DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Product: Heating Efficiency - CO

Description:

Prescriptive Gas rebates will be offered for Hot Water Boilers (~~Condensing and~~ non-condensing), Commercial Water Heaters and various heating system improvements, high efficiency furnaces,high efficiency unit heaters that are either: power vented (83% efficiency), ~~condensing (>= 90% efficiency)~~, or low-intensity tube radiant heaters. ~~Electric rebates will be offered for furnaces with ECM fans, both for new furnaces and for retrofitting existing furnaces.~~

Program References:

Measures for all Direct Install - Pre Rinse Sprayer	Refer to the "Commercial Refrigeration Efficiency-CO" program for assumptions and formulas for savings .
Measures for all Direct Install - Direct Install - Faucet Aerator	Refer to the "Commercial Refrigeration Efficiency-CO" program for assumptions and formulas for savings .

Gas Savings Algorithms:

Boiler	
New High Efficiency Boiler Savings (Gross Dth)	= Input Capacity x Alt x ((EFFh - Adj) / EFFb) - 1) x EFLH
Boiler Tune Up savings (Gross Dth)	= Input Capacity x Alt x ((EFFh / EFFb) - 1) x EFLH
Outdoor Air Reset savings (Gross Dth)	= Input Capacity x Alt x (1 - (EFFb / EFFh)) x EFLH
Stack Dampers savings (Gross Dth)	= Input Capacity x Alt x (1 - (EFFb / EFFh)) x EFLH
Modulating Burner Controls savings (Gross Dth)	= Input Capacity x Alt x (1 - (EFFb / EFFh)) x EFLH
O2 Trim Control savings (Gross Dth)	= Input Capacity x Alt x (1 - (EFFb / EFFh)) x EFLH
New Commercial Furnace	
New High Efficiency Furnace Savings (Gross Dth)	= Input Capacity x Alt x ((EFFh / EFFb) - 1) x Heat_EFLH/ 1,000,000
Steam Traps	
Steam Traps savings (Gross Dth)	= Leak_Rate x Leak_Hours x BTU_per_Pound / EFFb / 1,000,000
New Water Heater	
New Water Heater Savings (Dth)	=(Input Capacity x Alt x ((EFFh / EFFb) -1) x EFLH + ((SLb/EFFb) -(SLe / EFFh)) x SLHrs) / 1,000,000
Pipe Insulation	
Pipe Insulation Savings (Dth)	= LF x Hrs x (BTU_per_foot_U - BTU_per_foot_I) x Existing / EFFb
BTU_per_Foot_U	= Heat loss per foot of uninsulated pipe '= [Coef0 + (Coef1 x DeltaT) + (Coef2 x DeltaT^2) + (Coef3 x DeltaT^3)] 'where the coefficients are selected based on the pipe size and an insulation thickness (both provided by customer). 'Coefficient values are listed in Table 7.
BTU_per_Foot_I	= Heat loss per foot of insulated pipe '= [Coef0 + (Coef1 x DeltaT) + (Coef2 x DeltaT^2) + (Coef3 x DeltaT^3)] 'where the coefficients are selected based on the pipe size (provided by customer) and an insulation thickness of zero. 'Coefficient values are listed in Table 7.
DeltaT	= (Tfluid - Tambient)

