DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Product: Home Performance with ENERGY STAR Rebates

Residential natural gas and electric customers receive a cash rebate for implementing multiple energy efficiency improvements.

Envelope Algorithms:

Attic insulation ~~and bypass sealing~~ natural gas savings (Dth)	= (1 / (2 +Attic_Pre_R) - 1 / (2+Attic_Post_R)) x Attic SF x Dth_Per_SF_Attic
Attic insulation ~~and bypass sealing~~ electric savings (Heating and Cooling) - Customer kWh	= (1 / (2 +Attic_Pre_R) - 1 / (2+Attic_Post_R)) x Attic SF x (Heating_kWh_Per_SF_Attic + Cooling kWh_Per_SF_Attic)
Attic insulation ~~and bypass sealing~~ savings - Customer	= Customer kWh / Hours_Electric
Air sealing and weather-stripping natural gas savings (Dth) in 2012 and 2013 prior to 60-Day Notice	Energy savings for the air sealing and weather-stripping were calculated with Energy Gauge modeling software for CO Reference home model with typical home characteristics, calibrated to match energy use for the area and using resistance electric heating. 25% reduction = 7.4 Dth
Air sealing and weather-stripping savings - (Heating and Cooling) - Customer kWh in 2012 and 2013 prior to 60-Day Notice	Energy savings for the air sealing and weather-stripping were calculated with Energy Gauge modeling software for CO Reference home model with typical home characteristics, calibrated to match energy use for the area. Values are listed in Table 1 for various heating and cooling options. Values represent a 25% reduction in ACH from 0.60 to 0.45 and a reduction of 0.15 ACH.
CFM_Natural_Winter_Before (or After)	= CFM50_Before * 1/N_Winter or = CFM50_After * 1/N_Winter
CFM_Natural_Summer_Before (or After)	= CFM50_Before * 1/N_Summer = CFM50_After * 1/N_Summer
Air sealing / bypass sealing and weather-stripping natural gas savings (Heating) **2013 only**	Energy savings for the attic bypass sealing, air sealing, and weather-stripping will be calculated from actual field measurements using blower door testing performed by BPI certified contractors for home in CO heated with 0.78 AFUE furnace. = (CFM_Natural_Winter_before - CFM_Natural_Winter_after) x ATF x HDD x 24 hours/day / 0.78 Eff / 1,000,000 BTU/Dtherm
Air sealing / bypass sealing and weather-stripping savings - (Heating and Cooling) - Customer kWh **2013 Only**	Energy savings for the attic bypass sealing, air sealing, and weather-stripping will be calculated from actual field measurements using blower door testing performed by BPI certified contractors. For customers with electric cooling: Cooling = (CFM_Natural_Summer_before - CFM_Natural_Summer_after) x ATF x CDD x 24 hours/day / COP / 3412 Heating = (CFM_Natural_Winter_before - CFM_Natural_Winter_after) x ATF x HDD x 24 hours/day / COP / 3412
Wall insulation natural gas savings (Dth)	= Dth_Per_SF_Wall x Wall_SF
Wall insulation savings (Heating and Cooling) - Customer kWh	= kWh_Per_SF_Wall x Wall_SF

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Lighting Algorithms:

CFL savings_Customer kW	= (kW_Bulb_Existing - kW_Bulb_New) x (#_CFL_After - #_CFL_Before)
CFL savings_Customer kWh	= ~~CFL savings_Customer kW~~ (kW_Bulb_Existing - kW_Bulb_New) x (CFL_Hours_Total - CFL_Hours_Existing)

Thermostat Algorithms:

Setback thermostat natural gas savings (Gross Dth)	= 1.38% x 71.2 DTherms / year heating energy = 0.983 DTherms savings. 1.38% is based on 1 degree of heating set back out of 72.4 degree F temperature difference on a design day.
Setback thermostat Electric Energy savings (kWh)	= 1,358 kWh cooling energy x 5.26% = 71.47 kWh savings. 5.26% is based on 1 degree of cooling set back out of a 19 degree F temperature difference on a design day.
Setback thermostat Electric Demand savings (kW)	= Setback thermostat kWh / Hours_Electric_Cooling

Heating System Algorithms:

~~New HE Furnace or boiler natural gas savings (Gross Dth)~~	~~= Total_Heat_Losses_Old x (Effn - Effo) / (Effn x Effo)~~
New Furnace & Boiler Savings (Dth)	= ((BTUH x EFFn / EFFo) - BTUH) x (1 - oversize factor) x Hrs / 1,000,000
ECM Furnace Fan Efficiency Electric Energy Savings (kWh)	= (ECM_baseline_kW - ECM_Proposed_kW) x ECM_Operating_Hours
ECM Furnace Fan Efficiency Electric Demand Savings (kW)	= (ECM_baseline_kW - ECM_Proposed_kW)

Water Heater Algorithms:

High efficiency water heater natural gas savings (Gross Dth)	= Total_water_heat_output x (EFn - EFo) / (Efn x Efo)
Electric Storage Water Heater Baseline Energy Consumption (Baseline_kWh)	= Hot water energy / EFo
High Efficiency Heat Pump Storage Tank Consumption (Efficient _WH_kWh)	= Hot water energy / EFn
Water Heater Electric Savings (Customer kWh)	= Baseline_kWh - Efficient_WH_kWh + Cooling_Benefit - Heating Penalty
Water Heater Demand Savings (Customer kW)	= Customer kWh / Hours

Appliance Algorithms:

Dishwasher and Clothes Washer natural gas savings (Gross Dth) and electric energy savings (kWh)	= Appliance_Electric_Savings + (Hot_Water_Savings / Efn)

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Evap 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 - 164) kWh = 1,194 kWh
Demand Savings (Customer kW) Front Range	= 13 Seer 3 Ton - Tier 1 Evaporative cooler demand = (3.220 - .388) kW =2.832 kW
Energy Savings (Customer kWh) Mountain	= 13 Seer 3 Ton - Tier 1 Evaporative cooling energy = (840 - 101) kWh = 739 kWh
Demand Savings (Customer kW) Mountain	= 13 Seer 3 Ton - Tier 1 Evaporative cooler demand = (3.220 - .388) kW = 2.832 kW
Energy Savings (Customer kWh) Western Slope	= 13 Seer 3 Ton - Tier 1 Evaporative cooling energy = (1,581 - 191) kWh = 1,390 kWh
Demand Savings (Customer kW) Western Slope	= 13 Seer 3 Ton - Tier 1 Evaporative cooler demand = (3.220 - .388) kW = 2.832 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 - 164) kWh = 1,194 kWh
Demand Savings (Customer kW) Front Range	= 13 Seer 3 Ton - Tier 2 Evaporative cooler demand = (3.220 - .388) kW =2.832 kW
Energy Savings (Customer kWh) Mountain	= 13 Seer 3 Ton - Tier 2 Evaporative cooling energy = (840 - 101) kWh = 739 kWh
Demand Savings (Customer kW) Mountain	= 13 Seer 3 Ton - Tier 2 Evaporative cooler demand = (3.220 - .388) kW = 2.832 kW
Energy Savings (Customer kWh) Western Slope	= 13 Seer 3 Ton - Tier 2 Evaporative cooling energy = (1,581.02 - 191.51) kWh = 1,391 kWh
Demand Savings (Customer kW) Western Slope	= 13 Seer 3 Ton - Tier 2 Evaporative cooler demand = (3.220 - .388) kW = 2.832 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 - 320) kWh = 1,038 kWh
Demand Savings (Customer kW) Front Range	= 13 Seer 3 Ton - Whole house evap demand =(3.220 - .760) kW = 2.460 kW
Energy Savings (Customer kWh) Mountain	= 13 Seer 3 Ton - Whole house evap cooling energy = (840 - 198) kWh = 642 kWh
Demand Savings (Customer kW) Mountain	= 13 Seer 3 Ton - Whole house evap cooler demand = (3.220 - .760) kW = 2.460 kW
Energy Savings (Customer kWh) Western Slope	= 13 Seer 3 Ton - Whole house evap energy = (1,581 - 373) kWh = 1,208 kWh
Demand Savings (Customer kW) Western Slope	= 13 Seer 3 Ton - Whole house evap demand = (3.220 - .760) kW = 2.460 kW

AC Unit Algorithms:

Seasonal Energy Efficiency Ratio (SEER)	= Total seasonal cooling output (kBtuh) / Total electrical input (kWh); for estimating seasonal performance.
Energy Efficiency Ratio (EER)	= Rated cooling output (kBtuh) / Rated electrical input (kW) for equipment tested at 95F estimating peak cooling performance; EER = -0.02 x SEER^2 + 1.12 x SEER . This equation relating EER to SEER applies to all equipment in this product, and will be used if EER rating is not available. (Reference 28)
kW/ton	= 12 / Energy Efficiency Ratio
Coefficient of Performance (COP)	= EER / 3.412 or, EER = 3.412*COP
Coefficient of Performance (COP) Heating	= Heat Energy Output (Btu) / Energy Input to Compressor (Btu)

For Split System Air Conditioners and Air Source Heat Pumps and Ground Source Heat Pumps:

New Equipment Electrical Energy Savings (Customer kW	= Size x EFLH x (12/SEER_Standard - 12/SEER_Eff) / (1-Loss_No_QI)
New Equipment Electrical Demand Savings (Customer k	= Size x (12/EER_Standard - 12/EER_Eff)
Quality Install Electrical Energy Savings (Customer kWh	= Size x EFLH x (12/SEER_Eff) x (1/(1-Loss_No_QI) - 1/(1-Loss_QI))
Quality Install Electrical Demand Savings (Customer kW	= Size x (12/EER_Eff) x (1 - ((1-Loss_No_QI) / (1-Loss_QI)))
GSHP Cooling Electrical Energy Savings (Customer kW	=(GSHP_Size/2) x EFLH (12/SEER_Standard - 12/GSHP_SEER) / (1-Loss_No_QI)

