Product: Commercial Refrigeration

Prescriptive rebates will be offered for the installation of reach-in cases with doors, evaporator fan motor controls, night curtains on refrigerator and freezer cases, EC Motors for Refrigeration Evaporators, Anti-Sweat Heater Controls and/or replacement of standard refrigeration case doors with No Heat Case Doors, aerators on faucets, more energy efficient pre-rinse sprayers, replacement lighting equipment, and the cleaning of refrigerator and freezer coils.

Algorithms:

Enclosed Reach-In Cases	
Enclosed Reach-in Case Electrical Demand	= [(Btuh_base x LF x 1/COP)-(Btuh_ee x LF x 1/COP)] / 3412
Enclosed Reach-in Case Electrical Energy	= [(Btuh_base x LF x 1/COP)-(Btuh_ee x LF x 1/COP)] / 3412 x Hrs
Evaporative Fan Motor Controls	
Evaporator Fan Motor Control Electrical	= Baseline Fan Watts x (1-ESF) x LF
Evaporator Fan Motor Control Electrical	= Baseline Fan Watts x (1-ESF) x LF x Hrs
Night Curtains	
Night Curtains Electrical Demand Savings	= (Btuh_base x LF x C_inf x 1/COP) / 3412
Night Curtains Electrical Energy Savings	= (Btuh_base x LF x C_inf x 1/COP) / 3412 * Hrs
Floating Head Pressure Controls	
Floating Head Pressure Control Applications will go through the Custom program	Electrical energy savings and electrical demand savings will be calculated based on the project specific details. Each project will undergo an engineering review in accordance with standard engineering practices.
CHW Pre-Rinse	
CHW Pre-Rinse Electric (Customer kWh)	= EnergyToHeatWater / EF_electric / ConversionFactor
CHW Pre-Rinse Electric (Customer kW)	= Unit kWh Savings per Year / 8,760 hours
EnergyToHeatWater	= SpecificHeat x Density x WaterSaved x (Tset - Tcold)
WaterSaved	= (Flow_base x Hours_base - Flow_eff x Hours_eff) x Days
Unit Dth Savings per Year	`
EnergyToHeatWater	= SpecificHeat x Density x WaterSaved x (Tset - Tcold)
WaterSaved	= (Flow_base x Hours_base - Flow_eff x Hours_eff) x Days
CHW-Aerator-Electric	
CHW Aerator Electric (Customer kWh)	
CHW Aerator Electric (Customer kW)	
WaterSaved	= (Flow_base - Flow_eff) x TPD / 60 min/hr x Days
EnergyToHeatWater	= SpecificHeat x Density x WaterSaved x (Tfaucet - Tcold)
EPG	= Density x SpecificHeat x (Tfaucet - Tcold) / (ReEff x ConversionFactor)
Unit Dth Savings per Year	= EnergyToHeatWater / EF_gas / ConversionFactor
WaterSaved	= (Flow_base - Flow_eff) x TPD / 60 min/hr x Days
EnergyToHeatWater	= SpecificHeat x Density x WaterSaved x (Tfaucet - Tcold)
Tune-Up	
Tune-Up Electrical Energy Savings	= kW_hp_R,F*HP*(EFLH_dirty - EFLH_clean)*(1-SF)
Tune-Up Electrical Demand Savings	= Customer kWh / 8,760 hrs
Algorithms:	
Anti-Sweat Heater Controls kW Savings (Customer kW)	= ASHC_kWh/ASHC_Hours
Anti-Sweat Heater Controls kWh Savings (Customer kWh)	= ASHC_kWh = ASHC_Baseline_kW x Refrigeration_Factor x ASHC_Hours x %_Off
Electronically Commutated Motor Electrical	= (ECM_Baseline_Fan_ Watts - ECM_Efficient_Fan_ Watts) x Refrigeration_Factor
Electronically Commutated Motor Electrical	= (ECM_Baseline_Fan_ Watts - ECM_Efficient_Fan_ Watts) x Refrigeration_Factor x ECM_Hours
No Heat Case Doors (Customer kW, NHD_kW)	= (NHD_Baseline_kW - NHD_Efficient_kW) x Refrigeration_Factor
No Heat Case Doors (Customer kWh)	= NHD_kW x NHD_Hours
Electrical Energy Savings (Gross Generator kWh)	= Customer kWh / (1-TDLF)

