

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

21.1 Pneumatic to DDC

Algorithms

Customer kWh Savings = Customer kWh Cooling Savings + Customer kWh Heating Savings

*Customer kWh Cooling Savings = (kWh Savings per square foot) * Square Feet*

*Customer Coincident kW = kWh Savings * CF*

O&M Savings = 0

If electric heat: *Customer kWh Heating Savings = (Therms Savings per square foot) * $\frac{29.3}{0.8}$ * Square Feet*

If gas heat: *Customer Dth = (Therms Savings per square foot/10) * Square Feet*

*Incremental Cost = (Incremental Cost per square foot) * Square Feet*

Variables

Therms Savings per square foot	See Table 20.1.1	Small office
	See Table 20.1.1	Medium office
	See Table 20.1.1	Large Office
kWh Savings per square foot	See Table 20.1.1	Small office
	See Table 20.1.1	Medium office
	See Table 20.1.1	Large Office
Incremental cost per square foot	\$1.10	Average value to be used for all office sizes. (Ref. 5)
Electric heating savings per square foot (kWh)	See Table 20.1.1	Small office
	See Table 20.1.1	Medium office
	See Table 20.1.1	Large Office
Conversion Factor	10	Therms to Decatherms
Conversion Factor	29.3	Conversion from therms per sq. ft. to kWh per sq. ft.
Heating System Efficiency	0.8	Efficiency of heating equipment. (Ref. 3)
Square foot per thermostat	900	sq.ft./thermostat (national average, Ref. 1, page 23)
CF	0	Coincidence Factor
O&M Labor Savings	\$0.00	
O&M License Cost	\$0.00	
Lifetime	8	Years (Ref. 4)

Customer Inputs

M&V Verified

Office size	Yes	Small (0-10,000 sq. ft.), Medium (10,001-300,000 sq. ft.), Large (300,001+ sq. ft.)
Square Feet	Yes	Area served by the new thermostats (sq. ft.)
Number of Thermostats (qty.)	Yes	
Thermostat controls equipment providing heating and cooling to the space	Yes	Yes or No
Heating and Cooling setback of at least 8° F	Yes	Yes or No
Heating Fuel	Yes	Natural Gas or Electric
Quantity	Yes	Number of new thermostats

Table 21.1.1 Table of Savings (Ref. 1, Table 6A)

Location	Office Building Size	Model SF	Model Natural Gas Savings (kbtu) with setback heating at 62F (69F baseline)	Therm Savings per square foot	Model Electricity Savings (kWh) with setback cooling at 83F (75F baseline)	kWh Savings per square foot	Cost per square foot (\$/sf)
Boulder, CO.	Small	5,500	58,412	0.106	4,672	0.849	\$1.20
	Medium	53,630	507,275	0.095	10,778	0.201	\$1.10
	Large	498,500	4,569,352	0.092	93,652	0.188	\$0.90

References:

- The calculations, cost and tables used to determine Energy and Cost Savings were obtained from the report: Wireless Pneumatic Thermostat Evaluation Ronald Reagan Building and International Trade Center Washington D.C. (https://www.gsa.gov/cdnstatic/GPG_WPT_Report-508.pdf)
- ComEd prescriptive rebate calculator.
- State of Minnesota Technical Reference Manual, Version 4.0. Numerous measures where heating system efficiency is referenced.
- State of Minnesota Technical Reference Manual, Version 4.0. Commercial HVAC - Adjustment of Programmable Thermostats for Small Commercial Buildings
- 2018 CBECS. Table B1. Summary table: total and means of floorspace, number of workers, and hours of operation, 2018. Mean square feet per building for Office category: 17,200 square foot per building.

Changes from Recent Filing:

- New measure added based on the 2022 Xcel Energy Management Systems Evaluation.

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

21.2 Guest Room Energy Management

Algorithms

$$Customer\ kWh\ Cooling\ Savings = (Cooling_{Size}/1,000) * Quantity * EFLH_{cool} * \left(\frac{1}{Cooling_{Eff}}\right) * GREM_{Savings}$$

$$Customer\ Coincident\ kW = (Cooling_{Size}/1,000) * Quantity * \left(\frac{1}{Cooling_{Eff}}\right) * GREM_{Savings} * CF$$

$$If\ electric\ heat: Customer\ kWh\ Heating\ Savings = (Heating_{Size}/3,412) * Quantity * \left(\frac{1}{Heating_{Eff}}\right) * EFLH_{heat} * GREM_{Savings}$$

$$If\ gas\ heat: Customer\ Dth = (Heating_{Size}/1,000,000) * Quantity * \left(\frac{1}{Heating_{Eff}}\right) * EFLH_{heat} * GREM_{Savings}$$

$$Incremental\ Cost = Quantity * Incremental\ Cost_{per\ unit}$$

Variables

EFLH_cool	See table 20.1.2	Cooling equivalent full load hours
EFLH_heat	See table 20.2.2	Heating equivalent full load hours
Cooling_Eff	See table 20.3.2	Cooling efficiency of the HVAC system in units of EER
Heating_Eff	See table 20.4.2	Heating efficiency of the HVAC system in units of COP
GREM_savings	18.40%	Savings fraction for using GREM controls
CF	0.90	Deemed coincidence factor
Lifetime	15	Life of a new unit, in year
Incremental Cost (per unit)	\$260.00	Per unit, from MN TRM. (per room HVAC controller, which is the cost difference between a non-programmable thermostat and a GREM.)

