12.1 DX Units

Algorithms

$$\text{Customer } kWh = Size \times EFLH \times \left(\frac{12}{SEER_{Baseline}} - \frac{12}{SEER_{Eff}}\right) \times Qty$$

$$\text{Customer kW } = Size \times \left(\frac{12}{EER_{Baseline}} - \frac{12}{EER_{Eff}}\right) \times \text{Qty}$$

$$\text{Customer PC kW } = CF \times Size \times \left(\frac{12}{EER_{Baseline}} - \frac{12}{EER_{Eff}}\right) \times Qty$$

$$EER = SEER \times 0.85$$

$$Incremental\ Cost = Size\ \times Incremental\ Cost\ per\ Ton$$

Variables

EFLH	See Table 12.0.2	Equivalent Full Load Hours. The equivalent number of hours that the equipment would be running at full load over the course of the year.
$SEER_{Baseline}$ / $IEER_{Baseline}$	See Table 12.0.1	Deemed Baseline Efficiencies based on IECC 2018
$EER_{Baseline}$	See Table 12.0.1	Deemed Baseline Efficiencies based on IECC 2018
CF	90%	Coincidence Factor (Reference 1)
Incremental Costs Per Ton	See Table 12.0.3	Incremental Costs Per Ton.
NTG_Midstream	89% ~~92%~~	Net-to-gross = We will use ~~92%~~ 89% for all midstream cooling equipment (Reference 4).
SEER to EER conversion factor	0.85	SEER to EER conversion factor
Lifetime, years	20	Reference 11

Customer Inputs	M&V Verified	
$SEER_{Eff}$ / $IEER_{Eff}$	Yes	Seasonal (or Integrated) Energy Efficiency Ratio in Btu/W-hr of high efficiency equipment that the customer will install.
EER_{Eff}	Yes	EER of high efficiency equipment that the customer will install.
Size	Yes	The equipment capacity in tons.
Building Type / Market Segment	Yes	
County/Zone	Yes	
System Type	Yes	
Quantity Proposed Equipment (Qty)	Yes	

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 2018
7. Building America, Research Benchmark Definitions, 2010 (see p. 10). http://www.nrel.gov/docs/fy10osti/47246.pdf
8. Midstream Product Data Analysis by Product Management Vendor
9. California DEER Database 2008
10. Incremental costs for MSHPs were determined from the NEEP Incremental Cost Study Phase 2 Report
11. Equipment life is from Minnesota Technical Reference Manual (TRM) version 3.1 Jan 20, 2020.
12. 2017-2019 CO Cooling Program Participation Data, used for forecasts,minimum qualifying efficiencies

Changes from Recent Filing:

EFLH and Building Type/Market Segment updated

12.2 WSHP

Algorithms

$$WSHP_{Cooling}kWh = Size \times EFLH \times \left(\frac{12}{SEER_{Baseline}} - \frac{12}{SEER_{Eff}}\right)$$

$$WSHP_{Heating}kWh = Size_{Heat} \times EFLH_{Heat} \times \left(\frac{1}{COP_{Baseline} \times 3412} - \frac{1}{COP_{Eff} \times 3412}\right)$$

$$Customer\ kWh = (WSHP_{Cooling}\ kWh + WSHP_{Heating}kWh) \times Qty$$

$$Customer\ kW\ = Size \times \left(\frac{12}{EER_{Baseline}} - \frac{12}{EER_{Eff}}\right) \times Qty$$

$$Customer\ PC\ kW\ = CF \times Size \times \left(\frac{12}{EER_{Baseline}} - \frac{12}{EER_{Eff}}\right) \times Qty$$