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

GSHP Cooling Electrical Energy Savings (Customer kW	=GSHP_Size x (12/EER_Standard - 12/GSHP_EER)
GSHP Heating Electrical Energy Savings (Customer kW	=GSHP_Size x GSHP_EFLHH x (12/EER_Standard - 12/GSHP_EER) / (1-Loss_No_QI)

General Algorithms:

Net Dth	= Gross Dth x NTG
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

Envelope Variables:

Hours_Electric Heating	Hours of electric heating operations to meet heating requirements as seen in Table 1 for various heating types.
Hours_Electric Cooling	Hours of electric cooling operations to meet cooling requirements as seen in Table 1 for various cooling types.
Dth_Per_SF_Attic	= Dth loss per square foot of attic coefficient for home in CO heated with 0.78 AFUE furnace from Energy Gauge model = 0.2478
kWh_Per_SF_Attic	= kWh savings per square foot of attic coefficient for home in CO. Values are listed in Table 1 for various heating and cooling options.
Dth_Per_SF_Wall_Heating	= Dth loss per square foot of wall coefficient for home in CO heated with 0.78 AFUE furnace from Energy Gauge model = 0.02964. This value incorporates the change from R-0 to R-11 insulation in the wall.
kWh_Per_SF_Wall_Heating	= kWh loss per square foot of wall coefficient for home in CO. Values are listed in Table 1 for various heating and cooling options. The values incorporate the change from R-0 to R-11 insulation in the wall.
Coincidence Factor (CF) Heating	Probability that savings will occur during Xcel's system peak periods (0% since heating savings only)
Coincidence Factor (CF) Cooling	Probability that savings will occur during Xcel's system peak periods - 81%
O&M savings	= Operation and Maintenance savings are assumed to be zero for the insulation rebates.
RatticE	= Existing R value for the attic before insulation is added, provided by customer. We will use a minimum R-value of 2 for attics that have no insulation
RatticN	= New R value for the Attic after the insulation is added, provided by customer
RwallE	= Existing R value for the wall before insulation is added, provided by customer. We will use a minimum R-value of 5.57 for walls that have no cavity insulation
RwallN	= New R value for the wall after the insulation is added, provided by customer
SFAI	= Square footage of attic insulation added, provided by customer
SFWI	= Square footage of wall insulation added, provided by customer
SEER	= Assumed cooling system seasonal energy efficiency ratio. We will use 13 which is the federal minimum standard.

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

COP	= Coefficient of performance for electric heating system. We will use 3.5 for heat pumps, 2.25 for combo heat pump/resistance, and 1 for resistance units.
Total_Heat_Losses_Old	= Sum of the heat losses for the house before upgrades are performed. Will be calculated based on insulation and air sealing equations above using actual customer values. Assumes 15% of exterior walls have windows with a U-factor of 0.5.
Total_Heat_Losses_New	= Sum of the heat losses for the house after upgrades are performed. Will be calculated based on insulation and air sealing equations above using actual customer values. Assumes 15% of exterior walls have windows with a U-factor of 0.5.

Heating System Variables:

Eff	= Efficiency of natural gas fired building heating system. For newly installed units we will use the actual nameplate efficiency for the unit that was installed. For existing units, we will use 78% for non condensing units and 92% for condensing units.
Effo	= Efficiency of the old natural gas heating unit, we will use 78% for Furnaces and 80% for Boilers
Effn	= Efficiency of the newly installed natural gas heating unit. We will use the nameplate value provided by the customer.
Hrs	Equivalent Full Load Heating Hours for Furnace and Boiler equipment will be assumed as follows: 94% AFUE Furnace = 958 Hours 92% AFUE Furnace = 978 Hours 85% AFUE Boiler = 698 Hours
BTUH	= Size of the newly installed natural gas heating unit. We will use the nameplate value provided by the customer.
oversize factor	= Oversizing factor on new furnace or boiler Input BTUH nameplate. Colorado oversize factor is assumed to be zero
ECM_Operating Hours	Operating Hours of Furnace Fan without Central AC = 2,148 hours Operating Hours of Furnace Fan with Central AC = 2,484 hours

Water Heating Variables:

Efo	= Efficiency Factor of the old natural gas water heater. We will us 0.59 for non condensing tank units~~, 0.65 for power vent tank units, and 0.82 for tankless~~.
Efn	= Efficiency Factor of newly installed water heater. We will use nameplate data provided by the customer.
Heating_Penalty	= 522 kWh for homes with heat pumps and 1,039 kWh for homes with electric resistance heat. Homes with gas heat will incur an O&M dollar penalty instead of a Dth penalty.
Cooling_Benefit	= 177 kWh for homes with refrigerated air conditioning, 0 kWh for homes without refrigerated air conditioning.

