DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Program: 2011 CO Evaporative Cooling Deemed Savings (60 Day Notice)

Prescriptive rebates will be offered for the purchase and installation of evaporative coolers. Three tiers of rebates are offered based on the Evaporative Efficacy of the unit and the type of media. The rebates and analyses are based on a nominal 3 ton cooling load. Tier 1 units are standard efficiency evaporative coolers. Tier 2 units are high efficiency evaporative coolers (see assumptions for details). Tier 3 is an integrated HVAC system rebate that compares the "whole house" conventional HVAC with an integrated heating and evaporative cooling system in new homes or homes with major remodeling. Credit will be calculated based on the number and type of units installed, the type of the existing unit and **the location of the home**

Algorithms:

Tier 1: **13 SEER 3 Ton** to Tier 1 evap cooler savings:

Energy Savings (Customer kWh) **Front Range**	= **13 Seer 3 Ton** - Tier 1 Evaporative cooling energy = **(1,358 - 403) kWh = 955 kWh**
Demand Savings (Customer kW) **Front Range**	= **13 Seer 3 Ton** - Tier 1 Evaporative cooler demand = **(3.220 - .388) kW =2.83 kW**
Energy Savings (Customer kWh) **Western Slope**	= **13 Seer 3 Ton** - Tier 1 Evaporative cooling energy = **(1,581 - 485) kWh = 1,096 kWh**
Demand Savings (Customer kW) **Western Slope**	= **13 Seer 3 Ton** - Tier 1 Evaporative cooler demand = **(3.220 - .388) kW = 2.83 kW**

Tier 2: **13 SEER 3 Ton** to Tier 2 evap cooler savings:

Energy Savings (Customer kWh) **Front Range**	= **13 Seer 3 Ton** - Tier 2 Evaporative cooling energy = **(1,358 - 403) kWh = 955 kWh**
Demand Savings (Customer kW) **Front Range**	= **13 Seer 3 Ton** - Tier 2 Evaporative cooler demand = **(3.220 - .388) kW =2.83 kW**
Energy Savings (Customer kWh) **Western Slope**	= **13 Seer 3 Ton** - Tier 2 Evaporative cooling energy = **(1,581 - 485) kWh = 1,096 kWh**
Demand Savings (Customer kW) **Western Slope**	= **13 Seer 3 Ton** - Tier 2 Evaporative cooler demand = **(3.220 - .388) kW = 2.83 kW**

Tier 3: **13 SEER 3 Ton** HVAC to Integrated Evap Cooler

Energy Savings (Customer kWh) **Front Range**	= **13 Seer 3 Ton** - Whole house evap energy = **(1,358 - 791) kWh = 567 kWh**
Demand Savings (Customer kW) **Front Range**	= **13 Seer 3 Ton** - Whole house evap demand =**(3.220 - .760) kW = 2.46 kW**
Energy Savings (Customer kWh) **Western Slope**	= **13 Seer 3 Ton** - Whole house evap energy = **(1,581 - 952) kWh = 629 kWh**
Demand Savings (Customer kW) **Western Slope**	= **13 Seer 3 Ton** - Whole house evap demand = **(3.220 - .760) kW = 2.46 kW**

Electrical Energy Savings (Gross Generator kWh)	= Customer kWh / (1-TDLF)
Electrical Demand Savings (Gross Generator kW)	=Cust_kW * 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:

13 Seer 3 Ton A/C energy	=Energy use of 13 SEER 3 Ton AC unit = **1,358kWh - Front Range**: **1,581kWh - Western Slope**
13 Seer 3 Ton A/C demand	=Demand of **13 SEER 3 Ton** AC unit = **3.22 kW**
Tier 1 Evaporative cooler energy	= Motor HP x 0.746 x Load Factor / Motor Eff x OpHr = **403 kWh Front Range, 485 kWh Western Slope**
Tier 1 Evaporative cooler demand	= Motor HP x 0.746 x Load Factor / Motor Eff = **0.388 kW**
Tier 2 Evaporative cooler energy	= Motor HP x 0.746 x Load Factor / Motor Eff x OpHr = **403 kWh Front Range, 485 kWh Western Slope**
Tier 2 Evaporative cooler demand	= Motor HP x 0.746 x Load Factor / Motor Eff = **0.388 kW**
Tier 3 Evaporative cooler energy	= Motor HP x 0.746 x Load Factor / Motor Eff x OpHr = **791 kWh Front Range, 952 kWh Western Slope**
Tier 3 Evaporative cooler demand	= Motor HP x 0.746 x Load Factor / Motor Eff = **0.760 kW**

Ref_air_energy	= Modeled hourly energy use of home with 3 ton 13 SEER standard AC unit in Denver using ESPRE. =**Front Range 1,358 kWh** (Reference 1) & **Western Slope 1,581 kWh**
Ref_air_demand	= Btuh/EER x 1000. We will use 3.22 kW (Reference 2)
MotorHP	**Motor Horsepower - We will use 0.52 hp for tier 1 units. We will use 0.52 hp for tier 2 units and 1.02 Hp for tier 3 units represent the motor size for an evaporative cooler which corresponds to the cooling output of a 3 ton AC unit. (Reference 5)**
0.746	Standard conversion from HP to kW
Load Factor	Load factor for motor - We will use 80% for tier 1 and 80% on high and 10% on low for tier 2.
Motor Eff	Efficiency of the evaporative cooler motor - We will use 80% (Reference 3)
CF_AC	= Coincidence factor for the refrigerated air system, the probability that peak demand of the AC unit will coincide with peak utility system demand. **0.7** will be used. **(Reference 5)**
OpHr	**Operating hours of the evaporative cooler fan motor - We will use 1040 for Front Range and 1251 for Western Slope from Cadmus recommendations (Reference 5)**
TDLF	Transmission Distribution Loss Factor = **7.69**%, the percentage loss of electricity as it flows from the power plant to the customer, calculated using factors from Enhanced DSM Filing SRD-2
NTG	**Net-to-Gross Factor = We will use 52% for tier 1 evaporative cooling, and 59% for tier 2 and 100% for tier 3. (Reference 5)**
Incremental Costs	= Incremental cost of efficient technology over baseline technology. Values listed in Table 1
O&M savings	= Operation and Maintenance savings related to water use are listed in Table 2.
Measure Life	**= 15 years (Reference 5)**

