Product: Commercial Refrigeration
Description:

Prescriptive rebates will be offered for the installation of reach-in cases with doors, night curtains on refrigerator and freezer cases, EC Motors for Refrigeration Evaporators (retrofit only), Anti-Sweat Heater Controls (retrofit only) and/or replacement of standard refrigeration case doors with No Heat Case Doors, Retrofit of open multi-deck refrigerated cases with no heat doors, and replacement lighting equipment. Prescriptive rebates will also be offered for retrofitting open multideck coolers or freezers with solid glass doors.

Program References:

Measure "LED Refrigerated Case Lighting"	Refer to Program "CO - Lighting Efficiency" to find formulas for (Customer kW, Customer kWh, Customer PCkW, etc.) for the "LED Refrigerated Case Lighting" measure.
Measure "LED Ref and Frz Screw In Fixture Retrofit"	Refer to Program "CO - Lighting Efficiency - Small Business" to find formulas for (Customer kW, Customer kWh, Customer PCkW, etc.), in which the "LED Interior Lamp" measure is referenced.

Equations:

Direct Install	
~~Coil Cleaning Tune-Up~~	
~~F_GEN_Deem_Eq_kW_(Customer_kW)~~	~~= I_Qty_Prop_Equip * Eq.kW_Savings~~
~~F_Gen_kWh_Hrs2_(Customer_kWh)~~	~~= Customer_kW * Eq.Hours~~
~~F_GEN_PCkW_(PC_kW_Customer)~~	~~= Customer_kW * Eq.Coincidence_Factor~~
CHW Aerator	
F RFR kW (Customer_kW)	= Customer_kWh/Eq.Hours
F RFR Energy Elec (Customer_kWh)	= Density_Water * SpecificHeat * F_RFR_WtrSave * Eq.Water_Heater_Delta_T / Eq.Min_Efficiency_electric / Eq.Conversion_Factor_Electric * I_Qty_Prop_Equip
F RFR PCkW (PC_kW_Customer)	= Customer_kW * Eq.Coincidence_Factor
Increm_O_M_Savings	= F_RFR_WtrSave * Eq.Incremental_Cost_per_Gal * I_Qty_Prop_Equip
F RFR Energy Gas (Customer_Dth)	= Density_Water * SpecificHeat * F_RFR_WtrSave * Eq.Water_Heater_Delta_T / Eq.Min_Efficiency_gas / Eq.Conversion_Factor_gas * I_Qty_Prop_Equip
F_RFR_WtrSave	= (Eq.Baseline_GPM - Eq.Proposed_GPM) * Eq.Runtime_Hours * P_RFR_Hours * 60
Eq.Water_Heater_Delta_T	= Tset - Tcold
CHW Pre-Rinse	
F RFR kW (Customer_kW)	= Customer_kWh/Eq.Hours
F RFR Energy Elec (Customer_kWh)	= Density_Water * SpecificHeat * F_RFR_WtrSave * Eq.Water_Heater_Delta_T / Eq.Min_Efficiency_electric / Eq.Conversion_Factor_Electric * I_Qty_Prop_Equip
F RFR PCkW (PC_kW_Customer)	= Customer_kW * Eq.Coincidence_Factor
Increm_O_M_Savings	= F_RFR_WtrSave * Eq.Incremental_Cost_per_Gal * I_Qty_Prop_Equip
Customer_Dth	= Density_Water * SpecificHeat * F_RFR_WtrSave * Eq.Water_Heater_Delta_T / Eq.Min_Efficiency_gas / Eq.Conversion_Factor_gas * I_Qty_Prop_Equip
F_RFR_WtrSave	= (Eq.Baseline_GPM - Eq.Proposed_GPM) * Eq.Runtime_Hours * P_RFR_Hours * 60
Eq.Water_Heater_Delta_T	= Tset - Tcold
Prescriptive	
Anti-Sweat Heater Controls	
F Cool AntiSweat kW (Customer_kW)	= Eq.kW_Door * (1 + (Eq.Door_Heat / Eq.COP)) * Eq.PAF * I_Doors_Controlled
F Cool AntiSweat kWh (Customer_kWh)	= Customer_kW * Eq.Hours
F Cool Anti Sweat PCkW (PC_kW_Customer)	= Customer_kW * Eq.Coincidence_Factor
Open to Closed Refrigerated Cases	
Customer kW	= Customer kWh / Eq.Hours
Customer kWh	= (kWh_open - kWh_closed) x Linear Feet
PC_kW_Customer	= Customer_kW * Eq.Coincidence_Factor
kWh_open	= (Baseline_Load * Infil_open) x (Eq.Load_Factor * 1 / 3412 * Eq.Hours x 1 / COP_Min) - HVAC_kWh_Open
kWh_closed	=(Baseline_Load * Infil_closed) x (Eq.Load_Factor * 1 / 3412 * Eq.Hours x 1 / COP_Min) - HVAC_kWh_Closed

