DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Program: Cooling

Description:

Prescriptive rebates will be offered for new cooling equipment. Rebates may be dependent on equipment size or load that is offset and on meeting minimum efficiency requirements. Additional rebates may be available for efficiencies better than the minimum qualifying efficiencies.

Mid-Stream products will be incented at the Distributor to encourage the transformation of market availability of high efficiency cooling products.

Prescriptive rebates will be offered for the installation of EC Motors for Refrigeration Evaporators (retrofit only) and/or Anti-Sweat Heater Controls (retrofit only), along with closing multi-deck cases with solid doors. Prescriptive rebates will also be offered for retrofitting open multideck coolers or freezers with solid glass doors.

Custom rebates are available for cooling-related improvements that are not covered by the aforementioned prescriptive rebates. These would include such applications as heat recovery.

Program References:

Measure "ECM" in refrigerated cases	Refer to Program "CO - Refrigeration" to find formulas for (Customer kW, Customer kWh, Customer PCkW, etc.) for the "ECM" measures in refrigerated cases.
Measure "Anti-Sweat Heater Controls"	Refer to Program "CO - Refrigeration" to find formulas for (Customer kW, Customer kWh, Customer PCkW, etc.) for the "Anti-Sweat Heater Controls" measure.
Measure "ECM" in refrigerated cases	Refer to Program CO - Refrigeration to find references and tables for measure life, ECM_Baseline_Fan_ Watts, ECM_Efficient_Fan_Watts , ECM_Hours, CF, Refrigeration Factor, and Incremental Cost values, etc..
Measure "Anti-Sweat Heater Controls"	Refer to Program CO - Refrigeration to find references and tables for measure life, ASHC_Baseline_kW, ASHC_Hours, CF, %_Off, Refrigeration Factor, and Incremental Cost values, etc..
Measure "Retrofit of Open Multideck Cooler (or Freezer) Cases with Solid Glass Doors"	Refer to Program CO - Refrigeration to find references and tables for measure life, FI_Open, FI_Closed, FCR, COPhvac, COPrefrig, hours, CF, incremental costs, etc.
Measure "Water Source Heat Pumps"	Refer to Program CO - Heating Efficiency to find references and tables for EFLH_Heat by Climate Zone.

Conversions:

Energy Efficiency Ratio	For Forecasting purposes where the EER is not known it will be assumed based on the following equation: EER= -0.02*SEER^2+1.12*SEER (Reference 7) For forecasting purposes the EER for MSHPs will be determined by the following empirical formula based on AHRI information: = (-0.0003*(SEER/ton)^3 + 0.0101*(SEER/ton)^2 + 0.5264*(SEER/ton) - 0.0233)*tons
Seasonal Energy Efficiency Ratio	For Forecasting and energy calculations for PTAC units where SEER is not provided in the International Energy Conservation Code, 2015, the following algorithm will be used to derive SEER = 28 - SQRT(784 - (50 x EER))
kW/ton	= 12 / Energy Efficiency Ratio
Energy Efficiency Ratio	= 3.412 x Coefficient of Performance
Heating Seasonal Performance Factor (HSPF)	= 3.412 x Heat Energy Output (Btu) / Energy Input to Compressor (Btu)

Algorithms:

