 vs 13 SEER: 445 kWh per unit
Install AC SEER = 16 vs 13 SEER: 625 kWh per unit

33.5 SUMMER PEAK SAVINGS

Install AC SEER = 14 vs 13 SEER: 0.22 kW per unit
Install AC SEER = 15 vs 13 SEER: 0.42 kW per unit
Install AC SEER = 16 vs 13 SEER: 0.59 kW per unit

33.6 MEASURE LIFE

Residential central air conditioners have an average lifetime of 18 years.

33.7 INITIAL ONE-TIME COST

Estimates of the incremental cost of a system with a SEER above 13 versus the cost of a SEER 13 system. This incremental costs are :

Install AC SEER = 14 vs 13 SEER: $ 200 per unit
Install AC SEER = 15 vs 13 SEER: $ 900 per unit
Install AC SEER = 16 vs 13 SEER: $1,200 per unit

SECTION 34: RESIDENTIAL CENTRAL AIR-CONDITIONING SYSTEM, EARLY RETIREMENT

Measure IDs: KCP&L 4-6

34.1 TECHNOLOGY DESCRIPTION

Residential central air-conditioning systems were evaluated for the early retirement of an operating system with a unit having a Seasonal Energy Efficiency Rating (SEER) above 13 SEER.

34.2 METHODOLOGY AND ASSUMPTIONS

A spreadsheet calculation was performed using an assumed average SEER rating of 9 for the existing system versus a new replacement unit with a SEER rating above 13. SEER ratings were converted to equivalent Energy Efficiency Ratings (EER95) Savings at 12,000 BTU per Ton. Full load cooling hours assumed was based on information from ARI Unitary Directory, August 1, 1992 - January 31, 1993 for Kansas City, MO.

Key assumptions:

- Full load cooling hours = 1,050 hours/year
- Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.

34.3 ESTIMATED ENERGY SAVINGS – KWH

Install AC SEER = 14 vs 9 SEER: 3,331 kWh per unit
Install AC SEER = 15 vs 9 SEER: 3,331 kWh per unit
Install AC SEER = 16 vs 9 SEER: 3,484 kWh per unit

34.4 SUMMER PEAK SAVINGS

Install AC SEER = 14 vs 9 SEER: 2.29 kW per unit
Install AC SEER = 15 vs 9 SEER: 2.29 kW per unit
Install AC SEER = 16 vs 9 SEER: 2.41 kW per unit

34.5 MEASURE LIFE

For this case it was assumed that the replacement central air conditioner had an weighted average lifetime of 9.14 years. NOTE: It was assumed that the existing the existing equipment had a remaining available lifetime of 9 years and that a 13 SEER unit be required upon failure in 9 years.

34.6 INITIAL ONE-TIME COST

Estimates of the incremental cost of a system with a SEER above 13 versus the cost of a SEER 13 system. This incremental costs are :

Install AC SEER = 14 vs 13 SEER: $ 200 per unit
Install AC SEER = 15 vs 13 SEER: $ 900 per unit
Install AC SEER = 16 vs 13 SEER: $1,200 per unit

SECTION 35: RESIDENTIAL CENTRAL AIR-CONDITIONING SYSTEM, RECOMMISSIONING OF UNIT

Measure IDs: KCP&L 7

35.1 TECHNOLOGY DESCRIPTION

Residential central air-conditioning systems were evaluated for the recommissioning of an operating system.

35.2 METHODOLOGY AND ASSUMPTIONS

A spreadsheet calculation was performed using an assumed nameplate SEER rating of 8.5 versus system operating with a degraded SEER rating below 7.

Key assumptions:

- Full load cooling hours = 1,050 hours/year
- Cost estimates include material costs only. Installation costs and potential maintenance savings are not included.

35.3 ESTIMATED ENERGY SAVINGS – KWH

937 kWh per unit

35.4 SUMMER PEAK SAVINGS

0.27 kW per unit

35.5 MEASURE LIFE

For this case it was assumed that the re-commissioned central air conditioner had an expected lifetime of 10 years.

35.6 INITIAL ONE-TIME COST

Estimates of the system recommissioning cost were $135 per unit.