Customer Inputs

M&V Verified

Quantity Proposed Equipment (Qty.)	Yes	Quantity of HVAC units is usually the same as number of hotel/motel rooms.
Zone	Yes	Zone 1, 2 or 3
Cooling type	Yes	PTAC, PTHP, or chilled water fan coil unit
Cooling size	Yes	Nominal cooling capacity of the cooling system in BTU/hr
Heating type	Yes	PTAC/electric resistance, PTAC/hot water, PTHP, hot water fan coil unit
Heating size	Yes	Nominal heating capacity of the cooling system in BTU/hr

Table 21.1.2 EFLH_Cooling (Ref. 2)

Building Type	CO1	CO2	CO3
	Front Range EFLH w/out economizer	Western Slope EFLH w/out Economizer	Mountain EFLH w/out economizer
Lodging	720	688	462

Table 21.2.2 EFLH_Heating (Ref. 3)

Building Type	Denver
Lodging	1272

Table 21.3.2 Cooling System EER (Ref. 1)

PTAC, < 7,000 BTU	11.9
PTAC, 7,000-15,000 BTU	14.0 - (0.300 x Cap/1000)
PTAC, > 15,000 BTU	9.5
PTHP, < 7,000 BTU	11.9
PTHP, 7,000-15,000 BTU	14.0 - (0.300 x Cap/1000)
PTHP, > 15,000 BTU	9.5
Chilled Water Fan Coil Unit	12.5

Table 21.4.2 Heating System COP (Ref. 1)

PTAC, All Sizes	1
PTHP, < 7,000 BTU	3.3
PTHP, 7,000-15,000 BTU	3.7 - (0.052 x Cap/1000)
PTHP, > 15,000 BTU	2.9
Hot Water PTAC or Fan Coil Unit	0.8

References:

1. State of Minnesota Technical Reference Manual, Version 4.0. Commercial HVAC - Guest Room Energy Management Controls.
2. CO 21.0 HVAC Cooling file, EFLH Summary Tables tab.
3. CO 23.0 HVAC Heating file, EFLH Calc. tab.

Changes from Recent Filing:

1. New measure added based on the 2022 Xcel Energy Management Systems Evaluation. .

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

21.3 Rooftop DCV

Algorithms

$$Customer\ kWh\ Cooling\ Savings = \left((4.5 * CFM_{pre} * \Delta h) * \left(EFLH_{cool} * \frac{1}{EER} \right) * \frac{SF_C}{1000} * Quantity \right)$$

$$Customer\ Dth\ Savings = \frac{1.08 * CFM_{pre} * HDD65 * Hours}{1,000,000} * SF_H * Quantity$$

$$Incremental\ Cost = 1.32 * CFM_{pre} * Quantity$$

Variables

CFM_pre	Calculated	Constant outside air flow in CFM.
Δh	See table 21.1.3	Difference in enthalpy (Btu/lbm) between the design day outside air conditions and the return air conditions.
EFLH_cool	See table 21.2.3	Equivalent full load cooling hours based on building type
EER	10.9	Energy efficiency ratio of the existing equipment.
HDD65	See table 21.1.3	Heating Degree Days
SF_C	See table 21.2.3	Deemed cooling savings factor based upon building type
SF_H	See table 21.2.3	Deemed heating savings factor based upon building type
η	0.8	Efficiency of heating equipment
Conversion factor	1.08	Conversion factor for flow rate and specific volume of air
Conversion factor	4.5	Conversion factor for BTU, flow rate and specific volume
Conversion factor	1,000,000	Conversion factor for BTU to Dth
Measure Life	15	Life of a new unit, in years
Incremental Cost	See table 21.1.3	\$/CFM

Customer Inputs

M&V Verified

Quantity Proposed Equipment (Qty.)	Yes	Quantity of HVAC units is usually the same as number of hotel/motel rooms.
Size (tons)	Yes	The equipment capacity in tons.
Building Type (Facility Type)	Yes	
Zone	Yes	Zone 1, 2, or 3
CRM_pre (CFM)	Yes	Constant outside airflow in CFM
Hours	Yes	Average hours per day of operation