For Rooftop Units, Split Systems, Condensing Units, PTACs	
Gross Annual kWh Saved at Customer	= Size x EFLH x (12/SEER_Standard - 12/SEER_Eff) Note: IEER replaces SEER for most RTUs
Gross kW Saved at Customer	= Size x (12 / EER_Standard - 12 / EER_Eff)
Peak Coincident kW at the Customer (PC_KW_CUST)	= Size x (12 / EER_Standard - 12 / EER_Eff) x CF
For Water Source Heat Pumps	
Gross Annual kWh Saved at Customer	= Quantity x (WSHP_Cooling_kWh + WSHP_Heating_kWh)
Gross kW Saved at Customer	= Quantity x (Size x (12 / EER_Standard - 12 / EER_Eff))
Peak Coincident kW at the Customer (PC_KW_CUST)	= Quantity x (Size x (12 / EER_Standard - 12 / EER_Eff) x CF)
WSHP_Cooling_kWh	= Size x EFLH x (12/SEER_Standard - 12/SEER_Eff) Note: SEER = EER for water source heat pumps
WSHP_Heating_kWh	= Size_Heat x Heat_EFLH x (1 / (COP_Standard x 3412) - 1 / (COP_Eff x 3412))
For all Water Cooled or Air Cooled Chillers	
Gross Annual kWh Saved at Customer	= Quantity x (Size x EFLH x (IPLV_Standard - IPLV_Eff))
Gross kW Saved at Customer	= Quantity x (Size x (FLV_Standard - FLV_Eff))
Peak Coincident kW at the Customer (PC_KW_CUST)	= Quantity x (Size x (FLV_Standard - FLV_Eff) x CF)
For Water Cooled Centrifugal Chillers	
Gross Annual kWh Saved at Customer	= Quantity x (Size x EFLH x (IPLV_ARI_Adjusted - IPLV_Eff))
Gross kW Saved at Customer	= Quantity x (Size x (IPLV_ARI_Adjusted - IPLV_Eff))
Peak Coincident kW at the Customer (PC_KW_Cust)	= Quantity x (Size x (FLV_ARI_Adjusted - FLV_Eff) x CF)
FLV_ARI_Adjusted	= FLV_standard / Kadj
IPLV_ARI_Adjusted	= IPLV_standard / Kadj
Kadj	=A x B
A	=0.00000014592 x (Lift)^4 - 0.0000346496 x (Lift)^3 + 0.00314196 x (Lift)^2 - 0.147199 x (Lift) + 3.9302
B	=0.0015 x Lvg_Evap_T +0.934
Lift	=Lvg_Cond_T - Lvg_Evap_T
Minimum Qualifying FLV	= (FLV_standard / Kadj) - Qualifying FLV Offset = FLV_ARI_Adjusted - Qualifying FLV Offset
Minimum Qualifying IPLV	= (IPLV_standard / Kadj) - Qualifying IPLV Offset = IPLV_ARI_Adjusted - Qualifying IPLV Offset
For VFDs on Centrifugal Chillers	
Gross Annual kWh Saved at Customer	= Quantity x (Size x EFLH x (IPLV_VFD_Baseline - IPLV_VFD_Eff))
Gross kW Saved at Customer	= Quantity x (Size x (IPLV_VFD_Baseline - IPLV_VFD_Eff))
Peak Coincident kW at the Customer (PC_KW_CUST)	= Quantity x (Size x (FLV_VFD_Baseline - FLV_VFD_Eff) x CF)

For Direct Evaporative Pre-cooling for Air Cooled Condensers (DEPACC)

Gross Annual kWh Saved at Customer	= Quantity x (tons x EFLH x EFLH_Factor x kW_per_ton_Eff_Avg)
Gross kW Saved at Customer	= Quantity x (tons x kW_per_ton_Eff _Peak)
Incremental O&M Cost	= Quantity x (Incremental_O&M_Cost_Factor x EFLH x EFLH_Factor x Tons)

For Mini-Split Heat Pumps or Mini-Split Air Conditioners

Gross Annual kWh Saved at Customer	= Quantity x (Mini-Split Heating Energy Savings + Mini-Split Cooling Energy Savings)
Gross kW Saved at Customer	= Quantity x (Size x (12 / EER_Standard - 12 / EER_Eff))
Peak Coincident kW at the Customer (PC_KW_CUST)	= Quantity x (Size x (12 / EER_Standard - 12 / EER_Eff) X CF)
Mini-Split Cooling Energy Savings	= Size x EFLH x (12 / SEER_Standard - 12 / SEER_Eff)
Mini-Split Heating Energy Savings	= Size_Heat / 1000 x MSHP_EFLHH x (1 / HSPF_Standard - 1 / HSPF_Eff)

Variables:

General Water & Air Cooling Variables:

Size	Customer Input	= The equipment capacity in tons, provided by customer. The maximum size unit for MSHPs is 5 tons
EFLH	See Table 2	= Equivalent Full Load Hours. The equivalent number of hours that the equipment would be running at full load over the course of the year. Values are shown in Table 2 for different building types and locations, to be provided by the customer.
SEER_Standard, IEER_Standard	See Table 1	= Seasonal (or Integrated) Energy Efficiency Ratio in Btu/Wh of standard equipment, based upon the minimum acceptable efficiency defined by International Energy Conservation Code, 2015 (Reference 6). Value determined from table 1 based on customer provided equipment type and size.
SEER_Eff, IEER_Eff	Customer Input	= Seasonal (or Integrated) Energy Efficiency Ratio in Btu/Wh of High Efficiency equipment that the customer will install, provided by customer.
EER_Standard	See Table 1	= EER of standard equipment, based upon the minimum acceptable efficiency defined by the International Energy Conservation Code, 2015, for a specific type of equipment and size. Table 1.
EER_Eff	Customer Input	= EER of High Efficiency that the customer will install, provided by customer.
COP_Standard	4.3	= COP of standard Water Source Heat Pump equipment in Heating Mode for Water:Air Water Loop from the International Energy Conservation Code, 2015, Table 403.3.2.3 (2) .
COP_Eff	Customer Input	= COP of High Efficiency unit that the customer will install, provided by customer.