HVAC_kWh_Open	= (Eq.Baseline_Load * Eq.Infil_Open) * 1 / Eq.COP x 1 / 3412 * Eq.clg_duty_cyc * P_Clg_Hrs
HVAC_kWh_Closed	= (Eq.Baseline_Load * Eq.Infil_Closed) * 1 / Eq.COP x 1 / 3412 * Eq.clg_duty_cyc * P_Clg_Hrs 73 kW/ft for closed freezer cases.
Close_The_Case_Customer_Dth	= Eq.Baseline_Load * (Eq.Infil_open - * Eq.Infil_closed) * P_Htg_Hours * 1/1000000 * 1/Eq.Max_Efficiency
Kitchen Demand Controlled Ventilation	
F_DCV_kW (Customer_kW)	= i_qty_MC * i_hp_mc01 * P_kW_Factor
F_DCV_kWh (Customer_kWh)	= Customer_kW * P_DCV_hours
F_DCV_PC_kW (PC_kW_Customer)	= Customer_kW * P_DCV_CF
F_DCV_therms (Customer_Therms)	= i_qty_MC *i_hp_mc01 * P_DCV_therms_per_hp
Dishwashers	
F KC kW (Customer_kW)	= Eq.kW_Savings * I_Qty_Prop_Equip
F KC kWh (Customer_kWh)	= Eq.kW_Savings * Eq.Hours * I_Qty_Prop_Equip
F KC PCKW (PC_kW_Customer)	= Eq.kW_Savings * I_Qty_Prop_Equip * Eq.Coincidence_Factor
F HP Tstat Setback Thm (Customer_Therms)	= Eq.Therms_Savings * I_Qty_Prop_Equip
Increm_O_M_Savings	= Eq.Incremental_OM_Savings * I_Qty_Prop_Equip
Electronically Commutated Motors	
F Motors EC Motors kW (Customer_kW)	= (Eq.kW_Baseline - Eq.Proposed_kW) * I_Qty_Prop_Equip * (1 + 1/ Eq.COP)
F Motors EC Motors kwh (Customer_kWh)	= Customer_kW * Eq.Hours
F Motors EC Motors PCkW (PC_kW_Customer)	= Customer_kW * Eq.Coincidence_Factor
Medium Temperature Reach-In Cases	
F RCaNC kW (Customer_kW)	= Eq.kW_Savings_Factor * ((Eq.Baseline_Load - Eq.Proposed_Load) * Eq.Load_Factor * (1 / Eq.COP)) / 3412 * I_Linear_Ft
F RCaNC kWh (Customer_kWh)	= Customer_kW * Eq.Hours
F RCaNC PCkW (PC_kW_Customer)	= Customer_kW * Eq.Coincidence_Factor
No Heat Case Doors	
F NHDaFC kW (Customer_kW)	= (Eq.kW_Baseline - Eq.kW) * (1 + (Eq.Residual_Heat_Fraction / Eq.COP)) * I_Qty_Prop_Equip
F NHDaFC kWh (Customer_kWh)	= Customer_kW * Eq.Hours
F NHDaFC PCkW (PC_kW_Customer)	= Customer_kW * Eq.Coincidence_Factor