$$EER = SEER$$

$$Incremental\ Cost = Size\ \times Incremental\ Cost\ per\ Ton$$

Variables

EFLH	See Table 12.0.2	Equivalent Full Load Hours. The equivalent number of hours that the equipment would be running at full load over the course of the year.
$EFLH_{Heat}$	See Table 12.0.2	The equivalent number of hours that WSHP equipment would be running at Full Load over the course of the year for heating.
$SEER_{Baseline}$ / $IEER_{Baseline}$	See Table 12.0.1	Deemed Baseline Efficiencies based on IECC 2018
$EER_{Baseline}$	See Table 12.0.1	Deemed Baseline Efficiencies based on IECC 2018
CF	90%	Coincidence Factor (Reference 1)
Lifetime, years	15	Reference 11
3412	3,412	kWh to BTU conversion factor
NTG_Midstream	89% ~~92%~~	Net-to-gross = We will use ~~92%~~ 89% for all midstream cooling equipment (Reference 4).
Incremental Costs Per Ton	See Table 12.0.3	Incremental Costs Per Ton.
$COP_{Baseline}$	4.30	COP of standard Water Source Heat Pump equipment in Heating Mode for Water:Air Water Loop from the International Energy Conservation Code, 2018, Table 403.3.2(2).

Customer Inputs	M&V Verified	
$SEER_{Eff}$	Yes	SEER of high efficiency equipment that the customer will install.
EER_{Eff}	Yes	EER of high efficiency equipment that the customer will install.
COP_{Eff}	Yes	COP of High Efficiency unit that the customer will install.
Size	Yes	The equipment capacity in tons.
$Size_{Heat}$	Yes	Heating Capacity of Water Source Heat Pumps in BTU/h, provided by customer
Building Type / Market Segment	Yes	
County/Zone	Yes	
System Type	Yes	
Quantity Proposed Equipment (Qty)	Yes	

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
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
6. International Energy Conservation Code 2018
7. Building America, Research Benchmark Definitions, 2010 (see p. 10). http://www.nrel.gov/docs/fy10osti/47246.pdf
8. Midstream Product Data Analysis by Product Management Vendor
9. California DEER Database 2008
10. Incremental costs for MSHPs were determined from the NEEP Incremental Cost Study Phase 2 Report
11. Equipment life is from Minnesota Technical Reference Manual (TRM) version 3.1 Jan 20, 2020.

Changes from Recent Filing:

EFLH and Building Type/Market Segment updated

12.3 PTAC

Algorithms

Customer $kWh = Size \times EFLH \times \left(\frac{12}{SEER_{Baseline}} - \frac{12}{SEER_{Eff}}\right) \times Qty$

Customer kW $= Size \times \left(\frac{12}{EER_{Baseline}} - \frac{12}{EER_{Eff}}\right) \times Qty$

Customer PC kW $= CF \times Size \times \left(\frac{12}{EER_{Baseline}} - \frac{12}{EER_{Eff}}\right) \times Qty$

$EER = SEER \times 0.85$

$Incremental\ Cost = Size\ \times Incremental\ Cost\ per\ Ton$

Variables

EFLH	See Table 12.0.2	Equivalent Full Load Hours. The equivalent number of hours that the equipment would be running at full load over the course of the year.
$SEER_{Baseline}$ / $IEER_{Baseline}$	See Table 12.0.1	Deemed Baseline Efficiencies based on IECC 2018
$EER_{Baseline}$	See Table 12.0.1	Deemed Baseline Efficiencies based on IECC 2018
CF	90%	Coincidence Factor (Reference 1)
Incremental Costs Per Ton	See Table 12.0.3	Incremental Costs Per Ton.
NTG_Midstream	89% ~~92%~~	Net-to-gross = We will use ~~92%~~ 89% for all midstream cooling equipment (Reference 4).
SEER to EER conversion factor	0.85	SEER to EER conversion factor
Lifetime, years	20	Reference 11

Customer Inputs	**M&V Verified**	
$SEER_{Eff}$ / $IEER_{Eff}$	Yes	Seasonal (or Integrated) Energy Efficiency Ratio in Btu/W-hr of high efficiency equipment that the customer will install.
EER_{Eff}	Yes	EER of high efficiency equipment that the customer will install.
Size	Yes	The equipment capacity in tons.
Building Type / Market Segment	Yes	
County/Zone	Yes	
System Type	Yes	
Quantity Proposed Equipment (Qty)	Yes	

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
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
6. International Energy Conservation Code 2018
7. Building America, Research Benchmark Definitions, 2010 (see p. 10). http://www.nrel.gov/docs/fy10osti/47246.pdf
8. Midstream Product Data Analysis by Product Management Vendor
9. California DEER Database 2008
10. Incremental costs for MSHPs were determined from the NEEP Incremental Cost Study Phase 2 Report
11. Equipment life is from Minnesota Technical Reference Manual (TRM) version 3.1 Jan 20, 2020.