Unit Heaters	
Unit Heater Savings (Dth)	= Input Capacity x Alt x ((EFFh / EFFb) - 1) x EFLH-UH x (Oversize Factor_heat) / 1,000,000
Infrared Heater Savings (Dth)	= Dth_Base_Infrared - Dth_Eff_Radiant
Dth_Base_Infrared	= ((Infrared Input Capacity x Alt) / Radiation Size Factor) x (Oversize Factor_heat) x EFLH-UH x (1 Dth / 1000000 BTU) - Dth_fan
Dth_Eff_Radiant	= Infrared Input Capacity x Alt x Oversize Factor_heat x EFLH-UH
EFLH-UH	= (HDD_a x T_indoor ^2 - HDD_b x T_indoor + HDD_c) / (T_indoor - T_design) x 24 x %conditioned
FLH	= (HDD_a x T_indoor ^2 - HDD_b x T_indoor + HDD_c) / (T_indoor + T-Offset) x 24 x %conditioned.
Dth_fan	= Fan_kW x 3412 x FLH / 1,000,000 (For Infrared Unit Heater Measure only)
Ozone Laundry	
Ozone Laundry Natural Gas Savings (Gross Therms)	= (HW_e ÷ WH_{Eff}) X W_{utiliz} X Wusage_hot X % Hot_Water_Savings
Ozone Laundry Water Savings (Gross Gallons)	= W_{usage} x W_{utiliz} x % Water_Savings
Ozone Laundry O&M Savings	(Ozone Laundry Water Savings X (Water Rate + Sewer Rate) ÷ 1000) - (O&M Cost X Lb capacity of washing machine)

Electric Savings Algorithms:

~~EC Fan Motor on Commercial Furnace~~	
~~EC Fan Savings Customer kWh~~	~~=(Heating_kW_PSC - Heating_kW) x Heat_EFLH + (Cooling_KW_PSC -Cooling_kW) x Cool_EFLH + (Ventilation_kW_PSC - Ventilation_kW) x Ventilation_Only_Hours + Cooling_kWh_Savings~~
~~EC Fan Savings Customer kW~~	~~= Customer kWh / Op_Hrs~~
~~Cooling_kW_Savings~~	~~= (New_Furnace-Fan_Motor_HP) x (kW/ton x (Cooling_kW_PSC - Cooling_kW) x 3.413 / 12)~~
~~Cooling_kWh_Savings~~	~~= Cooling_kW_Savings x Cool_EFLH~~
~~Peak Coincident KW~~	~~= Customer kW X ECM Coincidence Factor~~
~~Heating Penalty~~	~~= New_Furnace-Fan_Motor_HP x Heating Penalty_per_New_Furnace_Fan_HP~~

Unit Heaters

Fan_kWh (Customer Gross kWh)	= Fan_kW x FLH (For Radiant Unit Heater Measure Only)
Fan_kW (Customer gross kW)	= Infrared Input Capacity x Heat_eff_infrared x Alt / Radiation Size Factor x Oversize Factor_heat x HP/BTUh x 0.746 x LF / Mtr_eff (For Infrared Unit Heater Measure Only)

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Boiler Variables

Variable ID	Value	Description
Alt	Table 1	Altitude Adjustment factor to adjust the sea level manufacturer's rated input for altitude effects
Input Capacity	Customer Input	Rated million BTUH input capacity of the boiler.
Adj		Adjustment for operation at less than nominal efficiency
	~~5%~~	~~Efficiency adjustment for condensing boilers. (Reference 29)~~
	0%	Efficiency adjustment for non-condensing boilers.
EFFb	Table 2	Efficiency of Baseline equipment.
EFFh	Table 2	Minimum Qualifying Efficiency for high efficiency equipment. Actual efficiency provided by the customer.
EFLH	Table 3	The equivalent full load heating hours for the boilers.
Conversion Factor	1,000,000	Conversion from Dth to BTU
Measure Life	Table 14	Refer to Table 14 in "Deemed Measure Life" tab.
Incremental Cost	Tables 7 to 12	Refer to Tables 7 to 12 in the "Deemed Incremental Cost" tab
NTG	86%	Net-to-gross = 86% Per 2011 Cadmus Program Evaluation and Michaels Energy Review.