FLV_Standard	See Table 1	= Full load cooling efficiency in kW/ton of standard equipment, based upon the minimum acceptable efficiency defined by International Energy Conservation Code, 2015, Table 403.2.3(7) for selected centrifugal chiller type, size, condensing and chilled water temperature (provided by customer). Table 1, excerpt. NOTE: For non-centrifugal chillers, FLV_Standard is the value in IECC Table 403.2.3(7), without variation for condenser and chilled water temperatures and condenser water flow rate.
IPLV_Standard	See Table 1	= Integrated Part Load Value (representing the average efficiency over a range of loaded states) cooling efficiency in kW/ton of standard equipment, based upon the minimum acceptable efficiency defined by International Energy Conservation Code, 2015 for chiller type and size (type and size provided by customer). Table 1
FLV_ARI_Adjusted	= IECC based FLV for water cooled centrifugal chillers adjusted to actual site rated conditions (provided by customer) per IECC 2015 code adjustment formulas.	
IPLV_ARI_Adjusted	= IECC based IPLV or NPLV for water cooled centrifugal chillers adjusted to actual site rated conditions (provided by customer) per IECC 2015 code adjustment formulas.	
Qualifying_FLV_Offset	0.016	= Offset used to determine Minimum Qualifying Full Load Value (FLV) for Centrifugal Chillers based on the k-adjusted Full Load cooling efficiency in kW/ton of standard equipment and for Screw/Scroll Chillers based on code Full Load cooling efficiency in kW/ton.
Qualifying_IPLV_Offset	0.016	= Offset used to determine Minimum Qualifying Integrated Part Load Value (IPLV) for Centrifugal Chillers based on the k-adjusted IPLV cooling efficiency in kW/ton of standard equipment and for Screw/Scroll Chillers based on code IPLV cooling efficiency in kW/ton.
Lvg_Evap_T	Customer Input	= The full load chilled water temperature leaving the evaporator, in deg F
Lvg_Cond_T	Customer Input	= The full load condenser water temperature leaving the condenser, in deg F
FLV_VFD_Baseline	Customer Input	= Full Load Value cooling efficiency in kW/ton, representing the efficiency of existing chiller without a VFD at 100% load, provided by customer.
FLV_VFD_Eff	Customer Input	= Full Load Value cooling efficiency in kW/ton, representing the efficiency of existing chiller with a VFD at 100% load, provided by customer.
IPLV_VFD_Baseline	Customer Input	= Integrated Part Load Value (representing the average efficiency over a range of loaded states) cooling efficiency in kW/ton of existing chiller without a VFD, provided by customer.
IPLV_VFD_EFF	Customer Input	= Integrated Part Load Value (representing the average efficiency over a range of loaded states) cooling efficiency in kW/ton of existing chiller with VFD, provided by customer.
FLV_Eff	Customer Input	= Full Load Value cooling efficiency in kW/ton, representing the efficiency at design conditions, provided by customer.
IPLV_Eff	Customer Input	= Integrated Part Load Value (representing the average efficiency over a range of loaded states) cooling efficiency in kW/ton of High Efficiency equipment, provided by customer.
Size_Heat	Customer Input	= Heating Capacity of Water Source Heat Pumps and Mini Split Heat Pump, in BTU/h, provided by customer
MSHP_EFLHH	950	= Mini-Split Heat Pump Equivalent Full Load Hours Heating (EFLH) : The equivalent number of hours that MSHP equipment would be running at Full Load over the course of the year for heating.

HSPF_Standard	8.2	= Heating Seasonal Performance Factor (HSPF) of standard equipment, based upon the minimum Federal standard for efficiency as manufactured.
MSHP_Primary_Use	Customer Input	= Mini-Split Heat Pump Primary use will be a picklist item of Heating or Cooling, provided by the customer.
HSPF_Eff	Customer Input	= Heating Seasonal Performance Factor (HSPF) of High Efficiency equipment that the customer will install, provided by the customer
3.412	= Conversion between BTU/h and Watts	
3412	= Conversion between BTU/h and kilowatts	
12000	= Conversion between BTU/h and tons	
CF	= Coincidence Factor, the probability that peak demand of the unit will coincide with peak utility system demand. 90% will be used for prescriptive rebates except VFD Chillers (Reference 1). For VFD Chillers we will use 0%.	
Measure Life	20	Measure life for all prescriptive water cooled chillers, air cooled chillers, RTUs, and WSHPs cooling equipment (Reference 2)
Measure Life	15	Measure life for all prescriptive PTAC cooling equipment (Reference 2)
Measure Life	18	Measure life for all prescriptive MSAC and MSHP cooling equipment (Reference 12)
Measure Life	20	Measure life for DEPACC instalaltions
NTG_Midstream	92%	Net-to-gross = We will use 92% for all midstream cooling equipment (Reference 4).
NTG_General_Cooling	92%	Net-to-gross = We will use 92% for all cooling equipment except MSHP units (Reference 4).
NTG_MSHP	100%	Net-to-gross = We will use 100% for all MSHP units (Reference 4).
NTG_Custom	87%	Net-to-gross = We will use 87% for all custom cooling projects (Reference 4).
NTG_Refrigeration	100%	Net-to-gross = Anti-Sweat Heaters and ECM measures which will be 100%. (Reference 4).
Incremental operation and maintenance cost	= $0 for all cooling system types (except direct evaporative pre-cooling)	
Baseline Cost of Equipment	The cost of equipment that would exactly meet code requirements.	
Incremental Cost of Equipment	See Table 4	Table 4 contains the incremental cost for equipment in the midstream product offerings. Incremental cost is the cost above the code requirements, expressed in a dollar per ton basis.
Incremental Cost of Equipment	See Table 5	Table 5 contains the incremental cost for equipment in the downstream product offerings. Incremental cost is the cost above the code requirements, expressed in a dollar per ton basis.