Changes from Recent Filing:

EFLH and Building Type/Market Segment updated

12.4 Scroll-Screw Chiller

Algorithms

$$Customer\ kWh = Size \times EFLH \times (IPLV_{Baseline} - IPLV_{Eff}) \times Qty$$

$$Customer\ kW = Size \times (FLV_{Baseline} - FLV_{Eff}) \times Qty$$

$$Customer\ PCkW = CF \times Size \times (FLV_{Baseline} - FLV_{Eff}) \times Qty$$

$$Incremental\ Cost = Size\ \times Incremental\ Cost\ per\ Ton$$

Variables

EFLH	See Table 12.0.2	Equivalent Full Load Hours. The equivalent number of hours that the equipment would be running at full load over the course of the year.
$FLV_{Baseline}$	See Table 12.0.1	Deemed Baseline Efficiencies based on IECC 2018
$IPLV_{Baseline}$	See Table 12.0.1	Deemed Baseline Efficiencies based on IECC 2018
CF	90%	Coincidence Factor (Reference 1)
Incremental Costs Per Ton	See Table 12.0.3	Incremental Costs Per Ton.
NTG_General_Cooling	71% ~~92%~~	Net-to-gross = We will use ~~92%~~ 71% for all cooling equipment except MSHP units (Reference 4).
Lifetime, years	20	Reference 11

Customer Inputs	M&V Verified	
FLV_{Eff}	Yes	Full Load Value cooling efficiency in kW/ton, representing the efficiency at design conditions for the customer's operating conditions.
$IPLV_{Eff}$	Yes	Integrated Part Load Value (representing the average efficiency over a range of loaded states) cooling efficiency in kW/ton of high efficiency equipment at the customer's operating conditions.
Size	Yes	The equipment capacity in tons.
Building Type / Market Segment	Yes	
County/Zone	Yes	
System Type	Yes	
Quantity Proposed Equipment (Qty)	Yes	
Air or Waterside Economizer	Yes	Check if the chiller is equpped with or without an Airside/Waterside Economizer

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 2018
7. Building America, Research Benchmark Definitions, 2010 (see p. 10). http://www.nrel.gov/docs/fy10osti/47246.pdf
8. Midstream Product Data Analysis by Product Management Vendor
9. California DEER Database 2008
10. Incremental costs for MSHPs were determined from the NEEP Incremental Cost Study Phase 2 Report
11. Equipment life is from Minnesota Technical Reference Manual (TRM) version 3.1 Jan 20, 2020.

Changes from Recent Filing:

EFLH and Building Type/Market Segment updated

12.5 Centrifugal Chillers

Algorithms

$$Customer\ kWh = Size \times EFLH \times (IPLV_{AHRI\_Adj} - IPLV_{Eff}) \times Qty$$

$$Customer\ kW = Size \times (FLV_{AHRI\_Adj} - FLV_{Eff}) \times Qty$$

$$Customer\ PCkW = CF \times Size \times (FLV_{AHRI\_Adj} - FLV_{Eff}) \times Qty$$

$$IPLV_{AHRI\_Adj} = IPLV_{AHRI} \div K_{adj}$$

$$FLV_{AHRI\_Adj} = FLV_{AHRI} \div K_{adj}$$

$$K_{adj} = A \times B$$

$$A = 0.00000014592 \times (Lift)^4 - 0.0000346496 \times (Lift)^3 + 0.00314196 \times (Lift)^2 - 0.147199 \times (Lift) + 3.9302$$