Steam Trap Variables

Variable ID	Value	Description
Leak_Rate	5	Leakage rate for low pressure steam traps in pounds of steam per hour. (Reference 24)
	11	Leakage rate for high pressure steam traps in pounds of steam per hour. (Reference 24)
Leak_Hours	6,000	Annual hours steam lines are pressurized; Based on estimated of 30% steam systems operate year round, and 70% heating only systems.
EFF_b	80%	Efficiency of Steam boiler.
BTU_Per_Pound	1,064	Loss in btu/lb for Steam Traps in Low Pressure Applications; 1164 BTU per pound lost to atmosphere, 964 BTU per pound lost to condensate; Assume 50/50 mix = 1064 BTU per pound. (Reference 24)
	1,081	Loss in btu/lb for Steam Traps in High Pressure Applications; = 1181 BTU per pound for lost to atmosphere, 981 BTU per pound lost to condensate. Assume 50/50 mix = 1081 BTU per pound. (Reference 24)
Measure Life	Table 14	Refer to Table 14 in "Deemed Measure Life" tab.
Incremental Cost	Tables 7 to 12	Refer to Tables 7 to 12 in the "Deemed Incremental Cost" tab
NTG	86%	Net-to-gross = 86% Per 2011 Cadmus Program Evaluation and Michaels Energy Review.

Water Heater Variables

Alt	Table 1	Altitude Adjustment factor to adjust the sea level manufacturer's rated input for altitude effects
Input Capacity	Customer Input	Rated BTUH input capacity of the hot water heater.
EFFh	Customer Input	The rated efficiency of the new water heater.
EFFb	80%	The minimum water heater thermal efficiency allowed by the federal standard
SLb	13.21	Standby Losses for baseline storage water heater in BTUH per gallon of storage. (Reference 23)
Sle	8.90	Standby Losses for efficient storage water heater in BTUH per gallon of storage. (Reference 23)
SLHrs	8,760	Standby loss annual hours for commercial water heaters.
EFLH	Table 3	Refrence: MN historical custom rebate projects
Measure Life	Table 14	Refer to Table 14 in "Deemed Measure Life" tab.
Incremental Cost	Tables 7 to 12	Refer to Tables 7 to 12 in the "Deemed Incremental Cost" tab
NTG	86%	Net-to-gross = 86% Per 2011 Cadmus Program Evaluation and Michaels Energy Review.

Pipe Insulation Variables

LF	Customer Input	Linear feet of insulation installed, provided by the customer.
Hrs	Table 4	Annual pipe heat loss hours
T_{fluid}	Customer Input	Average temperature of the fluid in the pipe receiving insulation in degrees F.
Pipe location	Customer Input	Ask the customer if the pipe is in a conditioned space or outside.
Pipe use	Customer Input	Ask customer if the steam/hotwater is used for Space heating + Domestic Water Heating, Space Heating Only, Domestic Water Heating Only.
$T_{ambient}$	70	Pipe located inside conditioned space and used for space heating and/or domestic hotwater
	51	Pipe located outside and used for spaceheating and/or domestic hot water. Based on full year average TMY3 temperatures for Colorado. Reference 10
	44	Pipe located outside and used for space heating only, average temperature excluding June-September based on TMY3 temperatures for Colorado. Reference 10
Was existing insulation replaced	Customer Input	Yes/No - Replacing existing deteriorated pipe insulation or Adding new insulation to existing bare pipe
Existing	1	Pipe insulation savings multiplier if no existing insulation is present.
	0.25	Pipe insulation savings multiplier if existing deteriorated insulation is being replaced.
Measure Life	Table 14	Refer to Table 14 in "Deemed Measure Life" tab.
Incremental Cost	Tables 7 to 12	Refer to Tables 7 to 12 in the "Deemed Incremental Cost" tab
NTG	86%	Net-to-gross = 86% Per 2011 Cadmus Program Evaluation and Michaels Energy Review.