Electrical Demand Savings (Gross Generator kW)	= Customer kW x CF / (1-TDLF)
Refrigeration_Factor	= Multiplier to include interactive effects of refrigeration energy to remove heat from the motor. Reduction in motor energy results in a reduction in refrigeration energy. = 1 + R_H/COP (See assumptions for values)
Electrical Demand Savings (Customer kW)	= (kW_Base - kW_EE) x HVAC_cooling_kWsavings_factor
Electrical Energy Savings (Customer kWh/yr)	= (kW_Base - kW_EE) x Hrs x HVAC_cooling_kWhsavings_factor
Natural Gas Savings (Dth)	= (kW_Base - kW_EE) x Hrs x HVAC_heating_penalty_factor
Lighting Controls -Electrical Energy Savings (Customer kWh/yr)	=(kW connected) x (1-PAF) x Hrs x HVAC_cooling_kWhsavings_factor
Lighting Controls -Electrical Demand Savings (Customer kW)	=(kW connected) x (1-PAF) x HVAC_cooling_kWsavings_factor
Lighting Controls -Natural Gas Savings (Dth)	=(kW connected) x (1-PAF) x Hrs x HVAC_heating_penalty_factor
Electrical Energy Savings (Gross Generator kWh)	= Customer kWh / (1-TDLF)
Electrical Demand Savings (Gross Generator kW)	= Customer kW x CF / (1-TDLF)
Electrical Energy Savings (Net Generator kWh)	= Gross Generator kWh x NTG
Electrical Demand Savings (Net Generator kW)	= Gross Generator kW x NTG

Variables:

Common

Hrs	= Annual operating hours = 8760
3412	= Conversion 1kWh = 3412 BTU
COP	= Coefficient of performance of compressor in the cooler/freezer. COP = 2.28 for cooler, COP = 1.43 for freezer (ref. 1)
SpecificHeat	= Specific Heat of Water; 1.0 btu / (lb x °F)
Density	= Density of Water; 8.34 lbs / gal
TDLF	Transmission-Distribution Loss Factor = 6.5%, the percentage loss of electricity as it flows from the power plant to the customer, calculated using factors from Enhanced DSM Filing SRD-2.
LF	= Load Factor of refrigeration system. Assumed to be 0.90 (ref. 2)
SpecificHeat	= Specific Heat of Water, 1.0 btu / (lb x °F)
EF_gas	= Efficiency of gas water heater, 0.75 (Ref. 3)
SpecificHeat	= Specific Heat of Water; 1.0 btu / (lb x °F)
Density	= Density of Water; 8.34 lbs / gal
ConversionFactor	= 1,000,000 Btu/Dth (gas water heater)
Enclosed Reach-In Cases	
Btuh_base	= Btuh load of the existing refrigerated case. 1,500 btuh/ft for open cases (Ref 3)
Btuh_ee	= Btuh load of the high efficiency refrigerated case. 267 btuh/ft for medium temp (Ref 5)
Evaporative Fan Motor Controls	
Speed Reduction	= new speed as a percent of full speed; 10% (Ref. 15)
Measure Life	= 15 years (Ref 1)
ESF	=Energy Savings Factor = (Speed Reduction)$^{2.5}$ = 0.32%
Baseline Fan Watts	=Average input watts for shaded pole motor; 95.08 (Ref. 15)
Control Time	=percent of time motor operates at reduced speed based on control setting; 30%
Efficient Hours	=Annual hours at reduced speed = baseline hours * control time
Night Curtains	
Btuh_base	= Btuh load of the existing refrigerated case. 1,500 btuh/ft for open cases (Ref 3)
C_inf	=Percentage of heat gain coming from infiltration. 69%. (Ref 1)
Hours_base	= Annual operating hours before the night curtains= 2920 (8 hr/day)
Hours_ee	= Annual operating hours after the night curtains = 1496