For Direct Evaporative Pre-cooling for Air Cooled Condensers (DEPACC) (Reference 5)

kW_per_ton_Eff_Avg	0.1488	Average kW/ton = kWh/ ton / DEPACC Operating hrs/yr = Efficiency improvement of incumbent air-cooled condensers in kW per ton resulting from installation of condenser evaporative pre-cooler averaged for annual cooling hours.
EFLH_Factor	1.1631	= DEPACC_Operating_Hours_Office / EFLH for Front Range Office (w/economizer)
DEPACC_Operating_Hours_Office	1134	DEPACC Operating hrs/yr = Estimated annual hours of operation of the DEPACC system for an office in the Front Range. Used to scale DEPACC operating hours to A/C EFLH by segment
kW_per_ton_Eff _Peak	0.4544	Peak Coincident kW/ton = Efficiency improvement of incumbent air-cooled condensers in kW per ton resulting from installation of condenser evaporative pre- cooler at summer cooling design conditions: 0.4% design temperatures @ DIA = 93.9°F DB and 64.7°F WB
Incremental_O&M_Cost_Factor	0.000886667	$ / ton-hour = (Water Cost / Ton) / DEPACC Operating Hours = Factor used to calculate Incremental annual non-energy Operations and Maintenance cost per ton-hr for water usage.
Baseline Cost of Equipment	= $0 because the baseline option is to do nothing.	
Incremental Cost of Equipment	See Table 3	= Tons x Incremental cost of DEPACC equipment from Table 3. Table 3 is expressed on a cost per ton basis.
Tons	Customer Input	Tons of cooling shown on the rated faceplate of the existing cooling equipment.

Inputs:

Information Provided by Customer:	
Rooftop Units / Split Systems / Air Cooled Chillers / PTAC / Water Source Heat Pumps / MSHP	Verified during M&V:
Cooling equipment type	Yes
County / Zone	Yes
Market segment	Yes
Cooling equipment size [tons]	Yes
Quantity of Cooling equipment by Size	Yes
Cooling equipment efficiency (EER or FLV in kW/ton - dependent on the technology)	Yes
Cooling equipment efficiency (SEER or IPLV in kW/ton - dependent on the technology)	Yes
Heating Season Performance Factor (HSPF) for Water Source Heat Pumps and Mini-Split Heat Pumps	Yes
Primary use, cooling or heating (MSHP)	
Centrifugal Chillers:	
County / Zone	Yes
Market segment	Yes
Chiller Size [tons]	Yes
Chiller FLV [kW/ton] at full load	Yes
Chiller IPLV [kW/ton] at full load	Yes
Chill water supply temperature [°F] at full load	Yes
Condenser water entering temperature [°F] at full load	Yes
Chilled water leaving temperature [°F]	Yes
Chill water flow [gpm/ton] at full load	Yes
Condenser water flow [gpm/ton] at full load	Yes
VFDs on Centrifugal Chillers	Verified during M&V:
County / Zone	Yes
Market segment	Yes
Chiller Size [tons]	Yes
Chiller FLV [kW/ton] at full load	Yes
Chiller IPLV [kW/ton] at full load	Yes
Chiller with VFD FLV [kW/ton] at full load	Yes
Chiller with VFD IPLV [kW/ton] at full load	Yes
Quantity of same size Chillers with VFD Retrofit	Yes
For DEPACC Provided by Customer:	Verified during M&V:
Cooling equipment type	Yes
Climate zone	Yes
Building type	Yes
Cooling equipment size (tons)	Yes

For Electronically Commutated Evaporator Fan Motors:	Verified during M&V:
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	
Open to Closed Case Retrofit	
Length of Case(s)	Yes
Freezer or Cooler?	Yes

Assumptions:

- Customer selection of cooling equipment is in lieu of equipment of the same size and configuration that met minimum 2015 International Energy Conservation Code requirements.
- Prescriptive rebates are not given for backup cooling equipment.
- Small RTU assumed to have gas heat for code baseline selection
- No Heating kW saving are claimed for MSHP during winter, only summer cooling kW savings are claimed.

DEPACC:

- Minimum equipment size that DEPACC can be installed on is 10 ton.
- Qualifying evaporative cooling units must have a minimum Media Saturation Effectiveness of 75% and above. The units must be installed with an evaporative media, a remote thermostat, outside air temp sensor and a periodic purge water control if sump is used.