Unit Heater Variables

Input capacity	Customer Input	Rated Input Capacity of the new non-infrared heater in BTU/h
Infrared Input Capacity	Customer Input	Rated Input Capacity of the new infrared heater in BTU/h
Alt	Table 1	Altitude Adjustment factor to adjust the sea level manufacturer's rated input for altitude effects
%conditioned	Customer Input	Percentage of the time during heating season the space is heated
T_indoor	Customer Input	Space temperature set point of space being heated
HP/BTUh	2.9683E-06	Average axial/propeller/centrifugal fan power (rated) per BTU/h of heating output. Taken from manufacturer data for 38 unit heaters from Trane and Sterling; Applies to Infrared Heaters only
Oversize Factor_heat	0.90	Factor to account for design oversize commonly found on unit heater installations. Reference 1
T_design	Table 5	Winter Design temperature for the given location. Reference 2.
LF	0.80	Design load factor of fan motor, deemed based on typical engineering assumption
EFFb	80%	Thermal efficiency of the baseline, non-power-vented, code-compliant unit heater. Reference 3.
EFFh	Table 2	Thermal efficiency of the new, efficient unit heater
EFLH	Table 3	The equivalent full load heating hours for unit heaters.
Heat_eff_infrared	80%	Thermal efficiency of the new, radiant heater. = 0.80, same as baseline because the radiant heaters do not have specific combustion efficiency improvements over the baseline unit heater, their savings are all from radiation heat transfer versus convection. Also, Ref 5 uses this value.
Radiation Size Factor	0.85	= Factor to account for the fact that radiant heaters should be designed smaller than an equivalent standard unit heater due to radiation heat transfer being more effective at producing thermal comfort. This also accounts for the lower room temperature afforded by radiant heaters. = 0.85 (Ref 4)
HDD_a	Table 5	Polynomial Constants used in calculating HDD based on TMY3 weather data and design indoor temperature. HDD is proportional to the indoor temperature based on the formula HDD = a * Tin^2 + b * Tin + c
HDD_b	Table 5	Polynomial Constants used in calculating HDD based on TMY3 weather data and design indoor temperature. HDD is proportional to the indoor temperature based on the formula HDD = a * Tin^2 + b * Tin + c
HDD_c	Table 5	Polynomial Constants used in calculating HDD based on TMY3 weather data and design indoor temperature. HDD is proportional to the indoor temperature based on the formula HDD = a * Tin^2 + b * Tin + c
T-Offset	Table 5	Difference between the maximum heating degree day and the indoor design temperature. See Table 5 for values in each climate zone.
Mtr_eff	29.58%	Average efficiency of 6 unit heater fans, calculated by taking the manufacturer-provided (Reznor, Sterling, and Trane) current draw to calculate power consumption and working backwards with the rated motor power and an assumed load factor of 0.8 to compute the efficiency for each fan and then taking the average of all of the fans. = 0.296 and includes both axial and centrifugal fans.
Conversion Factor	0.746	Conversion factor from HP to kW
Conversion Factor	1,000	Conversion factor from kBTU/h to BTU/h
Conversion Factor	3,412	Conversion factor from kW to BTU/h
Measure Life	Table 14	Refer to Table 14 in "Deemed Measure Life" tab.
Incremental Cost	Tables 7 to 12	Refer to Tables 7 to 12 in the "Deemed Incremental Cost" tab
NTG	86%	Net-to-gross = 86% Per 2011 Cadmus Program Evaluation and Michaels Energy Review.