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Lighting Variables:

#_CFL_After	= Number of CFL bulbs present in the home after the upgrade (minimum of 20), provided by the customer
#_CFL_Before	= Number of CFL bulbs present in the home before upgrade, provided by the customer
kW_Bulb_Existing	= Average wattage of incandescent bulb replaced by CFL, we will use 0.06294 kW in 2012 and 0.05808 kW in 2013
kW_Bulb_New	= Average wattage of newly installed CFL bulb, we will use 0.019 kW
CFL_Hours_Existing CFL_Hours_Total	= ~~Average~~ Cumulative annual operating hours for all existing and newly installed CFLs. The ~~average~~ cumulative value will be calculated for each customer based on the number of existing and ~~newly~~ total installed CFLs. ~~Estimated hours used for each bulb will be as shown in Table 3, which assumes that 10 bulbs pre-exist in 2012 and 12 bulbs pre-exist in 2013.~~ New Table 3, which assumes no pre-existing CFL lamps in the home, will be used to select the cumulative hours for existing CFLs and cumulative hours for total CFLs.

Appliance Variables:

Appliance_Electric_Savings	= We will use 77 kWh and 0.36 kW for Dishwhashers and 26 kWh and .09 kW for Clothes Washers (Reference 14)
Hot_Water_Savings	= We will use 12.72 Dth for Dishwhashers and 8.80 Dth for Clothes Washers (Reference 14)
Refrigerator replacement electric energy and demand savings (kWh and kW)	Energy savings for the refrigerator were based on the Energy Star Refrigerator Savings Calculator: http://www.energystar.gov/index.cfm?c=refrig.pr_refrigerators. Savings is 93.41 kWh and 0.011 kW.
Refrigerator recycling electric energy and demand savings (kWh and kW)	Energy savings for the refrigerator are based on shipment-weighted average efficiencies of units manufactured from 1993-2000 with appropriate degradation factors applied to calculate baseline energy consumption (http://enduse.lbl.gov/Projects/RED.html) Demand savings are based on using an Average kW/Peak kW ratio from Deemed Refrigerator Savings for Texas developed by Frontier Associates. Reference 8. Savings is 988.9 kWh and 0.13 kW.

Evap Variables:

13 Seer 3 Ton A/C energy	=Energy use of 13 SEER 3 Ton AC unit = 1,358 kWh - Front Range: 1,581kWh - Western Slope; 840 kWh - Mountains
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 = 164 kWh Front Range, 191 kWh Western Slope; 101 kWh Mountains
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 = 164 kWh Front Range; 191 kWh Western Slope; 101 kWh Mountain
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 = 321 kWh Front Range, 373 kWh Western Slope, 198 kWh Mountains
Tier 3 Evaporative cooler demand	= Motor HP x 0.746 x Load Factor / Motor Eff = 0.760 kW

EFLH Front Range/Denver	=422 Hours
EFLH Mountain Area	=261 Hours
EFLH Western Slope	=491 Hours

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 18) & Western Slope 1,581 kWh
Ref_air_demand	= Btuh/EER x 1000. We will use 3.22 kW (Reference 19)
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 22)
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 20)
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 22)
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 22)
Incremental Costs	= Incremental cost of efficient technology over baseline technology. Values listed in Table 4
O&M savings	= Operation and Maintenance savings related to water use are listed in Table 5.
Measure Life	= 15 years (Reference 22)
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 22)

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

AC Variables:

Size	= The new equipment capacity in tons, provided by customer
EFLH	= Equivalent Full Load Hours. The Equivalent number of hours that equipment would be running at Full Load over the course of the year. We will use 490.4 EFLH which was determined by modeling a home in Denver with a 3 ton 13 SEER AC unit. The resulting kWh were divided by the connected load to derive the EFLH value. Modeling used ESPRE simulation model which is an EPRI product.
GSHP_EFLHH	= Ground Source Heat Pump Equivalent Full Load Hours Heating: The equivalent number of hours that GSHP equipment would be running at Full Load over the course of the year for heating. We will use 846 EFLH for new homes and 1,419 for existing homes. GSHP EFLHH was determined by REMRATE modeling of a new and an existing home adjusted for Denver Degree Days. The resulting kWh were divided by the connected load to derive the EFLHH value.
SEER_Standard (Plan A)	= Seasonal Energy Efficiency Ratio of standard equipment, based upon the minimum Federal standard for efficiency as manufactured. For residential AC units, we will use 13 SEER.
SEER_Standard (Plan_B)	= Seasonal Energy Efficiency Ratio of existing equipment based upon the minimum Federal standard for efficiency manufactured between 1992 and 2006. For existing residential AC units, we will use 10 SEER.
SEER_Eff	= Seasonal Energy Efficiency Ratio of High Efficiency equipment that the customer will install, provided by the customer
EER_Standard (Plan_A)	= EER of standard equipment, based upon the minimum Federal acceptable efficiency. We will use 11.18 based on the federal standard 13 SEER and the conversion listed above.
EER_Standard (Plan_B)	= EER of existing equipment, based upon the 1992 to 2006 minimum Federal acceptable efficiency. We will use 9.2 based on the federal standard 10 SEER and the conversion listed above.
EER_Eff	= EER of High Efficiency that the customer will install, provided by customer. If value is not provided by the customer we will use the conversion listed above.
GSHP_EER	= EER of High Efficiency that the customer will install, provided by customer.
GSHP_SEER	= EER/0.95
Standard_COP	= Coefficient of Performance of electric resistance heater = 1.00 The COP of an airsource heatpump in an existing home = 2.0 The COP of an airsource heatpump in a new home = 3.1.
GSHP_COP	= Coefficient of Performance of GSHP equipment that the customer will install, provided by the customer. We will use COP if EER is not available. Baseline GSHP COP assumed to be 3.1
GSHP_Size	=Size of Ground Source Heat Pump, provided by customer. We will divide size by 2 for GSHP cooling calculations based on REMRATE modeling of a new and an existing home adjusted for Denver Degree Days. The resulting kWh were divided by the connected load to derive the EFLHH value.
Loss_No_QI Loss_No_QI_GSHP	Efficiency of unit lost due to improper installation. This is the Baseline condition for Quality Installations. We will use 30.5% which is the summation of the following losses: Equipment sizing = 3%, Refrigeration Charge = 13%, Improper air flow = 7%, Duct leaks = 7.5%. the Loss_No_QI_GSHP will be 14.5% (based on improper airflow plus duct leakage). ~~The losses for heating are only the duct leakage losses (7.5%)~~

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Loss_QI	Efficiency of unit lost due to improper installation. All non-QI losses will be eliminated with quality install in a new home so the Loss_QI for a new home will be 0. In existing homes and all Plan B installations, all non-QI losses will be eliminated except for the duct leakage losses. Duct leakage losses in an existing home will be cut in half resulting in a Loss_QI for existing homes of 3.75%. Savings will be reduced for quality installation according to the percentages above when it is determined through M & V that one or more facets of quality installation (equipment sizing, refrigeration charge, proper airflow, duct leakage) fall outside the acceptable range according to industry standards.
CF	= Coincidence Factor, the probability that peak demand savings will coincide with peak utility system demand. 0.90 will be used for prescriptive AC rebates. For GSHP .50 will be used.
Measure Life	Measure life is taken at 14 years for all Plan A cooling equipment, 7 years for all Plan B cooling equipment, and 7 years for Quality Installations (Reference 29). Plan Life for GSHP is 20 years (Reference 30).
Future Value	Estimated cost of the standard replacement equipment at expected end of life of current equipment
Rate	Assumed interest rate. 7.88% used for discounting the future purchase price and 2.57% used for inflation to calculate the future purchase price based on current cost.
Number of Periods	Number of years expected until existing equipment end of life
Incremental operation and maintenance cost	= 0 - conservative approach, taking no credit for improved mean time between failure.
Incremental Capital Cost	Incremental cost of efficient equipment. Values listed in table 6 below. Values will be scaled for different equipment sizes. Plan A and Plan B incremental capital costs include $200 for quality install.
Plan B Baseline Cost	The present value of a SEER 13 unit eight years in the future was calculated using a 10-year average inflation rate. The inflated value was then discounted back to present value using Xcel's Weighted Average Cost of Capital for Colorado. An average repair
GSHP Incremental Cost Split	Incremental Costs were split according to percentage of annual energy used for heating (81%) and percentage of annual a energy used for cooling (19%).
Federal Tax Incentive:	30% of installed Cost of Energy Star Certified GSHP

General Variables:

3412	Conversion from BTU to kWh, 1kWh = 3412 BTU
Hours	= We will use 1,073 hours which is determined by dividing the typical consumption by the typical output.
ATF	= Air Transfer Factor is a conversion factor for calculating BTU/hour from airflow in cubic feet / minute. The factor varies with altitude and air density. ATF will be deemed for the three climate zones as follows: Front Range = 0.891; Western Slope = 0.906 ; and Mountains = 0.813.
COP	= Coefficient of Performance for electric heating and cooling equipment. Electric resistance heat COP = 1.0; Standard AC or Air Source Heat Pump (ASHP) COP = 2.0; Ground Source Heat Pump (GSHP) = 4.0.
CFM50_Before (or After)	= Blower Door test air leakage rate at 50 pascals maintained pressure, measured in cubic feet per minute. The contractor will capture actual readings as part of the service.