Variable ID	**Value**	**Description**
Common		
Eq.Conversion_Factor_Electric	3,412	Conversion of BTU to kWh
Eq.Conversion_Factor_Gas	1,000,000	Conversion of BTU to Dth
SpecificHeat	1.0	Specific Heat of Water in btu / (lb x °F)
Density_water	8.34	Density of water in lbs/gal
Eq.COP (medium temp)	2.28	Coefficient of performance of compressor in the medium temperature applications (Reference
Eq.COP (low temp)	1.43	Coefficient of performance of compressor in the low temperature applications (Reference 1)
Eq.Min_Efficiency_electric	98%	Efficiency of electric water heater
Eq.Min_Efficiency_gas	80%	Efficiency of gas water heater (Reference 3)
Eq.Load_Factor (cooler)	62%	Load Factor of refrigeration cooler system (Reference 2)
Eq.Load_Factor (freezer)	80%	Load Factor of refrigeration freezer system (Reference 2)
Direct Install		
~~Coil Cleaning Tune-Up~~		
~~I_Qty_Prop_Equip~~	~~Customer Input~~	~~Quantity of proposed equipment installed~~
~~Eq.kW_Savings (Refrigerator)~~	~~0.031~~	~~Average kW savings for refrigerators~~
~~Eq.kW_Savings (Freezer)~~	~~0.049~~	~~Average kW savings for freezers~~
~~Eq.Hours (Refrigerator)~~	~~8,760~~	~~Equivalent full load hours saved for refrigerators~~
~~Eq.Hours (Freezer)~~	~~8,760~~	~~Equivalent full load hours saved for freezers~~
~~Lifetime~~	~~1~~	~~Measure lifetime~~
~~Eq.Incremental_Capital_Cost_Electric~~	~~$15.00~~	~~Incremental cost per unit~~
~~Eq.Coincidence_Factor (Refrigerator)~~	~~100%~~	~~Coincidence Factor for refrigerators~~
~~Eq.Coincidence_Factor (Freezer)~~	~~100%~~	~~Coincidence Factor for freezers~~
CHW Aerator		
I_Qty_Prop_Equip	Customer Input	Quantity of proposed equipment installed

Tset (restroom)	105	Hot water setpoint temperature; °F
Tset (kitchen)	125	Hot water setpoint temperature; °F
Tcold	51.4	Average groundwater temperature; °F (Reference 37)
Eq.Baseline_GPM	2.2	Nameplate flowrate of baseline in gpm
Eq.Proposed_GPM (restroom)	0.6	Nameplate flowrate of low-flow restroom application in gpm
Eq.Proposed_GPM (kitchen)	1.5	Nameplate flowrate of low-flow kitchen application in gpm
Eq.Runtime_Hours	See Table 2	Number of hours per day equipment is used (Reference 39)
P_RFR_Hours	See Table 2	Number of days per year the equipment is operated based on building type
Eq.Hours	8,760	Available equipment hours per year
Lifetime	9	Measure lifetime
Eq.Incremental_Capital_Cost_Electric & Gas	$8.00	Incremental Cost per unit (Reference 39)
Eq.Incremental_Cost_per_Gal	$0.009010	Water and sewer cost per gallon
Eq.Coincidence_Factor (restroom)	1%	Equipment coincidence factor
Eq.Coincidence_Factor (kitchen)	1%	Equipment coincidence factor
CHW Pre-Rinse		
Building Type	Customer Input	See Table 2 for list of choices
I_Qty_Prop_Equip	Customer Input	Quantity of proposed equipment installed
Tset	105	Hot water setpoint temperature; °F
Tcold	51.4	Average groundwater temperature; °F (Reference 37)
Eq.Baseline_GPM	1.6	Nameplate flowrate of baseline in gpm
Eq.Proposed_GPM	1.28	Nameplate flowrate of low-flow prerinse sprayer in gpm
Eq.Runtime_Hours	1.5	Number of hours per day equipment is used
P_RFR_Hours	See Table 2	Number of days per year the equipment is operated based on building type
Eq.Hours	8,760	Available equipment hours per year
Lifetime	5	Measure lifetime
Eq.Incremental_Capital_Cost_Electric & Gas	$45.00	Incremental Cost per unit
Eq.Incremental_Cost_per_Gal	$0.009010	Water and sewer cost per gallon
Eq.Coincidence_Factor	6%	Equipment coincidence factor
Prescriptive		
Anti-Sweat Heater Controls		
I_Doors_Controlled	Customer Input	Number of doors being controlled
Eq.kW_Door	See Table 4	Average anti-sweat heater kW per door without controls
Eq.kW_Door_Heat	0.35	Residual Heat fraction; estimated percentage of the heat produced by the heaters that remains in the freezer or cooler case and must be removed by the refrigeration unit. (Reference 24)
Eq.PAF	See Table 4	Percent of time the anti-sweat heaters are turned off by the controller
Eq.Hours	See Table 4	Hours per year
Measure Life	12	Lifetime
Eq.Incremental_Cost_per_Ton	See Table 4	Incremental cost of efficient measures; See Tables 4
Eq.Coincidence_Factor	See Table 4	Coincidence Factor (Reference 15)
Open to Closed Refrigerated Cases		
I_Linear_Ft	Customer Input	Linear feet of equipment installed
Eq.COP_Min (Cooler)	2.28	Coefficient of performance of compressor in the medium temperature applications (Reference
Eq.COP_Min (Freezer)	1.43	Coefficient of performance of compressor in the low temperature applications (Reference 1)
Eq.Hours	8760	Annual hours of operation of refrigerated case
Eq.Baseline_Load (Cooler)	1500	Cooler Total Load in BTU/h/ft (Ref 33)
Eq.Baseline_Load (Freezer)	1850	Freezer Total Load in BTU/h/ft (Ref 33)
Eq.Infil_open (Cooler)	81.77%	Fraction of Refrigerated Case Load that is infiltration for an open cooler
Eq.Infil_open (Freezer)	82.76%	Fraction of Refrigerated Case Load that is infiltration for an open freezer
Eq.Infil_clsd (Cooler)	13.77%	Fraction of Refrigerated Case Load that is infiltration for a closed cooler
Eq.Infil_clsd (Freezer)	14.76%	Fraction of Refrigerated Case Load that is infiltration for a closed freezer
P_Clg_Hrs	2908	Number of hours per year that facility is in cooling mode, based on using a location-specific (Denver) bin hours calculation and an assumed facility balance point of 60 F
Eq.clg_duty_cyc	70%	Cooling compressor duty cycle