~~Commercial Furnace Variables~~

~~Input capacity~~	~~Customer Input~~	~~Rated Input Capacity of the new furnace in BTU/h~~
~~New_Furnace Fan_Motor_HP~~	~~Customer Input~~	~~HP of new Furnace Fan ECM~~
~~Heat_EFLH~~	~~Table 6~~	~~Annual Equivalent Full Load Hours (EFLH).~~
~~Occ Hours~~	~~4,439~~	~~Annual operating hours of the space served by the furnace, assumed to be equal to the operating hours of a typical office, as used in the Small Business Lighting Efficiency program~~
~~Op_Hrs~~	~~Table 6~~	~~Combined heating and cooling full load hours occuring during unoccupied hours plus Occ Hours. Calculated using bin hours and the assumed balance point of 57F. This value is location specific. For projects without cooling, this value does not include any cooling full load hours.~~
~~Heating_kW_PSC~~	~~0.707~~	~~Reference 20~~
~~Cooling_kW_PSC~~	~~0.880~~	~~Reference 20~~
~~Ventilation_kW_PSC~~	~~0.747~~	~~Reference 20~~
~~Cool_EFLH~~	~~Table 6~~	~~Annual Equivalent Full Load Hours of the furnace in cooling mode, calculated by estimating building loads based on outdoor conditions and building balance point (balance point set by heating EFLH analysis at 57F)~~
~~Ventilation Only Hours~~	~~Table 6~~	~~Annual Hours of the furnace in ventilation mode, calculated by subtracting the cooling and heating EFLH occuring during occupied hours from Op Hrs.~~
~~kW/ton~~	~~1.105~~	~~Efficiency of air conditioning system, calculated by taking new baseline SEER of 13, dividing by 1.1 to get EER and then taking 12/EER to get kW/ton (1.015)~~
~~Cooling_kW~~	~~0.709~~	~~Reference 20~~
~~Heating_kW~~	~~0.271~~	~~Reference 20~~
~~Ventilation_kW~~	~~0.285~~	~~Reference 20~~
~~Conversion Factor~~	~~3.413~~	~~Conversion from Watts of power to BTU/h of heat~~
~~Conversion Factor~~	~~12,000~~	~~Conversion from BTU/h to tons of cooling~~
~~ECM Coincidence Factor~~	~~Table 6~~	
~~Heating Penalty_ per_ New_ ECM-HP~~	~~Table 6~~	
~~Measure Life~~	~~Table 14~~	~~Refer to Table 14 in "Deemed Measure Life" tab.~~
~~Incremental Cost~~	~~Tables 7 to 12~~	~~Refer to Tables 7 to 12 in the "Deemed Incremental Cost" tab~~
~~NTG~~	~~86%~~	~~Net-to-gross = 86% Per 2011 Cadmus Program Evaluation and Michaels Energy Review.~~

Ozone Laundry Variables		
W_{utiliz} (lbs laundry/yr)	Customer Input	Annual pounds of clothes washed per year
Water Heater Type	Customer Input	Standard Gas Storage WH, Condensing Gas WH, Tankless Gas WH or Plant Gas Boiler with Storage
Lb capacity of washing machine	Customer Input	Lb capacity of washing machine served by ozone generator
% Hot_Water_Savings	81%	How much more efficient is an ozone injection machine as a rate of hot water reduction (Reference 1)
W_{usage} (gal/lb of laundry)	2.03	How efficiently a typical conventional washing machine utilized hot and cold water per unit of clothes washed (Reference 1)
% Water_Savings	25%	How much more efficient an ozone injection washing machine is compared to a typical conventional washing machine as a rate of hot and cold water reduction (Reference 1)
$W_{usage\text{-}hot}$ (gallons/lbs laundry)	1.19	Hot water used by a typical conventional washing machine (Reference 1)
HW_e(Therms/gal)	0.007235	Energy required to make 140F hot water from 51.4 F ground water
Water Rate ($/1000 gal)	$2.60	Reference 32
Sewer Rate ($/1000 gal)	$3.78	Reference 33
Water Heater Thermal Efficiency (WH_{Eff})	Table 7	
O&M Cost ($ per lb capacity of washing machine)	$0.79	Reference 31
$Therm_{baseline}$ / Lb capacity of washing machine	37.90	Reference 31
Measure Life	Table 14	Refer to Table 14 in "Deemed Measure Life" tab.
Incremental Cost	Tables 7 to 12	Refer to Tables 7 to 12 in the "Deemed Incremental Cost" tab
NTG	86%	Net-to-gross = 86% Per 2011 Cadmus Program Evaluation and Michaels Energy Review.