CFM_Natural_Summer (or Winter)_Before (or After)	= Natural average infiltration rate in cubic feet per minute. This is calculated for summer and winter separately both Before and After the air sealing work is completed. The difference is the CFM savings used to calculate the energy savings. See Algorithms above.
N_Summer (N_Winter)	= Conversion factor used to relate actual measured CFM leakage rate (taken at a reference pressure of 50 pascals) to a natural CFM of infiltration. Factor is calculated from the assumptions of an ASHRAE Shelter Class of 3, Home height is based on the number of stories provided by the contractor, and TMY3 climatic data for average temperatures and wind speeds. See Table 8 for Summer and Winter N Factors.
NTG	Net-to-Gross Factor = We will use 94% based on reference 5.
CF	Coincidence Factor = Probability that peak demand of the bulb will coincide with peak utility system demand. As seen in Table 2 based on Reference 1.
TDLF	Transmission Distribution Loss Factor = 7.70%, the percentage loss of electricity as it flows from the power plant to the customer, calculated using factors from Enhanced DSM Filing SRD-2

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Table 1: Savings factors for electrically heated and cooled homes:

	Electric Resistance Heat	Air Source Heat Pump or Air Conditioner	Ground Source Heat Pump	Evaporative Cooling
Heating kWh_Per_SF_Attic	31.752	18.102	8.904	NA
Cooling kWh_Per_SF_Attic	NA	3.57	2.142	0.000
Heating kWh_per_SF_Wall	4.145	2.399	1.270	NA
Cooling kWh_per_SF_Wall	NA	0.214	0.141	0.000
Hours_Electric Heating	787	967	943	NA
Hours_Electric Cooling	NA	628	628	628
Heating Air Sealing and Weatherstripping Customer kWh 2012 and 2013 prior to 60-Day Notice	1521	908	444	NA
Cooling Air Sealing and Weatherstripping Customer kWh 2012 and 2013 prior to 60-Day Notice	NA	5	3	0

Table 2 (Reference 1):

Type of measure:	Measure life:	Incremental cost:	Coincidence Factor
Attic insulation ~~and bypass sealing~~	20 years (Reference 1)	Provided by Customer	Cooling 81% Heating 0%
Air sealing / Bypass Sealing and weather-stripping	10 years (Reference 1)	Provided by Customer	
Wall insulation	20 years (Reference 1)	$2,150 (Reference 6)	
CFLs	8.8 years (Reference 9)	$3.15 / Lamp replaced (Reference 10)	8%
Setback thermostat	5 years (Reference 11)	$50 (Reference 11)	0% Heating Only 81% w/ Central A/C
HE furnace AFUE 92%	18 years (Reference 12)	$450 (Reference 13)	NA
HE furnace AFUE 94%	18 years (Reference 12)	$505 (Reference 13)	NA
EC Motor for Furnace Fan	15 years	$464.33	70%
Boiler 85%	20 years (Reference 29)	$440 (Reference 17)	NA
Tankless water heater 82%	20 years (Reference 1)	$298 (Reference 13)	NA
Heat pump water heater (2.19 EF)	13 years (Reference 31)	$1150 (Reference 31)	NA
Power vented water heater (67%)	15 years (Reference 1)	$361.04 (Reference 13)	NA
Dishwasher	11 years (Reference 15)	$30 (Reference 14)	2%
Clothes washer	11 years (Reference 16)	$200 (Reference 14)	2%
Refrigerator replacement	13 years (Reference 14)	$30 (Reference 14)	100%
Refrigerator recycling	7.3 years (Reference 14)	$0 (Reference 11)	100%

Table 3 Residential CFL Operating Hours (Reference 9):

Lamp No. (Existing or Total)	Hours for Reference Lamp	Cumulative Annual Lamp Hours - 2013
0	0	0
1	1,210	1,210
2	1,210	2,420
3	1,210	3,630
4	1,210	4,840
5	1,210	6,050
6	1,027	7,077
7	1,027	8,104
8	1,027	9,131
9	1,027	10,158
10	888	11,046
11	888	11,934
12	864	12,798
13	864	13,662
14	864	14,526
15	864	15,390
16	864	16,254
17	864	17,118
18	829	17,947
19	772	18,719
20	772	19,491
21	720	20,211
22	720	20,931
23	720	21,651
24	720	22,371
25	708	23,079
26	669	23,748
27	669	24,417
28	669	25,086
29	669	25,755
30	669	26,424
31	669	27,093
32	669	27,762
33	616	28,378
34	616	28,994
35	616	29,610
36	616	30,226

37	616	30,842
38	616	31,458
39	513	31,971
40	435	32,406
41	435	32,841
42	406	33,247
43	406	33,653
44	406	34,059
45	406	34,465
46	406	34,871
47	406	35,277
48	406	35,683
49	406	36,089
50	406	36,495