$$B = 0.0015 \times Lvg_{Evap} + 0.934$$

$$Lift = Lvg_{Cond} - Lvg_{Evap}$$

$$Minimum\ Qualifying\ FLV = FLV_{AHRI\_Adj} - Qualifying\ FLV_{Offset}$$

$$Minimum\ Qualifying\ IPLV = IPLV_{AHRI\_Adj} - Qualifying\ IPLV_{Offset}$$

$$Incremental\ Cost = Size \times Incremental\ Cost\ per\ Ton$$

Variables

EFLH	See Table 12.0.2	Equivalent Full Load Hours. The equivalent number of hours that the equipment would be running at full load over the course of the year.
FLV_{AHRI}	See Table 12.0.1	Full load cooling efficiency in kW/ton of standard equipment, based upon the minimum acceptable efficiency defined by International Energy Conservation Code, 2018, Table 403.2.3(7) for selected centrifugal chiller type, size, condensing and chilled water temperature (provided by customer).
$IPLV_{AHRI}$	See Table 12.0.1	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, 2018 for chiller type and size (type and size provided by customer).
FLV_{AHRI_Adj}		IECC based FLV for water cooled centrifugal chillers adjusted to actual site rated conditions (provided by customer) per IECC 2018 code adjustment formulas.
$IPLV_{AHRI\_Adj}$		IECC based IPLV or NPLV for water cooled centrifugal chillers adjusted to actual site rated conditions (provided by customer) per IECC 2018 code adjustment formulas.
Lifetime, years	20	Reference 11
0.00000014592, 0.0000346496, 0.00314196, 0.147199, 3.9302, 0.0015, 0.934		Coefficients to calculate K_{adj} (adjustment factor) per IECC 2018 code adjustment formulas
NTG_General_Cooling	71% ~~92%~~	Net-to-gross = We will use ~~92%~~ 71% for all cooling equipment except MSHP units (Reference 4).
Incremental Costs Per Ton	See Table 12.0.3	Incremental Costs Per Ton.
CF	90%	Coincidence Factor (Reference 1)

Customer Inputs	M&V Verified	
FLV_{Eff}	Yes	Full Load Value cooling efficiency in kW/ton, representing the efficiency at design conditions for the customer's operating conditions.
$IPLV_{Eff}$	Yes	Integrated Part Load Value (representing the average efficiency over a range of loaded states) cooling efficiency in kW/ton of high efficiency equipment at the customer's operating conditions.
Lvg_{Evap} (Chilled water supply temperature [°F] at full load)	Yes	The full load water temperature leaving the evaporator, in °F.
Lvg_{Cond} (Condenser water leaving temperature [°F] at full load)	Yes	The full load water temperature leaving the condenser, in °F.
Size	Yes	The equipment capacity in tons.
Building Type / Market Segment	Yes	
County/Zone	Yes	
System Type	Yes	
Quantity Proposed Equipment (Qty)	Yes	
Chill water flow [gpm/ton] at full load	Yes	
Condenser water flow [gpm/ton] at full load	Yes	

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 2018
7. Building America, Research Benchmark Definitions, 2010 (see p. 10). http://www.nrel.gov/docs/fy10osti/47246.pdf
8. Midstream Product Data Analysis by Product Management Vendor
9. California DEER Database 2008
10. Incremental costs for MSHPs were determined from the NEEP Incremental Cost Study Phase 2 Report
11. Equipment life is from Minnesota Technical Reference Manual (TRM) version 3.1 Jan 20, 2020.

Changes from Recent Filing:

EFLH and Building Type/Market Segment updated

12.6 Air-Cooled Chillers

Algorithms

$$\text{Customer } kWh = Size \times EFLH \times \left(\frac{12}{SEER_{Baseline}} - \frac{12}{SEER_{Eff}}\right) \times Qty$$

$$\text{Customer kW } = Size \times \left(\frac{12}{EER_{Baseline}} - \frac{12}{EER_{Eff}}\right) \times Qty$$

$$\text{Customer PC kW } = CF \times Size \times \left(\frac{12}{EER_{Baseline}} - \frac{12}{EER_{Eff}}\right) \times Qty$$