Eq.COP	3.2	Coefficient of Performance for facility HVAC system, from Ref 33. This assumes a DX rooftop unit or similar
P_Htg_Hours	5155	Number of hours per year that facility is in heating mode, based on using a location-specific (Denver) bin hours calculation and an assumed facility balance point of 60 F, with a 5 degree economizing dead band before heating starts at 55 F
Eq.Max_Efficiency	80%	Heating System Efficiency
Eq.Coincidence_Factor	100%	Coincidence Factor, based on 8,760 hour run time per year
Measure Life	12.00	Lifetime (Ref 11)
Eq.Incremental_Capital_Cost_Electric	$497.82	Incremental cost of efficient measures per linear foot (Ref 34) The incremental cost is split by avoided revenue requirements between gas and electric cost.
Kitchen Demand Controlled Ventilation		
i_qty_MC	Customer Input	Quantity of proposed equipment installed
i_hp_mc01	Customer Input	Horsepower of proposed equipment installed
P_kW_Factor	See Table 10	kW savings per horsepower of controlled fan
P_DCV_hours	See Table 10	hours of operation
P_DCV_CF	See Table 10	Coincidence Factor, based on Zone
P_DCV_therms_per_hp	See Table 10	Therms savings per horsepower of controlled fan
Measure Life	20	Lifetime
Eq.Incremental_Cost_per_HP	$2,284.26	Incremental cost per HP
Dishwashers		
I_Qty_Prop_Equip	Customer Input	Quantity of proposed equipment installed
Eq.kW_Savings	See Table 9	kW savings per dishwasher
Eq.Hours	See Table 9	Annual hours of operation
Eq.Coincidence_Factor	See Table 8	Coincidence Factor
Eq.Therms_Savings	See Table 6	Natural gas savings per dishwasher
Measure Life	See Table 7 & 8	Lifetime
Eq.Incremental_Cost	See Table 7 & 8	Incremental cost per dishwasher
Eq.Incremental_OM_Savings	See Table 7 & 8	Incremental O&M savings due to decrease in water consumption
Electronically Commutated Motors		
I_Qty_Prop_Equip	Customer Input	Quantity of proposed equipment installed
Eq.kW_Baseline	See Table 3	Average input power for shaded pole or permanent split capacitor motor (Reference 15)
Eq.Proposed_kW	See Table 3	Average input power for efficient motor (Reference 15)
Eq.Hours	See Table 3	Hours per year (freezer subtracts defrost time) (Reference 15)
Eq.Incremental_Cost_per_Ton	See Table 3	Incremental cost per motor
Eq.Coincidence_Factor	See Table 3	Coincidence Factor
~~Medium Temperature Reach-In Cases~~		
~~I_Linear_Ft~~	~~Customer Input~~	~~Linear feet of equipment installed~~
~~Eq.kW_Savings_Factor~~	~~100%~~	~~Percent of time the doors are used~~
~~TDA~~	~~5.5~~	~~Total Display area per linear foot. Assumed to be 5.5 square feet based on a 5.5 foot tall glass door.~~