CF	= Coincidence Factor = 0
TDLF	Transmission-Distribution Loss Factor = 6.5%, the percentage loss of electricity as it flows from the power plant to the customer, calculated using factors from Enhanced DSM Filing SRD-2.
Measure Life	= 4 years (Ref. 16)
Persistence Factor	= Percent of time the covers are used.
O&M Savings	= ($3.16) based on 60 seconds per 15 feett to install or remove curtains (.41 hrs/yr) at CO Minimum wage of $7.78/hr
CHW Pre-Rinse	
Flow_base	= 1.6 gal/min (Ref. 6)
Flow_eff	= flow rate of new pre-rinse sprayer, in gal/min 1.28 gpm
Hours_base	= 0.605 hr/day (Ref 6 & 9) prorated to match measure equipment spec
Hours_eff	Assumed to be the same as the Hours_base = 0.605 hr/day (Ref 6 & 9)
Days	= See Table 2
Tset	= 105°F; Hot water setpoint (Ref. 6)
Tcold	= Average groundwater temperature per Table 1 (Ref. 7)
EF_electric	= 0.98 (Ref. 8)
ConversionFactor	= 3,412 Btu/kWh (electric water heater)
Measure Lifetime (years)	= 5 (Ref. 1)
Density	= 8.34 lbs / gal
CHW-Aerator-Elec	
TPD	= usage Time per Day = 10 minutes in kitchen and 30 minutes in lavatory (Ref 13)
GPM_base	= Flow rate of existing aerator, nameplate = 2.2 gpm
GPM_low	= Flow rate of proposed aerator, nameplate = 0.5 gpm restroom, 1.5 gpm kitchen
TF	=Throttling Factor = 70% (Ref 4) Accounts for lower flow and pressure when valve is not fully open, or contamination in pipes, valves, or aerator components
Days	= See Table 2; Days of operation
Tfaucet	= 90°F; Temperature of typical faucet usage (Ref. 14)
Tcold	= Average groundwater temperature per Table 1 (Ref. 4)
ReEff	= Efficiency of lectric water heater, 98% (Ref. 4)
ConversionFactor	= 3,412 Btu/kWh (electric water heater)
Measure Lifetime (years)	= 10 (Ref. 1)
Tune-Up	
kW_hp_R	= kW per average compressor HP, Refrigerator - 1.497 kW/hp (Reference 2)
kW_hp_F	= kW per average compressor HP, Freezer - 1.252 kW/hp (Reference 2)
EFLH_dirty	=DC*hrs
EFLH_clean	=EFLH_dirty*(1-SF)
SF	= Savings Factor = 7% (Ref. 2)
DC	=Duty Cycle of the compressor, Refrigerator = 0.62, Freezer = 0.80 (Ref. 2)
HP	= Horsepower of compressor, provided by customer
Anti-Sweat Heater Controls:	
ASHC_Baseline_kW	= Average anti-sweat heater kW per door without controls, Table 4 (Reference 23 and 24)
ASHC_Hours	= Hours per year for anti-sweat heaters, Table 4 (Reference 23)
CF	= Coincidence Factor, Table 4 (Reference 15)
%_Off	= Percent of time the anti-sweat heaters are turned off by the controller, Table 4 (Reference15)
EC Motors for Refrigeration Evaporators:	
ECM_Baseline_Fan_ Watts	= Average input watts for shaded pole or permanent split capacitor motor, Table 3 (Reference 15)
ECM_Efficient_Fan_Watts	= Average input watts for efficient motor, Table 3 (Reference 15)
ECM_Hours	= Hours per year (freezer subtracts defrost time), Table 3 (Reference 15)
No Heat Case Doors:	
NHD_Baseline_kW	= Average kW for a standard case door, Table 5 (Reference 23 and 24)
NHD_Efficient_kW	= Average kW for a no heat case door, Table 5 (Reference 2)
NHD_Hours	= Hours per year for no heat case doors, Table 5 (Reference 2)
NHD_kW	= No heat case doors kW savings