Table 4. Incremental Cost of Evaporative Coolers (Reference 23,24,25):

	Baseline Cost	HE Cost	Incremental Cost
Tier1: 13 Seer AC to Evap	$ 4,329	$ 1,022	$ (3,307)
Tier2: 13 SEER AC to HE Evap	$ 4,329	$ 1,989	$ (2,340)
Tier 3: 13 SEER AC to Whole House Evap	$ 4,329	$ 7,542	$ 3,213

Table 5. Operation and Maintenance Savings (Reference 26):

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)	$ (10.26)
13 Seer 3 Ton A/C	Integrated whole house evap cooling (Tier 3)	$ (6.77)

Table 6. Incremental Capital Costs of AC Measures:

Unit Description	Current Year Purchase Price	Baseline Plan A Cost	Incremental Plan A Cost / Ton	Baseline Plan B Cost	Incremental Plan B Cost / Ton
13 SEER 3 ton unit	$ 4,329	NA	NA	NA	NA
14 SEER 3 ton unit	$ 4,948	NA	NA	$ 3,949	$ 333.11
14.5 SEER 3 ton unit	$ 5,050	$ 4,329	$ 240	$ 3,949	$ 366.50
15 SEER 3 ton unit	$ 5,222	$ 4,329	$ 298	$ 3,949	$ 424.50
16 SEER 3 ton unit	$ 5,569	$ 4,329	$ 413	$ 3,949	$ 539.50
17 SEER 3 ton unit	$ 6,002	$ 4,329	$ 558	$ 3,949	$ 684.50
18 SEER 3 ton unit	$ 6,435	$ 4,329	$ 702	$ 3,949	$ 828.50
GSHP 14.1 EER 3.4 ton unit*	$ 9,770	$ 6,251	$ 1,379.42		
GSHP 14.1 EER 6 ton unit*	$ 16,790	$ 6,448	$ 1,379.42		

* Current Year Purchase Price for GSHP units is discounted by Federal Tax Incentive.
Incremental costs for unit sizes not listed will be interpolated/extrapolated from listed values

Incremental costs for GSHP to High Efficient GSHP will use the incremental cost table for standard A/C Units. This is due to a GSHP to HE GSHP the loop cost are the same so that cost is ignored. When the baseline system has electric resistance heat or is an air source heat pump the cost for the ground loop is included. The cost to install a GSHP loop is approximately $2,005 per ton.

Table 7. AC Plan B baseline present value cost calculation:

Discount Rate	7.88%	
10 Yr. Avg. Inflation Rate	2.57%	
SEER=	13	3 Ton Unit
2009 Cost=	$ 4,329	**Incremental Cost**
2010	$ 4,440	$ 4,440
2011	$ 4,554	$ 4,222
2012	$ 4,671	$ 4,014
2013	$ 4,792	$ 3,816
2014	$ 4,915	$ 3,629
2015	$ 5,042	$ 3,450
2016	$ 5,171	$ 3,281
2017	$ 5,304	$ 3,119

Table 8: N Factors for Determining Air Sealing Air Change Rates:

	Summer N Factor			Winter N Factor		
No. Stories	**Front Range**	**Western Slope**	**Mountains**	**Front Range**	**Western Slope**	**Mountains**
1	20.596444	19.702694	19.248689	14.108395	15.708906	14.863818
2	18.098424	17.747368	15.762584	11.068408	12.116026	11.283390
3	16.852021	16.899301	13.909654	9.508149	10.307679	9.517099

Table 9: Heating and Cooling Degree Days by Climate Zone

	Front Range	Western Slope	Mountains
HDD	5,922	5,782	7,769
CDD	970	1,375	570

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Provided by Customer:
Type of Measures Implemented

The Home Performance with ENERGY STAR Product provides a "systems approach" to comprehensive energy improvements. Public Service uses this approach by requiring an upgraded home "shell," including code level attic insulation and a reduction in air infiltration coupled with a combustion safety check if naturally vented combustion appliances (furnace/boiler or water heater) remain in the home after product participation.

Product savings were determined by using a surrogate computer modeled home (modeled with Energy Gauge) with characteristics that approximate the most common home attributes as reported in the 2005 Home Use Survey and the energy consumption characteristics of the metropolitan Denver general housing stock excluding low-income customers. Low-income customers may participate in this product, but also have dedicated product offerings. Savings were determined by modeling the required improvements for the product (attic insulation and air infiltration control) and setting a secondary "baseline", then adding the product "options" to the model. Wall insulation, programmable thermostat impacts, furnace and water heater improvements were modeled with this technique.