Table 21.1.3 Enthalpies, heating degree days and incremental costs

Zone	Design Cooling h (Btu/lbm) (Ref. 2)	Cooling Return h (Btu/lbm) (Ref. 1)	HDD65 (deg. F - days) (Ref. 2)	Incremental Cost (\$/CFM) (Ref. 1)
Front Range: #1	31.30	28.36	5,667	1.32
Western: #2	31.70	28.36	5,416	1.32
Mountain: #3	28.60	28.36	8,215	1.32

Table 21.2.3 Cooling and Heating Savings Factors and EFLH_cool per zone in MN by building type

Building Type	SF_C	SF_H	EFLH (w/ Economizer) (Ref. 3)		
			Zone 1	Zone 2	Zone 3
Full Service Restaurant	0.34	0.62	1037	1224	502
Hospital	0.34	0.40	1446	1663	813
Large Office	0.15	0.28	1387	1623	726
LargeHotel	0.15	0.18	1005	1132	614
Medium Office	0.15	0.28	688	799	388
Outpatient Healthcare	0.29	0.34	1358	1507	886
Primary School	0.34	0.63	711	837	395
Quick Service Restaurant	0.34	0.62	920	1093	402
Secondary School	0.34	0.63	1390	1570	856
Small Hotel	0.15	0.18	586	656	364
Small Office	0.15	0.28	586	656	364
Stand-alone Retail	0.34	0.62	873	1000	537
Strip Mall	0.34	0.62	763	865	457
Warehouse (non-refrigerated)	0.31	0.36	112	156	58
Other/Miscellaneous	0.30	0.51	919	1056	526

References:

1. State of Minnesota Technical Reference Manual, Version 4.0. Commercial HVAC - Demand Control Ventilation
2. 2021 ASHRAE Climatic Design Conditions for Colorado
3. Table 21.0.1 Equivalent Full Load Hours (Cooling) by Building Type

Changes from Recent Filing:

1. New measure added based on the 2022 Xcel Energy Management Systems Evaluation.

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Table 21.0.1 Equivalent Full Load Hours (Cooling) by Building Type				
	County/Zone	CO1	CO1	CO1
	System Type	Front Range EFLH	Front Range EFLH w/ Economizer	Front Range EFLH Hydronic System
Building Type / Market Segment				
Data Center	Data CenterCO1	8760	8760	8760
Full Service Restaurant	Full Service RestaurantCO1	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 HealthcareCO1	2469	1358	2662
Primary School	Primary SchoolCO1	948	711	1142
Process Load	Process LoadCO1	5840	5840	5840
Quick Service Restaurant	Quick Service RestaurantCO1	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-refrigerated)CC	129	112	765

	County/Zone	CO2	CO2	CO2
	System Type	Western Slope EFLH	Western Slope EFLH w/ Economizer	Western Slope EFLH Hydronic System
Building Type / Market Segment				
Full Service Restaurant	Full Service RestaurantCO2	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 HealthcareCO2	2536	1507	2711
Primary School	Primary SchoolCO2	1048	837	1226
Quick Service Restaurant	Quick Service RestaurantCO2	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-refrigerated)CC	170	156	847
Process Load	Process LoadCO2	5840	5840	5840
Data Center	Data CenterCO2	8760	8760	8760

	County/Zone	CO3	CO3	CO3
	System Type	Mountain EFLH	Mountain EFLH w/ Economizer	Mountain EFLH Hydronic System
Building Type / Market Segment				
Full Service Restaurant	Full Service RestaurantCO3	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 HealthcareCO3	2109	886	2621
Primary School	Primary SchoolCO3	691	395	941
Quick Service Restaurant	Quick Service RestaurantCO3	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-refrigerated)CC	83	58	577
Process Load	Process LoadCO3	5840	5840	5840
Data Center	Data CenterCO3	8760	8760	8760

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Recommended System Type by Equipment Type

Equipment Type	Table 12.0.2. System Type
Rooftop Units (RTUs) <5.4 tons	EFLH
Rooftop Units (RTUs) >5.4 tons	EFLH w/Economizer
Mini Split System	EFLH
PTAC	EFLH
Water Cooled Chiller	Hydronic System
Water Source Heat Pump	Hydronic System
Air Cooled Chiller	Hydronic System

Heating Equivalent Full Load Hours	Zone	EFLH_{Heat}
CO1: Denver / Front Range	CO1	950
CO2: Grand Junction / Western Slope	CO2	950
CO3: Alamosa / Mountain is climate zone	CO3	950

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
- * WSHP's will use Non-Economizer hours for all projects.
- * RTU's that are less than 5.4 tons will use Non-Economizer hours for all projects.
- * Air Cooled Chillers and RTU's will use Hydronic System hours for all projects.
- * PTAC's will use Non-Economizer Small Hotel hours for all projects.