R_H	= Residual Heat fraction; estimated percentage of the heat produced by the heaters or motors that remains in the freezer or cooler case and must be removed by the refrigeration unit. = 100% for evaporator motors and 35% for anti-sweat heaters and no heat
Coincidence Factor	= Probability that peak demand savings will coincide with peak utility system demand = 100%
Measure Life	= Length of time the measure will be operational: 15 years for EC Motors, (Reference 17); 12 years for ASHC (Reference 21); 10 years for No Heat Case Doors (Reference 20).
NTG	Net-To-Gross = 100%
Incremental cost	See Tables 3, 4 and 5
TDLF	Transmission-Distribution Loss Factor = 6.5%, the percentage loss of electricity as it flows from the power plant to the customer, calculated using factors from Enhanced DSM Filing SRD-2.
Lighting:	
Hrs	= Annual Operating Hours. Hours to be obtained from Table 7. The type of facility is to be supplied by the customer.
kW_Base	= Baseline fixture wattage (kW per fixture) determined from stipulated fixture wattages from Standard Fixture information. Fixture type provided by customer. Table 9
kW_EE	= High Efficiency fixture wattage (kW per fixture) determined from stipulated fixture wattages from Standard Fixture information. Fixture type provided by customer. Table 9
HVAC_cooling_kWhsavings_factor	= Cooling system energy savings factor resulting from efficient lighting from Table 1. Reduction in lighting energy results in a reduction in cooling energy, if the customer has air conditioning. Existence of air conditioning to be provided by customer.
HVAC_cooling_kWsavings_factor	= Cooling system demand savings factor resulting from efficient lighting from Table 1. Reduction in lighting demand results in a reduction in cooling demand, if the customer has air conditioning. Existence of air conditioning to be provided by customer.
HVAC_heating_kWsavings_factor	= Heating system penalty factor resulting from efficient lighting. Reduction in lighting demand results in an increase in heating usage, if the customer has gas heating. A value of -0.00088738 Dth/kWh given by (Reference 31).
CF	= Coincidence Factor, the probability that peak demand of the lights will coincide with peak utility system demand. CF will be determined based on customer provided building type in table 7.
Measure Life	= Length of time the lighting equipment will be operational, see Table 8 for Measure Lifetimes
Baseline Cost	= Cost of the baseline technology. For Retrofit, the cost is $0.00 since the baseline is to continue to operate the existing system. For New Construction, the cost is that of the lower efficiency option. Costs by (Reference 31) and vendors.
High Efficiency Cost	= Cost of the High Efficiency technology. Costs given in table 9 (Reference 31) and vendors**.**
kW connected	Total connected fixture load, determined as the sum of stipulated fixture wattages from Deemed Fixture Table 9.
PAF	Stipulated power adjustment factor based on control type from Table 9.
TDLF	Transmission Distribution Loss Factor = **6.50**%, the percentage loss of electricity as it flows from the power plant to the customer, calculated using factors from Enhanced DSM Filing SRD-2
NTG	Net-to-gross = 84% for prescriptive measures (Reference 5) and 96% for Custom Efficiency Lighting and Lighting Redesign based on the additional influence.
Incremental operation and maintenance cost	= Other annual savings or costs associated with the electrical savings. For Lighting, this consists of additional natural gas for heating. Methodology given by Reference 29.

Required inputs from customer/contractor:

Evaporative Fan Motor Controls
Capacity (tons) of Refrigeration Unit

CHW Pre-Rinse
Gas or electric water heater, customer ZIP code

CHW-Aerator
Gas or electric water heater, customer ZIP code

Floating Head Pressure
Capacity (Hp) Compressor
Condenser Maximum Temperature (°F)
Condenser Approach Temperature (°F)

Verified during M&V:

Minimum Condenser Temperature (°F)	
Tune-Up	
Size of Compressor (HP)	
For Electronically Commutated Evaporator	
Size of motor	Yes
Application of motor (Display Case or Walk-in)	Yes
Case or Walk-in temperature (Medium Temp or Low Temp)	Yes
For Walk-in's: Fan diameter (<= 15 inches or >15 inches	Yes
Cost	
For Anti-Sweat Heaters:	
Number of doors controlled	Yes
Number of controllers	Yes
Cost	
For No Heat Doors:	
Number of doors replaced	Yes
Door kW	Yes
Cost	Yes
Lighting	
Number of Fixtures	Yes
Lighting equipment type	Yes
Building type	Yes
Existence of air conditioning	Yes

Assumptions:

Enclosed Reach-In Cases

Existing case must be either a freezer or cooler multi-deck case.
Existing specialty, self-contained, and island cases do not qualify.
This measure is for replacement of open cases with new cases that include a case door.
Replacement cases must have doors, be tied into a central refrigeration system, and be purchased new.

Night Curtains

Install night curtains on open refrigerated cases to reduce heat transfer and mixing of air inside and outside the case.
Applies to professionally-installed, “permanent”, low emissivity (reflective) night curtain products only. (per linear foot)

EC Motors

Each motor is replaced with the same size on a 1 for 1 basis.
Rebates do not apply to rewound or repaired motors.

Lighting

- Each replacement lighting fixture is going in on a one-for-one basis for existing fixtures. New construction fixtures are put in on a one-for-one basis instead of lower efficiency options.
- In the Technical Assumptions, one will note that the Operating Hours does not appear, but rather a modified version. the methodology defines kW Savings on the basis of difference In kW with the HVAC Cooling Demand factor.