- Units should have outdoor air, humidity and controls to determine operation of spray nozzles to wet media. If sump is used, periodic purge control would need to be installed.
- Condenser fan energy costs due to DEPACC media are not expected to increase measurably. Media decreases condenser fan cfm while increasing fan static.
- Denver Water 2018 average rate at $3.167/1000 gal (Source https://www.denverwater.org/business/billing-and-rates/2018-rates)
- DEPACC estimate of water consumed by the evaporative pre-cooling system is 0.28 gallons per ton-hour of cooling based on manufacturer's data.

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.

Tables:

Table 1. Deemed Baseline Efficiencies (IECC 2015)
EQUIPMENT BASELINE EFFICIENCIES REQUIRED BY CODE, NOTE: For Rooftop Units Larger Than 5.4 Tons, Add 0.2 to Both IEER and EER for Units That Have No Heat or Electric Heat

Equipment	Equipment Classification	EER	SEER/ IEER/ IPLV	Path A FLV (kW/ton)	Path A IPLV (kW/ton)	COP or HSPF
Rooftop Units less than 5.4 tons	Standard Efficiency	11.76	**14.00**			
Split Systems less than 5.4 tons	Standard Efficiency	11.18	**13.00**			
Rooftop Units Condensing Units & Split Systems 5.5-11.3 tons	Standard Efficiency	**11.00**	**12.60**			
Rooftop Units & Split Systems 11.4-19.9 tons & Condensing Units > 11.4 tons	Standard Efficiency	**10.80**	**12.20**			
Rooftop Units & Split Systems 20-63.3 tons	Standard Efficiency	**9.80**	**11.40**			
Rooftop Units greater than 63.3 tons	Standard Efficiency	**9.50**	**11.00**			
Water Source Heat Pumps (Water:Air - Water Loop)	Standard Efficiency	**13.00**	13.00			**4.30**
PTAC Replacement <= 7000 BTUH	Standard Efficiency	**9.41**	11.07			
PTAC Replacement >7000 BTUH to <15000 BTUH	Standard Efficiency	**= 10.9-(0.213 * (Size BTUH / 1000)**	= 28 - SQRT(784 - (50 x EER))			
PTAC Replacement >=15000 BTUH	Standard Efficiency	**7.71**	9.06			
scroll/screw chiller < 75 tons	Standard Efficiency			**0.750**	**0.600**	
scroll/screw chiller >=75 to < 150 tons	Standard Efficiency			**0.720**	**0.560**	
scroll/screw chiller >=150 to <300 tons	Standard Efficiency			**0.660**	**0.540**	
scroll/screw chiller >= 300 to <600 tons	Standard Efficiency			**0.610**	**0.520**	
scroll/screw chiller >= 600 tons	Standard Efficiency			**0.560**	**0.500**	
Centrifugal Chillers < 150 tons	ARI rated Efficiency			**0.610**	**0.550**	
Centrifugal Chillers >= 150 to < 300 tons	ARI rated Efficiency			**0.610**	**0.550**	
Centrifugal Chillers >=300 tons to < 400 tons	ARI rated Efficiency			**0.560**	**0.520**	
Centrifugal Chillers >=400 tons to < 600 tons	ARI rated Efficiency			**0.560**	**0.500**	
Centrifugal Chillers >= 600 tons	ARI rated Efficiency			**0.560**	**0.500**	
Air-Cooled Chillers - < 150 tons	Standard Efficiency	**10.100**	**13.700**			
Air-Cooled Chillers - >= 150 tons	Standard Efficiency	**10.100**	**14.000**			
Mini-Split Heat Pump (16-21 SEER, 9-12 HSPF)	Standard Efficiency	8.75	**14.00**			**8.20**
Mini-Split Heat Pump (21-24 SEER, 9-12 HSPF)	Standard Efficiency	8.75	**14.00**			**8.20**
Mini-Split Heat Pump (24-26 SEER, 9-12 HSPF)	Standard Efficiency	8.75	**14.00**			**8.20**

NOTES

* Bold values indicates direct sourcing to IECC 2015, tables 403.2.3(x), otherwise estimated by using the code SEER in the algorithm above to get EER, or using EER in the following algorithm to get SEER = 28 - SQRT(784 - (50 x EER)). For water-sourced heat pumps only, the EER is set equal to the SEER because the condenser water loop temperature is assumed to be maintained by cooling towers.

* High Efficiency IEER, SEER and EER values are supplied by Customer.

* ARI rated efficiency is converted to Standard efficiency as per Table 403.2.3(7)

* Values for Centrifugal Chillers assumed to be at ARI rating conditions of 85 degrees condensing temperature, 44 degrees chilled water temperature, 2.4 gpm/ton chill water flow, and 3 gpm/ton condenser water flow. Reference International Energy Conservation Code (IECC), 2015, Sec. 403.2.3.1
* Values for PTAC from IECC 2015 formula, Table 403.2.3(3) for Cooling Mode, Replacements.
* Chiller categories are now aligned with the IECC 2015.