Table 1: Altitude Adjustment factor to adjust the sea level

Climate Zone	Alt
CO1: Denver / Front Range	0.823
CO2: Alamosa / Mountain is climate zone	0.756
CO3 Grand Junction / Western Slope	0.837

Table 2: Heating Equipment Efficiencies

	Baseline Efficiency (EFFb)	Efficient Efficiency (EFFh)	Unit	Reference
New Boilers (Non-Condensing) <300,000 BTU/h	80.0%	85.0%*	AFUE	Ref. 11
New Boilers (Non-Condensing) >= 300,000 BTU/h and <=2,500,000 BTU/h	80.0%	85.0%*	Et (Thermal Eff)	Ref. 11
New Boilers (Non-Condensing) >2,500,000 BTU/h	82.0%	85.0%*	Ec (Combustion Eff	Ref. 11
~~New Boilers (Condensing) <300,000 BTU/h~~	~~80.0%~~	~~92.0%*~~	~~AFUE~~	~~Ref. 11~~
~~New Boilers (Condensing) >= 300,000 BTU/h and <=2,500,000 BTU/h~~	~~80.0%~~	~~92.0%*~~	~~Et (Thermal Eff)~~	~~Ref. 11~~
~~New Boilers (Condensing) >2,500,000 BTU/h~~	~~82.0%~~	~~92.0%*~~	~~Ec (Combustion Eff~~	~~Ref. 11~~
~~Boiler Tune Up (Non-Condensing)~~	~~78.0%~~	~~80.0%~~		~~Ref. 12~~
~~Boiler Tune Up (Condensing)~~	~~87.2%~~	~~88.0%~~		~~Ref. 29~~
Outdoor Air Reset	80.0%	83.0%		Ref. 13
Stack Dampers	80.0%	81.0%		Ref. 14
Modulating Burner Controls	80.0%	83.0%		Ref. 15
O2 Trim Control	80.0%	82.0%		Ref. 16
Steam Traps	80.0%	N/A		Ref. 17
Commercial Furnaces < 225,000 BTUH input	78.0%	92.0%*	AFUE	Ref. 3
Commercial Furnaces >= 225,000 BTUH input	80.0%	92.0%*	Et (Thermal Eff)	Ref. 3
Water Heaters	80.0%	92.0%*		Ref. 18
Unit Heater (Non-condensing)	80.0%	83.0%*		Ref. 3
~~Unit Heater (Condensing)~~	~~80.0%~~	~~90.0%*~~		~~Ref. 3~~
Pipe Insulation	80.0%	N/A		Ref 17

*High efficiency boiler and furnace efficiencies are per customer. Listed efficiencies are minimum qualifying efficiencies.

Table 3: Effective Full Load Heating Hours

Equipment	Use	Hours	Explanation
Boiler	Space Heating Only	769	Based on Bin Analysis assuming 30% oversizing for boiler plant. See "Forecast Boiler Op Hours " tab.
	Domestic Hot Water Only	674	
	Space Heating and Domestic Hot Water	1,443	Based on Bin Analysis assuming 30% oversizing for boiler plant. See "Forecast Boiler Op Hours " tab.
Furnace	All	950	
Commercial Water Heaters	All	1,092	Based on historical custom rebate projects from MN

Table 4: Hours for Pipe Insulation

Use of Pipe	Location	Pipe Insulation Hours	Explanation
Domestic Hot Water	Inside	5,558	Hours when outside temp is above building balance point. Heat loss from pipe is wasted.
Domestic Hot Water	Outside	8,760	Domestic hot water available year round, outside temp is always less than 120 F.
Space Heating	Inside	1,648	Hours when boiler is running but outdoor temp is above building balance point
Space Heating	Outside	4,791	Hours that boiler is running