Table 1: Average Water Mains Temperatures (Ref. 6).

Location	Temperature (□F)
Denver, CO	57.6
Golden, CO	55.6
Grand Junction, CO	59.7

Table 2: Deemed Annual Hot Water Use by Building Type (Ref. 6)

Building Type	Days Per Year
Large Office	250
Fast Food Restaurant	365
Sit-Down Restaurant	365
Grocery	365
Elementary School	200
Jr. High/High School/College	200
Health	365
Hotel	365
Other Commercial	250
Average	**304**

The following building types were considered not to apply to this measure: Small Office, Retail, Warehouse and Motel.

Table 3: Baseline Watts, Efficient Watts, Operating Hours and Incremental Cost for EC Motors by Application (Reference 15 and 18)

Motor Application	ECM_Baseline_Fan_ Watts	ECM_Efficient_ Fan_Watts	ECM_Hours	ECM Incremental Cost
EC Motors - Medium Temp Display Case	71	24	8,672	$ 88.00
EC Motors - Low Temp Display Case	81	27	8,672	$ 88.00
EC Motors - Medium Temp Walk-in, Evap fan <= 15" Diameter	136	44	8,585	$ 180.00
EC Motors - Low Temp Walk-in, Evap fan <= 15" Diameter	154	50	8,585	$ 180.00
EC Motors - Medium Temp Walk-in, Evap fan > 15" Diameter	138	69	8,585	$ 180.00
EC Motors - Low Temp Walk-in, Evap fan > 15" Diameter	156	78	8,585	$ 180.00

Table 4: Baseline kW, % Off, Operating Hours and Incremental Cost for Anti-Sweat Heater Controls by Application (Reference 23 and 24)

Anti-Sweat Heater Controls	ASHC_Baseline_kW	%_Off	ASHC_Hours	Incremental Cost	CF
Medium Temp Display Case	0.105	97%	8,760	$ 180.00	97%
Low Temp Display Case	0.191	97%	8,760	$ 180.00	97%

Table 5: Baseline Watts, Efficient Watts, Operating Hours and Incremental Cost for No Heat Case Doors by Application (Reference 2, 23 and 24)

No Heat Case Doors	NHD_Baseline_kW	NHD_Efficient_kW	NHD_Hours	NHD Incremental Cost
Medium Temp Display Case	0	0.121	8,760	$ 275.00
Low Temp Display Case	0	0.238	8,760	$ 800.00

Table 6: HVAC Interactive Factors (Reference 29)

HVAC system	HVAC_cooling_kWhsavings_factor	HVAC_cooling_kWsavings_factor	Heating Penalty	kW/Ton	COP
Heating only	1.00	1.00	Methodology given by Reference 2	-	-
Heating and cooling	1.11	1.33	Methodology given by Reference 2	-	-
Cooler Door Retrofit to LED Secondary Benefits Factor	1.41	1.41	0.000000	1.41	$ 2.49
Freezer Door Retrofit to LED Secondary Benefits Factor	1.59	1.59	0.000000	2.09	$ 1.68

Table 7: Coincident Peak Demand Factors and Annual Operating Hours by Building Type (Reference 28 and 30)

Building Type	CF	Annual Operating Hours
24-Hour Facility	94%	8234
College	71%	5010
Cooler Door Retrofit to LED	94%	Matches Segment
Elemen./Second. School	73%	2080
Freezer Door Retrofit to LED	94%	Matches Segment
Grocery (All) / Big Box Retail (larger than 50,000 SF)	94%	5478
Health	84%	3392

Table 7: Coincident Peak Demand Factors and Annual Operating Hours by Building Type (Reference 28 and 30) Cont'd

Hospital	84%	4532
Hotel/Motel	51%	2697
Manufacturing	96%	5913
Night Time Exterior (LED Canopy/Soffit Lights Only)	0%	4380
Office	78%	3435
Other/Misc.	96%	2278
Restaurant	94%	4156
Retail	94%	3068
Safety or Code Required (Including Exit Signs)	100%	8760
Traffic Signals	50%	4380
Warehouse	96%	2388

Table 8: Measure Lifetimes in Years (Reference 31 and 15)

Measure	Lifetime in Years
LED Interior Lamps	12
LED Interior Fixtures	20
Low Wattage T8 Lamps	8
Ballasted CFLs	18
Integrated 25W Ceramic Metal Halide	7
T8 Lighting Systems	18
T5 Lighting Systems	18
Lighting Controls	18

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