Table 1. Incremental Cost of Evaporative Coolers (Reference 6,7,8)

		Baseline	HE Cost	Incremental
Tier 1	**13 Seer AC to Evap**	**4,329**	**1,022**	**-3,307.00**
Tier 2	**13 SEER AC to HE Evap**	**4,329**	**1,989**	**-2,340.00**
Tier 3	**13 SEER AC to Whole House Evap**	**4,329**	**7,542**	**3,213.00**

Table 2. Operation and Maintenance Savings (Reference 9)

Base System	New System	O&M Savings
13 Seer 3 Ton A/C	Standard Evap Cooling (Tier 1)	**$ (10.26)**
13 Seer 3 Ton A/C	High Efficient Evap Cooling (Tier 2)	**$ (6.77)**
13 Seer 3 Ton A/C	**Integrated whole house evap cooling (Tier 3)**	$ (6.77)

Provided by Customer:
Type of unit installed (Tier 1 or Tier 2) or installation type (Tier 3).

Verified during M&V
Yes

Assumptions:
The installed unit is assumed to have a 3/4 hp motor (commonly available unit).
Qualifying equipment must be new and be a permanently installed direct (Tier 1 or 2), indirect or two-stage evaporative cooling unit. Portable coolers or systems with vapor compression equipment are not eligible, nor is used or reconditioned equipment.
Tier 1: Qualifying evaporative cooling units must have a minimum Industry Standard Rated airflow of 2,500 CFM

Tier 2: Qualifying evaporative cooling units must meet tier 1 requirements and additionally have a minimum Media Saturation Effectiveness of 85%. The units must be installed with a remote thermostat and a periodic purge water control.
Tier 3: Integrated HVAC system rebate that compares the "whole house" conventional HVAC with an integrated heating and evaporative cooling system in new homes or homes with major remodeling. Tier 3 evaporative cooling units must be indirect or indirect/direct combination units. Units utilizing only direct cooling units do not qualify for Baseline equipment in the incremental analysis was revised to accurately reflect the alternatives that customers consider when installing evaporative air conditioning compared to refrigerated air conditioning

The technical assumptions for the Evaporative Cooling Rebate product were developed assuming that a standard 13 SEER central air conditioning system was replaced or displaced by either a standard evaporative cooling system or a high efficiency evaporative cooling unit with the same capacity. These units have a measure life of 10 years. The NTG for the Tier 1 evaporative coolers is 59.7%. This was determined in the 2006 Summit Blue Consulting report. The NTG for the Tier 2 evaporative coolers is assumed to be 100% due to the low market participation. The average of these two numbers (80%) will be used for the Evaporative Cooling Rebate product.

Changes from 2011:

Per Cadmus the HP for evap coolers should be as follows: .52HP for Tier 1/ Tier 2 and 1.02 HP for Tier 3
Added Western Slope as a location along with its weather data
Moved to a 3 Ton 13Seer baseline for all tiers
Moved from 10 to 15 year life on all tiers
Per Cadmus review the CF was changed to .7
Per Cadmus review the NTG was changed .52 for tier 1, and .59 for tier 2, tier 3 remains at 1.0

References:

1. ESPRE 2.1 engineering model: Simplified energy analysis methods for residential buildings
2. Building America, Research Benchmark Definitions, Pg 9, http://www.eere.energy.gov/buildings/building_america/pdfs/37529.pdf
3. Average motor efficiency for 0.75 hp motor from NEMA, http://www.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/small_motors_tsd.pdf
4. Kinney, Larry. New Evaporative Cooling Systems: An Emerging Solution for Homes in Hot Dry Climates with Modest Cooling Loads. SWEEP 2007
5. 2010 Cadmus program review
6. Baseline 13 SEER 3 ton unit costs from a survey of vendors by Xcel in 2011
7. http://www.google.com/products?q=home+depot+evaporative+cooler+cost&ie=UTF-8&oe=utf-8&rls=org.mozilla:en-US:official&client=firefox-a&um=1&sa=X&oi=product_result_group&resnum=1&ct=title
8. http://www.toolbase.org/TechInventory/techDetails.aspx?ContentDetailID=750: "A two-stage evaporative cooler with a cooling capacity equivalent to a three-ton conventional system retails for about $1,800." The California Energy Commission states that installation costs are equivalent to refrigerated air systems, so only equipment cost is included in this analysis (http://www.consumerenergycenter.org/home/heating_cooling/evaporative.html: "Installation costs of swamp coolers are comparable to air conditioning units").
9. SWEEP 2007 Report. O&M Savings based on manufacturers water use data and an assumed $3.82/thousand gallons cost for water (Denver Water Board).
10. ASHRAE Applications 2007 p.36.3 Used AC window unit as estimate for evaporative cooler.