~~Table 2. Equivalent Full Load Hours by Building Type~~

~~Building Type / Market Segment~~	~~Front Range EFLH~~	~~Front Range EFLH w/ Economizer~~	~~Western Slope EFLH~~	~~Western Slope EFLH w/ Economizer~~	~~Mountain EFLH~~	~~Mountain EFLH w/ Economizer~~
~~Education~~	~~620~~	~~545~~	~~653~~	~~588~~	~~439~~	~~368~~
~~Health/ Medical~~	~~985~~	~~866~~	~~1,038~~	~~934~~	~~697~~	~~585~~
~~Lodging~~	~~654~~	~~574~~	~~688~~	~~620~~	~~462~~	~~388~~
~~Office~~	~~1,109~~	~~975~~	~~1,168~~	~~1,052~~	~~785~~	~~659~~
~~Retail~~	~~492~~	~~432~~	~~518~~	~~466~~	~~348~~	~~292~~
~~Mixed Use (office and retail)~~	~~749~~	~~658~~	~~788~~	~~710~~	~~530~~	~~444~~
~~Data Centers~~	~~8,760~~	~~8,760~~	~~8,760~~	~~8,760~~	~~8,760~~	~~8,760~~
~~Process Loads~~	~~5,840~~	~~5,840~~	~~5,840~~	~~5,840~~	~~5,840~~	~~5,840~~

~~NOTES:~~

~~* EFLH- Zone 1 (Front Range/Denver); Zone 2 (Western State as represented by Grand Junction) and Zone 3 (Mountain Areas as represented by Alamosa)~~
~~* Market segment hours scaled from Minnesota OES data (Reference 10) with Office value calculated for Denver and Grand Junction Typical Meteorological Year data. Distributions developed from CBECS data (Reference 3)~~
~~* WSHP's will use Non-Economizer hours for all projects.~~
~~* RTU's that are less than 4.5 tons will use Non-Economizer hours for all projects.~~
~~* Air Cooled Chillers and RTU's will use Economizer hours for all projects.~~
~~* PTAC's will use Non-Economizer Lodging hours for all projects.~~

Table 2. Equivalent Full Load Hours by Building Type

		CO1	CO1	CO1
Building Type / Market Segment		**Front Range EFLH**	**Front Range EFLH w/ Economizer**	**Front Range EFLH Hydronic System**
Data Center	Data CenterCO1	8760	8760	8760
Full Service Restaurant	Full Service RestaurantC	1284	1037	1820
High-rise Apartment	High-rise ApartmentCO1	1797	1387	1768
Hospital	HospitalCO1	2579	1446	3178
Large Office	Large OfficeCO1	2124	1387	2341
LargeHotel	LargeHotelCO1	2404	1005	2453
Medium Office	Medium OfficeCO1	1209	688	1068
Mid-rise Apartment	Mid-rise ApartmentCO1	1647	688	1610
Outpatient Healthcare	Outpatient HealthcareCO	2469	1358	2662
Primary School	Primary SchoolCO1	948	711	1142
Process Load	Process LoadCO1	5840	5840	5840
Quick Service Restaurant	Quick Service Restaurant	1099	920	2036
Secondary School	Secondary SchoolCO1	1685	1390	1423
Small Hotel	Small HotelCO1	2010	586	1882
Small Office	Small OfficeCO1	826	586	755
Stand-alone Retail	Stand-alone RetailCO1	1154	873	1088
Strip Mall	Strip MallCO1	901	763	885
Warehouse (non-refrigerated)	Warehouse (non-refrigera	129	112	765

Building Type / Market Segment		CO2 Western Slope EFLH	CO2 Western Slope EFLH w/ Economizer	CO2 Western Slope EFLH Hydronic System
Full Service Restaurant	Full Service RestaurantC	1440	1224	2028
High-rise Apartment	High-rise ApartmentCO2	2010	1224	1986
Hospital	HospitalCO2	2706	1663	3261
Large Office	Large OfficeCO2	2257	1623	2432
LargeHotel	LargeHotelCO2	2468	1132	2539
Medium Office	Medium OfficeCO2	1309	799	1174
Mid-rise Apartment	Mid-rise ApartmentCO2	1803	799	1767
Outpatient Healthcare	Outpatient HealthcareCO	2536	1507	2711
Primary School	Primary SchoolCO2	1048	837	1226
Quick Service Restaurant	Quick Service Restaurant	1258	1093	2217
Stand-alone Retail	Stand-alone RetailCO2	1249	1000	1173
Strip Mall	Strip MallCO2	988	865	947
Secondary School	Secondary SchoolCO2	1840	1570	1535
Small Hotel	Small HotelCO2	2061	656	1923
Small Office	Small OfficeCO2	872	656	808
Warehouse (non-refrigerated)	Warehouse (non-refrigera	170	156	847
Process Load	Process LoadCO2	5840	5840	5840
Data Center	Data CenterCO2	8760	8760	8760