$$EER = SEER \times 0.85$$

$$Incremental\ Cost = Size\ \times Incremental\ Cost\ per\ Ton$$

Variables

EFLH	See Table 12.0.2	Equivalent Full Load Hours. The equivalent number of hours that the equipment would be running at full load over the course of the year.
$SEER_{Baseline}$ / $IEER_{Baseline}$	See Table 12.0.1	Deemed Baseline Efficiencies based on IECC 2018
$EER_{Baseline}$	See Table 12.0.1	Deemed Baseline Efficiencies based on IECC 2018
CF	90%	Coincidence Factor (Reference 1)
Incremental Costs Per Ton	See Table 12.0.3	Incremental Costs Per Ton.
NTG_General_Cooling	89% ~~92%~~	Net-to-gross = We will use ~~92%~~ 89% for all midstream cooling equipment (Reference 4).
SEER to EER conversion factor	0.85	SEER to EER conversion factor
Lifetime, years	20	Reference 11

Customer Inputs	M&V Verified	
$SEER_{Eff}$ / $IEER_{Eff}$	Yes	Seasonal (or Integrated) Energy Efficiency Ratio in Btu/W-hr of high efficiency equipment that the customer will install.
EER_{Eff}	Yes	EER of high efficiency equipment that the customer will install.
Size	Yes	The equipment capacity in tons.
Building Type / Market Segment	Yes	
County/Zone	Yes	
System Type	Yes	
Quantity Proposed Equipment (Qty)	Yes	

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
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
6. International Energy Conservation Code 2018
7. Building America, Research Benchmark Definitions, 2010 (see p. 10). http://www.nrel.gov/docs/fy10osti/47246.pdf
8. Midstream Product Data Analysis by Product Management Vendor
9. California DEER Database 2008
10. Incremental costs for MSHPs were determined from the NEEP Incremental Cost Study Phase 2 Report
11. Equipment life is from Minnesota Technical Reference Manual (TRM) version 3.1 Jan 20, 2020.

Changes from Recent Filing:

EFLH and Building Type/Market Segment updated

12.7 VFD Chill Retrofit

Algorithms

$$Customer\ kWh = Size \times EFLH \times (IPLV_{VFDBaseline} - IPLV_{VFDEff}) \times Qty$$

$$Customer\ kW = Size \times (FLV_{VFDBaseline} - FLV_{VFDEff}) \times Qty$$

$$Customer\ PCkW = CF \times Size \times (FLV_{VFDBaseline} - FLV_{VFDEff}) \times Qty$$

$$Incremental\ Cost = Size \times Incremental\ Cost\ per\ Ton$$

Variables

EFLH	See Table 12.0.2	Equivalent Full Load Hours. The equivalent number of hours that the equipment would be running at full load over the course of the year.
Incremental Costs Per Ton	See Table 12.0.3	Incremental Costs Per Ton.
NTG_General_Cooling	71% ~~92%~~	Net-to-gross = We will use ~~92%~~ 71% for all cooling equipment except MSHP units (Reference 4).
Lifetime, years	15	Equal to the value used in the Motors and Drives program for VFDs.

Customer Inputs	M&V Verified	
$FLV_{VFDBaseline}$ [Chiller Full Load efficiency without VFD]	Yes	Full Load Value cooling efficiency in kW/ton, representing the efficiency of existing chiller without a VFD at 95% load.
FLV_{VFDEff} [Chiller Chiller Full Load efficiency with VFD]	Yes	Full Load Value cooling efficiency in kW/ton, representing the efficiency of existing chiller with a VFD at 95% load.
$IPLV_{VFDBaseline}$ [Chiller Part Load efficiency without VFD]	Yes	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.
$IPLV_{VFDEff}$ [ChillerPart Load Efficiency with VFD]	Yes	Integrated Part Load Value (representing the average efficiency over a range of loaded states) cooling efficiency in kW/ton of existing chiller with a VFD.
Size	Yes	The equipment capacity in tons.
Building Type / Market Segment	Yes	
County/Zone	Yes	
System Type	Yes	
Quantity of same size Chillers with VFD Retrofit (Qty)	Yes	

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 2018
7. Building America, Research Benchmark Definitions, 2010 (see p. 10). http://www.nrel.gov/docs/fy10osti/47246.pdf
8. Midstream Product Data Analysis by Product Management Vendor
9. California DEER Database 2008
10. Incremental costs for MSHPs were determined from the NEEP Incremental Cost Study Phase 2 Report
11. Equipment life is from Minnesota Technical Reference Manual (TRM) version 3.1 Jan 20, 2020.