~~Eq.Baseline_Load~~	~~1,652~~	~~Btuh/ft load of the standard efficiency refrigerated case (Reference 38)~~
~~Eq.Proposed_Load~~	~~262~~	~~Btuh/ft load of the high efficiency refrigerated case. (Reference 5)~~
~~Eq.Hours~~	~~8,760~~	~~Equipment hours per year~~
~~Lifetime~~	~~15~~	~~Measure lifetime~~
~~Eq.Incremental_Cost_per_LF~~	~~$686.29~~	~~Incremental cost per linear feet of efficient measure (Reference 21).~~
~~Eq.Coincidence_Factor~~	~~100%~~	~~Equipment coincidence factor~~
New Medium Temperature Reach-In Cases		
I_Linear_Ft	Customer Input	Linear feet of equipment installed
Eq.kW_Savings_Factor	100%	Percent of time the doors are used
TDA	5.5	Total Display area per linear foot. Assumed to be 5.5 square feet based on a 5.5 foot tall glass door.
Eq.Baseline_Load	1,652	Btuh/ft load of the standard efficiency refrigerated case (Reference 38)
Eq.Proposed_Load	262	Btuh/ft load of the high efficiency refrigerated case. (Reference 5)
Eq.Hours	8,760	Equipment hours per year
Lifetime	15	Measure lifetime
Eq.Incremental_Cost_per_LF	$337.58	Incremental cost per linear feet of efficient measure (Reference 21 & 40).
Eq.Coincidence_Factor	100%	Equipment coincidence factor
No Heat Case Doors		
I_Qty_Prop_Equip	Customer Input	Quantity of proposed equipment installed
Eq.kW_Baseline	See Table 5	Average kW for a standard case door (Reference 23 and 24)
Eq.kW	See Table 5	Average kW for a no heat case door (Reference 2)
Eq.Residual_Heat_Fraction	0.35	Estimated percentage of the heat produced by the heaters that remains in the freezer or cooler case and must be removed by the refrigeration unit.
Eq.Hours	See Table 5	Hours per year for no heat case doors (Reference 2)
Eq.Incremental_Capital_Cost_Electric	See Table 5	Incremental cost per door
Eq.Coincidence_Factor	See Table 5	Coincidence Factor

Inputs:	**Verified during M&V:**
Direct Install	
~~Coil Cleaning Tune-Up~~	
~~Type of Unit (fereezer or refrigerator)~~	~~Yes~~
~~Quantity (# of units)~~	~~Yes~~
CHW-Aerator	
Gas or electric water heater	Yes
Quantity (# of faucet aerators)	Yes
Building type	Yes
CHW Pre-Rinse	
Gas or electric water heater	Yes
Quantity (# of sprayers)	Yes
Building type	Yes
Prescriptive	
Anti-Sweat Heater Controls	
Application temperature (medium or low temperature case)	Yes
Number of doors controlled	Yes
Open to Closed Case Retrofit	
Application temperature (cooler or freezer)	Yes
Linear feet installed	Yes
Kitchen Demand Controlled Ventilation	
Quantity (# of motors controlled)	Yes
County/Zone	Yes
Horsepower (per motor controlled)	Yes
Electronically Commutated Motors	
Case type (Display Case or Walk-in)	Yes
Application temperature (Medium Temp or Low Temp)	Yes
Quantity (# of motors)	Yes

~~Medium Temperature Reach-In Cases~~	
~~Application temperature (medium temperature)~~	~~Yes~~
~~Linear feet installed~~	~~Yes~~
New Medium Temperature Reach-In Cases	
Application temperature (medium temperature)	Yes
Linear feet installed	Yes
For No Heat Doors:	
Application temperature (freezer or refrigerator)	Yes
Quantity (# of doors)	Yes

Assumptions:

Enclosed Reach-In Cases, Open to Closed Case Retrofit
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.
Open to Closed Case retrofits must use "no heat" doors
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.

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40. Custom Project History

Changes from 2017 / 2018 Plan:

Updated runtime hours for pre-rinse sprayers.
Updated coincidence factor and kW savings for coil cleaning tune-up measure.
Updated incremental costs for medium-temp enclosed reach-in case measure.
Updated heating efficiency and incremental costs for open to closed refrigerated cases calculations.
Updated lifetime, incremental costs, and runtime hours for aerators.
Added annual gallons per faucet values breakdown by end-use as oppsoed to using same value for all end-uses.
Added gas savings for open to closed refrigerated cases.