Building Type / Market Segment		CO3 Mountain EFLH	CO3 Mountain EFLH w/ Economizer	CO3 Mountain EFLH Hydronic System
Full Service Restaurant	Full Service RestaurantC	797	502	1395
High-rise Apartment	High-rise ApartmentCO3	1332	614	1496
Hospital	HospitalCO3	2098	813	3009
Large Office	Large OfficeCO3	1631	726	2093
LargeHotel	LargeHotelCO3	2377	614	2510
Medium Office	Medium OfficeCO3	1058	388	980
Mid-rise Apartment	Mid-rise ApartmentCO3	1277	388	1422
Outpatient Healthcare	Outpatient HealthcareCO	2109	886	2621
Primary School	Primary SchoolCO3	691	395	941
Quick Service Restaurant	Quick Service Restaurant	591	402	1322
Stand-alone Retail	Stand-alone RetailCO3	915	537	960
Strip Mall	Strip MallCO3	694	457	735
Secondary School	Secondary SchoolCO3	1294	856	1166
Small Hotel	Small HotelCO3	1804	364	1785
Small Office	Small OfficeCO3	668	364	622
Warehouse (non-refrigerated)	Warehouse (non-refrigera	83	58	577
Process Load	Process LoadCO3	5840	5840	5840
Data Center	Data CenterCO3	8760	8760	8760

NOTES:

*** EFLH- Zone 1 (Front Range/Denver); Zone 2 (Western State as represented by Grand Junction) and Zone 3 (Mountain Areas as represented by Alamosa)**
*** Market segment hours scaled from Minnesota OES data (Reference 10) with Office value calculated for Denver and Grand Junction Typical Meteorological Year data. Distributions developed from CBECS data (Reference 3)**
*** WSHP's will use Non-Economizer hours for all projects.**
*** RTU's that are less than 4.5 tons will use Non-Economizer hours for all projects.**
*** Air Cooled Chillers will use Hydronic System hours for all projects.**
*** PTAC's will use Non-Economizer Small Hotel hours for all projects.**

Table 3. DEPACC Incremental Cost (Reference 5)

System Tons	$/ton
40	$ 248.27
80	$ 219.91
120	$ 209.23
160	$ 202.80
320	$ 190.49

Table 4 Midstream Minimum Qualifying Tiers and Incremental Costs

Equipment	Equipment Tier	Min Qualifying SEER/IEER/ IPLV	Min Qualifying EER	Min Qualifying COP or HSPF	Incremental Cost per Ton, $/ton (Reference 8)
Rooftop Units less than 5.4 tons	Tier 1	15.00	12.20		$98.20
Rooftop Units less than 5.4 tons	Tier 2	16.00	12.20		$147.77
Rooftop Units less than 5.4 tons	Tier 3	17.00	12.20		$338.17
Rooftop Units less than 5.4 tons	Tier 4	18.00	12.20		$797.92
Split Systems less than 5.4 tons	Tier 1	15.00	12.20		$98.20
Split Systems less than 5.4 tons	Tier 2	16.00	12.20		$147.77
Split Systems less than 5.4 tons	Tier 3	17.00	12.20		$338.17
Split Systems less than 5.4 tons	Tier 4	18.00	12.20		$797.92
Rooftop Units & Split Systems 5.5-11.3 tons	Tier 1	13.00	11.60		$80.71
Rooftop Units & Split Systems 5.5-11.3 tons	Tier 2	13.80	11.60		$130.61
Rooftop Units & Split Systems 5.5-11.3 tons	Tier 3	14.60	11.60		$116.82
Rooftop Units & Split Systems 5.5-11.3 tons	Tier 4	18.00	11.60		$285.89
Rooftop Units & Split Systems 11.4-19.9 tons	Tier 1	12.60	11.60		$107.75
Rooftop Units & Split Systems 11.4-19.9 tons	Tier 2	13.40	11.60		$171.56
Rooftop Units & Split Systems 11.4-19.9 tons	Tier 3	14.00	11.60		$196.87
Rooftop Units & Split Systems 11.4-19.9 tons	Tier 4	17.50	11.60		$319.10
Rooftop Units & Split Systems 20-63.3 tons	Tier 1	12.00	10.30		$12.96
Rooftop Units & Split Systems 20-63.3 tons	Tier 2	12.60	10.30		$68.35
Rooftop Units & Split Systems 20-63.3 tons	Tier 3	13.30	10.30		$145.64
Rooftop Units & Split Systems 20-63.3 tons	Tier 4	15.00	10.30		$165.22
Rooftop Units greater than 63.3 tons	Tier 1	12.00	10.00		$110.00
Rooftop Units greater than 63.3 tons	Tier 2	12.80	10.00		$140.50
Rooftop Units greater than 63.3 tons	Tier 3	14.00	10.00		$266.50
Rooftop Units greater than 63.3 tons	Tier 4	16.00	10.00		$336.75
Air-Cooled Chillers - < 150 tons	Tier 1	14.5	10.3		$48.86
Air-Cooled Chillers - < 150 tons	Tier 2	15.0	10.3		$75.68
Air-Cooled Chillers - < 150 tons	Tier 3	16.0	10.3		$105.05
Air-Cooled Chillers - < 150 tons	Tier 4	18.0	10.3		$191.88
Air-Cooled Chillers - >= 150 tons	Tier 1	14.5	10.3		$48.86
Air-Cooled Chillers - >= 150 tons	Tier 2	15.0	10.3		$75.68
Air-Cooled Chillers - >= 150 tons	Tier 3	16.0	10.3		$105.05
Air-Cooled Chillers - >= 150 tons	Tier 4	18.0	10.3		$191.88
PTAC (Replacements) - 11 EER	Tier 1		11.0		$172.34
PTAC (Replacements) - 11.5 EER	Tier 2		11.5		$254.77
PTAC (Replacements) - 12 EER	Tier 3		12.0		$376.64
Water-source Heat Pumps	Tier 1	13.50	13.50	4.40	$163.64
Water-source Heat Pumps	Tier 2	15.00	15.00	4.40	$245.45
Water-source Heat Pumps	Tier 3	16.00	16.00	4.40	$327.27
Water-source Heat Pumps	Tier 4	18.00	18.00	4.40	$490.91
MSAC 16-21 SEER - MS	Tier 1	16.00	10.50		$337.87
MSAC 21-24 SEER - MS	Tier 2	21.00	10.50		$545.61
MSAC 24+ SEER - MS	Tier 3	24.00	10.50		$570.04
Mini-Split Heat Pump (16-21 SEER, 9-12 HSPF)	Tier 1	16.00	10.50	9.00	$337.87
Mini-Split Heat Pump (21-24 SEER, 9-12 HSPF)	Tier 2	21.00	10.50	9.00	$545.61
Mini-Split Heat Pump (24-26 SEER, 9-12 HSPF)	Tier 3	24.00	10.50	9.00	$570.04