Changes from Recent Filing:

EFLH and Building Type/Market Segment updated

12.9 DEPACC

Algorithms

$$Customer\ kWh_{With\ Economizer} = Size \times DEPACC\ EFLH\ Factor \times EFLH_{With\ Economizer} \times KW\ per\ Ton_{Average}$$

$$Customer\ kWh_{No\ Economizer} = Size \times DEPACC\ EFLH\ Factor \times EFLH_{No\ Economizer} \times KW\ per\ Ton_{Average}$$

$$Customer\ KW = Size \times KW\ per\ Ton_{peak}$$

$$Customer\ PC\ KW = Size \times KW\ per\ Ton_{peak} \times Coincidence\ Factor$$

$$Incremental\ Cost\ of\ Equipment = Size \times Incremental\ Cost\ per\ Ton$$

Variables

DEPACC EFLH Factor	1.1631	= DEPACC_Operating_Hours_Office / EFLH for Front Range Office (w/economizer). Equivalent Full Load Hours. The equivalent number of hours that the equipment would be running at full load over the course of the year.
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
$EFLH_{With\ Economizer}$	See Table 12.0.2	Equivalent Full Load Hours. The equivalent number of hours that cooling equipment with an economizer would be running at full load over the course of the year.
$EFLH_{No\ Economizer}$	See Table 12.0.2	Equivalent Full Load Hours. The equivalent number of hours that cooling equipment without an economizer would be running at full load over the course of the year
$KW\ per\ Ton_{Average}$	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.
$KW\ per\ Ton_{Peak}$	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
Coincidence Factor	90%	Probability that the calculated Customer kW will coincide with the period of peak generator operation
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.
Incremental Cost of Equipment	See Table 12.9.0 DEPACC Incremental Costs	$ / 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	$0.00	= $0 because the baseline option is to do nothing.
NTG_General_Cooling	71% ~~92%~~	Net-to-gross = We will use ~~92%~~ 71% for all cooling equipment except MSHP units (Reference 4).
Lifetime	20	Life of a new Direct Evaporative Cooling unit, in years

Customer Inputs	M&V Verified	
Size	Yes	The rated cooling equipment capacity in tons.
Building Type / Market Segment	Yes	
County/Zone	Yes	
System Type	Yes	
Quantity Proposed Equipment (Qty)	Yes	
Economizer	Yes	Indicates if the equipment does or does not have a functional cooling economizer (ie., Air or Waterside Economizer).

Table 12.9.0 DEPACC Incremental Costs

System Tons	Incremental Capital Cost ($/ton)	Incremental Electrical O&M Cost ($/ton-hr)
10 to 59	$ 248.27	$ 0.0008867
60 to 99	$ 219.91	$ 0.0008867
100 to 139	$ 209.23	$ 0.0008867
140 to 239	$ 202.80	$ 0.0008867
240 and above	$ 190.49	$ 0.0008867

References:

1. Cypress, Ltd. Analysis of office building load profile and RTU efficiency improvement from application of wet bulb depression to reduce air cooled condensing temperatures.

Changes from Recent Filing:

EFLH and Building Type/Market Segment updated

Assumptions:

1. Minimum equipment size that DEPACC can be installed on is 10 ton.

2. 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.

3. 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.

4. Condenser fan energy costs due to DEPACC media are not expected to increase measurably. Media decreases condenser fan cfm while increasing fan static.

5. Denver Water 2018 average rate at $3.167/1000 gal (Source https://www.denverwater.org/business/billing-and-rates/2018-rates)

6. 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.

