

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Product: Cooling Efficiency - Direct-Evaporative Pre-cooling for Air-Cooled Condensers (DEPACC)

Prescriptive rebates will be offered for Direct Evaporative Pre-cooling Technology for Air Cooled Condensers (DEPACC) for Rooftop Units (RTU) for retrofit installations.

Algorithms:

Seasonal Energy Efficiency Ratio (SEER)	=cooling output in Btu (British thermal unit) during a typical cooling-season divided by the total electric energy input in watt-hours during the same period=Btu/Wh
Energy Efficiency Ratio	= Seasonal Energy Efficiency Ratio x 0.85
kW/ton	= 12 / Energy Efficiency Ratio
Cooling Electrical Energy Savings (Customer kWh)	= Tons x EFLH x kW_per_ton_Eff_Avg * EFLH Factor
EFLH Factor	= DEPACC_Operating_Hours_Office / EFLH for Front Range Office. See Table 2.
Cooling Electrical Demand Savings (Customer kW)	= Tons x kW_per_ton_Eff_Peak
Incremental O&M Cost	= Incremental_O&M_Cost_Factor * EFLH/ EFLH for Front Range Office. See Table 2.
Electrical Energy Savings (Gross Generator kWh)	= Customer kWh / (1-TDLF)
Electrical Demand Savings (Gross Generator kW)	= Customer kW x CF / (1-TDLF)
Electrical Energy Savings (Net Generator kWh)	= Gross Generator kWh x NTG
Electrical Demand Savings (Net Generator kW)	= Gross Generator kW x NTG

Variables:

Size	= Refers to the size of the existing rooftop unit that will use pre-cooling for air-cooled condensers on DX units. The equipment capacity in tons, provided by customer
EFLH	= 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.
kW_per_ton_Eff_Avg	= 0.244 kW/ ton Efficiency improvement of incumbent air-cooled condensers in kW per ton resulting from installation of condenser evaporative pre- cooler averaged for annual cooling hours.

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

DEPACC_Operating_Hours_Office	= 1574 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	= 0.483 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: 1% design temperatures @ DIA = 92°F DB and 60°F WB
Measure Life	Measure life is taken at 20 years for all prescriptive cooling equipment. (Reference 2). Custom measure lifetime derived from past projects.
CF	Coincidence Factor = the probability that peak demand of the equipment will coincide with peak utility system demand= 90%
TDLF	=Transmission-Distribution (Demand) Loss Factor = 6.50%, the percentage loss of electricity as it flows from the power plant to the customer during peak system demand. (The Transmission Distribution Loss Factor for Demand)
NTG	Net-to-gross = 95% This measure is not widely used or installed currently in the CO market per information from manufacturers
Incremental_O&M_Cost_Factor	Factor used to calculate Incremental annual Operations and Maintenance cost by segment; Estimated at \$1.98 average cost per ton per year of water usage for front range office.
Baseline Cost of Equipment	= \$0 because the baseline option is to do nothing.
Incremental Cost of Equipment	The incremental cost of equipment above the code requirements, typically expressed on a dollar per ton basis.
Tons	Tons of cooling shown on the rated faceplate of the existing cooling equipment.
Baseline kW/ton	1.17 kW/ton based on modeled unit at Denver design conditions.

Provided by Customer:

Cooling equipment type
Climate zone
Building type
Cooling equipment size (tons)

Verified during M&V:

Yes
Yes
Yes
Yes

Assumptions:

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

- To convert equipment from a Seasonal Energy Efficiency Ratio (SEER) to an Energy Efficiency Ratio (EER), multiply SEER by 0.85. The conversion factor of 0.85 is a generally accepted factor for converting from SEER to EER. Once EER is obtained, convert EER to kW/ton using the following equation: $\text{kW/ton} = 12/\text{EER}$. To convert kW/ton to kW, multiply by tons.
- Average size unit to be 150 tons
- Qualifying evaporative cooling units must have a minimum Media Saturation Effectiveness of 85% and above. The units must be installed with 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 due to media decreasing condenser fan cfm.
- Denver Water 2013 estimated rates <http://www.denverwater.org/BillingRates/RatesCharges/2013ApprovedRates/> at \$4.50/1000 gal
- DEPACC manufacturer's estimate of water consumed by the evaporative pre-condensing system .28 gallons per tonHr of cooling

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Table 2. Equivalent Full Load Hours by Building Type - Market segment hours scaled from Minnesota Department of Commerce, Division of Energy Resources (DER) data (Reference 2) with Office value calculated for Denver and Grand Junction Typical Meteorological Year data. Distributions developed from CBECS data (Reference 1). This is not applicable to Data Centers

Building Type	Front Range EFLH	Western Slope EFLH	EFLH Factor Front Range	EFLH Factor Western Slope	O&M Cost Front Range, \$/ton-yr	O&M Cost Western Slope, \$/ton-yr
Education - Community College	725	844	1.43	1.23	1.30	1.52
Education - Secondary School	456	531	1.43	1.23	0.82	0.96
Education - University	981	1,142	1.43	1.23	1.77	2.05
Health/Medical - Clinic	833	969	1.43	1.23	1.50	1.74
Health/Medical - Hospital	1,616	1,880	1.43	1.23	2.91	3.38
Lodging	1,356	1,578	1.43	1.23	2.44	2.84
Office	1,102	1,283	1.43	1.23	1.98	2.31
Retail	975	1,135	1.43	1.23	1.75	2.04

EFLH*- Zone 1 (Front Range/Denver) and Zone 2 (Western State as represented by Grand Junction)

Table 3. Incremental Cost (Ref 3)

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

Notes:

Ref files: (Large computer files available for reference) (Ref 3)
 Xcel DEPACC Notes 111312 R2.docx
 EproModel 150ksf OfficeData Center 010313REV 7.xlsx
 EnergyPro http://www.energysoft.com/main/page_energypro_ep_information.html
 EnergyPRO User's Manual, EnergyPro Version 5 by EnergySoft, LLC July 2011 p. 120

References

1. CBECS (Commercial Buildings Energy Consumption Survey), 2003 - Total Floor space of Cooled Buildings by Principal Building Activity - source of market segment distributions

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

2. Minnesota Department of Commerce, Division of Energy Resources (DER)
3. Cypress, Ltd.
4. Plumbing Code 1985 ASHRAE Handbook
5. Reference Source: http://www.engineeringtoolbox.com/us-outdoor-design-temperature-humidity-d_296.html

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

|