Table 5: HDD Estimation constants and Site Weather Data

Climate Zone	HDD_a	HDD_b	HDD_c	altitude (ft ASL)	T_design
CO1: Denver / Front Range	2.87	-111.29	901.25	5,285	-4.00
CO2: Alamosa / Mountain is climate zone	2.65	-103.77	906.11	4,839	3.40
CO3 Grand Junction / Western Slope	3.33	-109.56	1,677.73	7,536	-16.80

Climate Zone	T-Offset
CO1: Denver / Front Range	-12.40
CO2: Alamosa / Mountain is climate zone	-14.62
CO3: Grand Junction / Western Slope	4.96

~~**Table 6: Annual Hours, CF and Heating Penalty - EC Fan Motors on Commercial Furnaces**~~

~~Climate Zone~~	~~New and Retrofit ECM~~			
	~~Annual Operating Hours for Furnace with Cooling (Op_Hrs)~~	~~Annual Operating Hours for Furnace without Cooling (Op_Hrs)~~	~~Annual Equivalent Cooling Full Load Hours (Cool_EFLH)~~	~~Annual Equivalent Heating Full Load Hours (Heat_EFLH)~~
~~CO1: Denver / Front Range~~	~~3,579~~	~~3,215~~	~~765~~	~~950~~
~~CO2: Alamosa / Mountain is climate zone~~	~~3,755~~	~~3,611~~	~~460~~	~~1,396~~
~~CO3: Grand Junction / Western Slope~~	~~3,717~~	~~3,139~~	~~1,083~~	~~856~~

~~Climate Zone~~	~~New and Retrofit ECM~~	
	~~Annual Ventilation Only Hours for Furnace with Cooling~~	~~Annual Ventilation Only Hours for Furnace without Cooling~~
~~CO1: Denver / Front Range~~	~~1,865~~	~~2,265~~
~~CO2: Alamosa / Mountain is climate zone~~	~~1,900~~	~~2,215~~
~~CO3: Grand Junction / Western Slope~~	~~1,779~~	~~2,567~~

~~Climate Zone~~	~~New ECM~~		~~Retrofit ECM~~	
	~~ECM Coincidence Factor for Furnace with Cooling~~	~~ECM Coincidence Factor for Furnace without Cooling~~	~~ECM Coincidence Factor for Furnace with Cooling~~	~~ECM Coincidence Factor for Furnace without Cooling~~
~~CO1: Denver / Front Range~~	~~53.76%~~	~~101.50%~~	~~54.83%~~	~~101.71%~~
~~CO2: Alamosa / Mountain is climate zone~~	~~51.47%~~	~~102.01%~~	~~52.34%~~	~~102.25%~~
~~CO3: Grand Junction / Western Slope~~	~~56.02%~~	~~88.29%~~	~~57.35%~~	~~88.44%~~

~~Climate Zone~~	~~New ECM~~		~~Retrofit ECM~~	
	~~Heating Penalty for Furnace with Cooling (Heating Penalty_ per_New_ECM HP)~~	~~Heating Penalty for Furnace without Cooling (Heating Penalty_ per_New_ECM HP)~~	~~Heating Penalty for Furnace with Cooling (Heating Penalty_ per_New_ECM HP)~~	~~Heating Penalty for Furnace without Cooling (Heating Penalty_ per_New_ECM HP)~~
~~CO1: Denver / Front Range~~	~~-$6.64~~	~~-$6.64~~	~~-$8.23~~	~~-$8.23~~
~~CO2: Alamosa / Mountain is climate zone~~	~~-$9.75~~	~~-$9.75~~	~~-$12.09~~	~~-$12.09~~
~~CO3: Grand Junction / Western Slope~~	~~-$5.98~~	~~-$5.98~~	~~-$7.42~~	~~-$7.42~~

Table 7: Water Heater Efficiencies for Ozone Laundry

Water Heater Type	Thermal Eff (%)
Gas Non-Condensing Storage	80%
Gas Condensiing Storage	95%
Gas Tankless	96%
Gas Storage with Side-Arm Boiler	80%