12.10 Mini-Split Heat Pump

Algorithms

$$Cooling\ Electrical\ Energy\ Savings\ (kWh) = Size \times EFLH \times \left(\frac{12}{SEER_{Baseline}} - \frac{12}{SEER_{Eff}}\right)$$

$$Heating\ Electrical\ Energy\ Savings\ (kWh) = \frac{MSHP_{Size_{Heating}}}{1000} \times MSHP\_EFLHH \times \left(\frac{1}{HSPF_{Standard}} - \frac{1}{HSPF\_Eff}\right)$$

$$Customer\ kWh = Cooling\ Electrical\ Energy\ Savings + Heating\ Electrical\ Energy\ Savings$$

$$Customer\ kW = Size \times \left(\frac{12}{EER_{Baseline}} - \frac{12}{EER_{Eff}}\right)$$

$$Customer\ PC\ kW = CF \times Size \times \left(\frac{12}{EER_{Baseline}} - \frac{12}{EER_{Eff}}\right)$$

Variables

EFLH	See Table 12.0.2	Equivalent Full Load Hours. The equivalent number of hours that the equipment would be running at full load over the course of the year.
MSHP_EFLHH	950	Mini-Split Heat Pump Equivalent Full Load Hours Heating: The equivalent number of hours that MSHP equipment would be running at full load over the course of the year fo heating. From Heating Efficiency Program.
$SEER_{Baseline}$	See Table 12.0.1	Seasonal (or Integrated) Energy Efficiency Ratio in BTU/W-hr of standard equipment, based upon the minimum acceptable efficiency defined by the current building code.
$EER_{Baseline}$	See Table 12.0.1	EER of standard equipment, based upon the minimum acceptable efficiency defined by the current building code. If unavailable, EER_Baseline is calculated from SEER_Eff using a polynomial conversion.
HSPF_Standard	8.20	Heating Seasonal Performance Factor (HSPF) of standard equipment, based upon the minimum Federal standard for efficiency as manufactured.
SEER to EER conversion factor	0.85	SEER to EER conversion factor
CF	90%	Coincidence Factor
NTG_General_Cooling	89% ~~92%~~	Net-to-gross = We will use ~~92%~~ 89% for all midstream cooling equipment.
Measure Life[2]	18	Life of a new unit, in years

Customer Inputs	**M&V Verified**	
Cooling capacity (BTU/h)	Yes	(Btu/h) Size - Cooling capacity of equipment at standard ARI test conditions
Cooling efficiency (SEER)	Yes	SEER_Eff - Seasonal (or Integrated) Energy Efficiency Ratio in Btu/W-hr of high efficiency equipment that the customer will install.
Cooling efficiency (EER)	No	EER_Eff - Full-load efficiency of efficient equipment. If unavailable, value is calculated from SEER_Eff using a polynomial conversion.
Heating capacity (BTU/h)	Yes	(Btu/h) MSHP_Size_Heating - Heating capacity of Mini Split Heat Pump at 17 F outdoor air temperature, in BTU/h
Heating efficiency (HSPF)	Yes	HSPF_Eff - Heating Seasonal Performance Factor (HSPF) of High Efficiency equipment that the customer will install.
Building Type / Market Segment	Yes	
County/Zone	Yes	
System Type	Yes	
Quantity Proposed Equipment (Qty)	Yes	
Primary use, cooling or heating (MSHP)	No	

References:

1. Incremental costs for MSHPs were determined from the NEEP Incremental Cost Study Phase 2 Report

2. 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

3. IECC 2018 for Equipment Baseline Efficiencies

4. No heating demand (kW) saving are claimed for MSHP during winter, only summer cooling demand (kW) savings are claimed.

5. It is assumed that NO supplemental heating source is used.

6. For new Mini-Split Heat Pumps (MSHP) it is assumed that the MSHP is being installed in either new construction or to supplement an existing heating ar cooling system. The MSHP rebate is intended to incent customers to install a high efficiency MSHP rather than the code level baseline unit.