Table 5.
MINIMUM QUALIFYING EQUIPMENT EFFICIENCIES AND INCREMENTAL

Equipment	Incremental Cost per Ton, $/ton (References 9, 11)	Minimum qualifying FLV	Minimum Qualifying IPLV	Minimum Qualifying FLV Offset from Adjusted Code Value	Minimum Qualifying IPLV Offset from Adjusted Code Value
scroll/screw chiller < 75 tons	$128.00	0.734	0.584		
scroll/screw chiller >=75 to < 150 tons	$128.00	0.704	0.544		
scroll/screw chiller >=150 to <300 tons	$70.00	0.644	0.524		
scroll/screw chiller >= 300 to <600 tons	$70.00	0.594	0.504		
scroll/screw chiller >= 600 tons	$70.00	0.544	0.484		
Centrifugal Chillers < 150 tons	$177.00			0.016	0.016
Centrifugal Chillers >= 150 to < 300 tons	$177.00			0.016	0.016
Centrifugal Chillers >=300 tons to < 400 tons	$177.00			0.016	0.016
Centrifugal Chillers >=400 tons to < 600 tons	$177.00			0.016	0.016
Centrifugal Chillers >= 600 tons	$177.00			0.016	0.016
VFD's for Chillers	$71.88				

References:

1. NYSERDA (New York State Energy Research and Development Authority); NY Energy $mart Programs Deemed Savings Database - Source for coincidence factor
2. ASHRAE, 2011, Applications Handbook, Ch. 37, table 4, Comparison of Service Life Estimates
3. CBECS (Commercial Buildings Energy Consumption Survey), 2012 - Total Floor space of Cooled Buildings by Principal Building Activity - source of market segment distributions
4. NTG for cooling is updated through a 2017 program evaluation.
5. Cypress, Ltd. Analysis of office building load profile and RTU efficiency improvement from application of wet bulb depression to reduce air cooled condensing temperatures.
6. International Energy Conservation Code 2015
7. Building America, Research Benchmark Definitions, 2010 (see p. 10). http://www.nrel.gov/docs/fy10osti/47246.pdf
   Approximation: EER = 1.12 x SEER - 0.02 x SEER^2
8. Midstream Product Data Analysis by Product Management Vendor
9. California DEER Database 2008
10. Minnesota Office of Energy Security (MOES) 2008 Cooling Equivalent Full Load Hours
11. Incremental costs for MSHPs were determined from the NEEP Incremental Cost Study Phase 2 Report
12. MSHP equipment life is from Measure Life Report Residential and Commercial/Industrial Lighting and HVAC Measures; http://library.cee1.org/content/measure-life-report-residential-and-commercialindustrial-lighting-and-hvac-measures

Changes from 2017 / 2018 Plan

Incremental cost are adjusted according to updated information from registered distributors.
Equivalent Full Load Hours updated to correct discrepancies between climate zones.

Water Source Heat Pump measures altered to capture heating energy savings compared to baseline equipment.
Minimum qualifying EERs have been evaluated and updated to improve measure level performance.