Inputs:

(Inputs as required by referenced programs)

<u>For boilers:</u>

New Boiler size rated at sea level (million BTUH)

New boiler type (Non-Condensing ~~or Condensing)~~

Boiler Use (Space heating and/or water heating)

<u>For steam traps:</u>

<u>High or low pressure</u>

Incremental cost

<u>For all but boilers, steam traps, and pipe insulation:</u>

Boiler size (BTUH)

Implemented measure

Incremental cost

<u>For Insulation:</u>

Linear feet of insulation added

Nominal diameter of pipe

Thickness of insulation

Insulation R-Value or thermal conductivity (k)

Average fluid temperature

Pipe location (conditioned space or not)

Pipe use (Space heating and/or water heating)

Was existing insulation replaced

Incremental cost

% Process load

<u>For Water Heaters:</u>

Building type

Square footage served by water heater

Storage capacity (gallons); 0 if tankless

BTUH input

Other Water Heater BTUH Input

Thermal efficiency rating

~~**For Furnaces:**~~

~~New furnace size (BTUH)~~

~~New furnace efficiency~~

~~**For Furnace fans:**~~

~~New furnace fan size (hp)~~

<u>For non-radiant unit heaters:</u>

Space temperature set point

% of the time the space is heated

Input capacity of the heater in BTU/h

Fan type (blower/propeller)

For radiant heaters:
Space temperature set point
% of the time the space is heated
Input capacity of the heater in kBTU/h

Assumptions:
- Each boiler or furnace is replaced with the same size on a 1 for 1 basis.
- Only boilers used for space and/or domestic water heating can receive prescriptive rebates; other boilers must go through Custom Efficiency.
- Assumed savings for boiler tune-up = 2% for non condensing boiler. This is an average value of the two years, 4% initial to no savings at the end of the two years. Life of
- Assumed savings for outdoor air reset on non condensing boilers = 3%. Life of product is 20 years. The Natural Gas consortium states up to 5% savings
- Assumed savings for installing Stack dampers on non condensing boilers = 1%. Life of product is 20 years. Canada energy council, up to 4%
- Assumed savings for modulating burner controls on non condensing boilers = 3%. Life of product is 20 years. The Natural Gas consortium states up to 4% savings
- Assumed savings for O2 trim controls on non condensing boilers = 2%. Life of product is 20 years. The Natural Gas consortium states of 2 to 4% savings
- The baseline efficiency for the furnace is based on 2015 IECC, minimum of 80%.
- Thermal Efficiency as defined in ASHRAE 90.1-2007 indicates the total efficiency of the boiler equal to 100% fuel energy minus all losses.
- Prescriptive rebates are only given for furnaces put into service, rebates are not given for backup furnaces.
- Furnaces must have a minimum efficiency of 92% AFUE for a rebate, and 94% AFUE or higher efficiency will receive a larger rebate.
- Infrared heater is vented (has exhaust to exterior)
- % Conditioned" is the percentage of the time that the space temperature set point is maintained
- The infrared heater has no fan energy consumption (it may have a very small (<100W) fan to distribute hot exhaust, but that is ignored)
- The fan full load hours equal the heating full load hours
- Fan power per BTU/h is constant, regardless of fan size for each fan type
- Heat produced by the fan is beneficial to heating the space
- Fan motor efficiency is constant
- Radiant heaters are low-intensity tube type
- Furnace fan will operate for ventilation during all business hours, assumed to be equal to the "office" lighting hours for the business lighting program technical assumptions
- For furnace fan measure, cooling is assumed to be 13 SEER and heating 90% efficient
- The baseline PSC furnace fan motor is 2/3 the size of the new motor, based on Ref 20 and 21
- Furnace fan measure: there is no ventilation during unoccupied hours
- Climate zone assumed to be Denver, unless otherwise specified

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