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) and air-cooled chillers 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 (Ref 4)
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 EFLH_Factor x kW_per_ton_Eff_Avg
Cooling Electrical Demand Savings (Customer kW)	= Tons x kW_per_ton_Eff _Peak
Incremental O&M Cost	= Incremental_O&M_Cost_Factor x EFLH x EFLH_Factor x Tons
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:

kW_per_ton_Eff_Avg	= 258 kWh/ ton / 1574 DEPACC_Operating_Hours_Office = 0.164 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.
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.
EFLH Factor	= DEPACC_Operating_Hours_Office / EFLH for Front Range Office = 1.424
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	= 0.328 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

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Measure Life	Measure life is taken at 20 years for all prescriptive cooling equipment. (Reference 2). Custom measure lifetime derived from past projects.
Incremental_O&M_Cost_Factor	= ($1.98 / Ton) / 1574 DEPACC Hours = $0.0012579 / ton-hour 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	= Tons x Incremental cost of DEPACC equipment from Table 3. Table 3 is expressed on a cost per ton basis.
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.
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.
CF	Coincidence Factor = the probability that peak demand of the equipment will coincide with peak utility system demand= 90%
TDLF	=Transmission-Distirubtion (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 = 80% to align with the Cooling Efficiency Program.

Provided by Customer:	**Verified during M&V:**
Cooling equipment type	Yes
Climate zone	Yes
Building type	Yes
Cooling equipment size (tons)	Yes

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 a generally accepted factor for converting from SEER to EER. Once EER is obtained, convert EER to kW/ton using the following equation: kW/ton = 12/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 75% 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 condensor 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

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 (Ref 1). ~~This is not applicable to Data Centers~~

Building Type	Front Range EFLH	Western Slope EFLH	Mountain EFLH	EFLH Factor Front Range	EFLH Factor Western Slope	O&M Cost Front Range, $/sq ft-yr	O&M Cost Western Slope, $/sq ft-yr
Education - Community College	725	844	449	1.42	1.21	1.39	1.52
Education - Secondary School	456	531	282	1.42	1.22	0.82	2.95
Education - University	981	1,142	607	1.41	1.21	1.77	2.05
Health/Medical - Clinic	833	969	515	1.42	1.23	1.50	1.74
Health/Medical - Hospital	1,616	1,880	999	1.42	1.23	2.91	3.26
Lodging	1,356	1,578	839	1.42	1.23	2.44	2.84
Office	1,102	1,283	682	1.42	1.23	1.98	2.31
Retail	975	1,135	603	1.42	1.23	1.75	2.04
Data Centers	8,760	8,760	8,760				
Process Loads	5,840	5,840	5,840				

EFLH*- Zone 1 (Front Range/Denver) and Zone 2 (Western State as represented by Grand Junction) and Zone 3 (Mountain Areas as represented by Alamosa)

Table 3. Incremental Cost (Ref 3)

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

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

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