Changes from Recent Filing:

EFLH and Building Type/Market Segment updated

12.11 Mini-Split AC

Algorithms

$$Customer\ kWh = Size \times EFLH \times \left(\frac{12}{SEER_{Baseline}} - \frac{12}{SEER_{Eff}}\right)$$

$$Customer\ kW = Size \times \left(\frac{12}{EER_{Baseline}} - \frac{12}{EER_{Eff}}\right)$$

$$Customer\ PC\ kW = CF \times Size \times \left(\frac{12}{EER_{Baseline}} - \frac{12}{EER_{Eff}}\right)$$

Variables

EFLH	See Table 12.0.2	Equivalent Full Load Hours. The equivalent number of hours that the equipment would be running at full load over the course of the year.
$SEER_{Baseline}$	See Table 12.0.1	Seasonal (or Integrated) Energy Efficiency Ratio in BTU/W-hr of standard equipment, based upon the minimum acceptable efficiency defined by the current building code.
$EER_{Baseline}$	See Table 12.0.1	EER of standard equipment, based upon the minimum acceptable efficiency defined by the current building code. If unavailable, EER_Baseline is calculated from SEER_Eff using a polynomial conversion.
SEER to EER conversion factor	0.85	SEER to EER conversion factor
CF	90%	Coincidence Factor
NTG_General_Cooling	89% ~~92%~~	Net-to-gross = We will use ~~92%~~ 89% for all midstream cooling equipment.
Measure Life[2]	18	Life of a new unit, in years

Customer Inputs	M&V Verified	
Cooling capacity (BTU/h)	Yes	(Btu/h) Size - Cooling capacity of equipment at standard ARI test conditions
Cooling efficiency (SEER)	Yes	SEER_Eff - Seasonal (or Integrated) Energy Efficiency Ratio in Btu/W-hr of high efficiency equipment that the customer will install.
Cooling efficiency (EER)	No	EER_Eff - Full-load efficiency of efficient equipment. If unavailable, value is calculated from SEER_Eff using a polynomial conversion.
County/Zone	No	
Building type	Yes	
System Type	Yes	
Equipment quantity	Yes	
Primary use, cooling or heating (MSHP)	No	

References:

1. Incremental costs were determined from the NEEP Incremental Cost Study Phase 2 Report

2. 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

3. IECC 2018 for Equipment Baseline Efficiencies

4. For new Mini-Split Air Conditioners (MSAC) it is assumed that the MSAC is being installed in either new construction or to supplement an existing cooling system. The MSAC rebate is intended to incent customers to install a high efficiency MSAC rather than the code level baseline unit.

Changes from Recent Filing:

EFLH and Building Type/Market Segment updated

18.9 Residential Saver's Switch

Algorithms

$$Customer\ kWh = Quantity\ Equipment\ * Equipment\ kWh\ Savings\ *\ Cooling\ Savings$$

$$Customer\ kW = Quantity\ Equipment\ * Equipment\ kW\ Savings\ *\ Cooling\ Savings$$

$$Customer\ Coincident\ kW = Quantity\ Equipment\ * Equipment\ PCkW\ Savings\ *\ Cooling\ Savings$$

Variables

Quantity Equipment	Customer Input	Quantity of smart saver switches installed.
Equipment kW Savings	2.628	Customer kW savings per unit with a smart switch
Equipment kWh Savings	4	Annual kWh savings per unit with a smart switch
Equipment PCkW Savings	0.930	Peak Coincident kW savings perunit with a smart switch
Lifetime	15	Length of time the switch will be operational
NTG	1	Net-to-Gross factor for Residential Demand Response will be 100% as customers would not have the ability to install a switch or participate in events without the program.
~~Cooling Scaling Factor~~	~~See Table 18.9.1~~	~~Cooling Scaling factor based on home type~~

~~Table 18.9.1~~

~~Smart Thermostat Home Type~~	~~Single Family~~	~~Multi-Family~~	~~Townhome/Duplex~~
~~Cooling Scaling Factor~~	~~100%~~	~~35%~~	~~64%~~
~~Heating Scaling Factor~~	~~100%~~	~~15%~~	~~52%~~

Customer Inputs	M&V Verified	
Number of units with switch installed.	Yes	

References:

(1) DNV GL & AEC, January 2016. Saver's Switch Program, Residential Program, 2015 Impact Evaluation Report.
(2) Xcel Energy, May 2018. Saver's Switch Control History.
(3) Nexant, 2017. Evaluation of 2016 Smart Thermostat Pilot.
(4) DNV GL & AEC, January 2018. Saver's Switch Program, Residential Wireless Modeling & Event Day Report, Version 8.

Changes from Recent Filing:

None