Actual cost of Attic Insulation
Actual Cost of Air Sealing

BTUH size of new fuel fired heating equipment
EFFn of new heating equipment
EFn of new domestic water heating equipment
Blower Door Test-in CFM50
Blower Door Test-out CFM50
Climate Zone (Front Range, Western Slope, or Mountains)
Number of Stories above grade in Home
Conditioned Square Footage

General Assumptions:
The baseline home had an existing level of insulation in the attic of R-19 and the change case had an elevated insulation level of R-40.
The baseline home had an existing ACH natural of 0.60 and the change case had a 25% reduction to 0.45 ACH natural.
The baseline home had an existing level of insulation in the walls of R-0 and the change case had an elevated insulation level of R-11.
The baseline water heater is a 40 gallon capacity with an Efficiency Factor (EF) of 59%.
Any home with an existing ACH natural of 0.45 ACH will not be eligible for the air sealing measure.
A Blower Door Test will be required for all participating homes.
The Attic Bypass Air Sealing energy savings will be captured with Air Sealing and Weather Stripping measure.
TMY3 Climate Data used for the following areas: Front Range = Denver; Western Slope = Grand Junction; Mountains = Alamosa
Heating Degree Days are based on a 65 F breakpoint temperature.
Cooling Degree Days are based on a 65 F breakpoint temperature.
Air Sealing based on an indoor temperature of 70 F.

The 2013 Air Sealing measure was calculated separately using the model home as a baseline and assuming three tiers of air reduction percentages derived from a data set of 349 homes tested both before and after improvement measures. The data was provided by Populs and the homes are located in the Front Range area. Natural air exchange calculations are in accordance with IECC 2009 and ASHRAE Fundamentals.

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Evap 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/di
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
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 (

AC Assumptions:

Baseline equipment meets applicable minimum Federal standards for efficiency
Baseline equipment installation (for QI) has 30.5% efficiency losses.
Baseline equipment installation in Existing Homes has 26.75% efficiency losses
High efficiency equipment exceeds minimum Federal standards for efficiency
Installed equipment does not operate at optimum efficiency until a Quality Installation is completed.

To qualify for a rebate, each piece of equipment must meet the minimum EER and SEER requirements. The customer should provide both the EER and SEER values for the particular piece of equipment. If the customer is unable to provide both values, the value
10-year Average Inflation Rate = 2.57%
CO Weighted Average Cost of Capital = 7.88%
Average Cost of Central AC Repair=$750 (EEBC)
Federal Tax Incentive: As part of the American Recovery and Reinvestment Act of 2009 a Federal Tax Incentive of 30% of the installed cost of a new Ground Source Heat Pump system is available to taxpayers through 2016.
GSHP New Home REMRATE Modeling = Larger , more tightly built, better insulated new home was modeled with GSHP COP of 3.3
GSHP Existing Home REMRATE modeling = Smaller, less tightly built, poorly insulated existing home was modeled with GSHP of 3.3.
GSHP Installed Loop Cost/Ton = $2004 per loop per Ton
GSHP Baseline Equipment Cost combines AC unit and electric resistance heating
GSHP appropriate Quality Install savings included in modeling
No Heating kW saving are claimed for GSHP during winter, only summer cooling kW savings are claimed.

Gas Assumptions:

The baseline water heater is 40 gallon capacity with an Efficiency Factor (EF) of 59%.
The average baseline product cost is based on the cost from RS MEANS Repair and Remodeling Cost Data 2007

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Electric Assumptions:
Typical hot water energy requirement = 4,395 kWh/yr with no losses.
EF for new heat pump water heater = 2.19
EF for baseline electric water heater = 0.91

Building Characteristics for Prototype Home Used for Modeling:

- Single Family
- Two story (Reference 3)
- 3 bedroom 2 bathroom (Reference 3)
- 2000 square feet (Reference 3)
- Basement foundation (Reference 3)
- HVAC:
  - heating - gas furnace 78 AFUE (55.9 kBtu unit required) - 85% of homes have gas heating, and 78% of which are forced air furnaces (Reference 2)
  - cooling - 59% have Central Air Conditioning model required a 2.5 ton unit to meet the cooling load (Reference 2)
  - air handler is in the basement and supply ducts and return ducts are assumed to be in majority interior space
- Windows:
  - 61% of homes have double pane windows (Reference 2)
  - double pane low-E are standard (Reference 4)
  - Model assumes 15% of wall area glazing
  - applied a u-factor of 0.53 (average between clear glass double pane and low-E)

Insulation Levels:

- Existing Ceiling Insulation: R-19 (Reference 4)
- Existing Wall Insulation: R-11 (Reference 4)

Basement Assumptions

- Assumed basement walls to have R-11 insulation
- Basement is considered finished space but not conditioned
- The air handler is located in the basement
- Some homes will have smaller sections of the basement conditioned – maybe a bonus room etc, however this cannot be easily modeled in EnergyGauge

Appliances (Reference 2)

- 85% have dishwashers
- 74% electric ranges
- 88% and 89% have clothes washer and dryer (electric)
- 85% water heating is gas - model used a 40 gallon storage tank
- 68% of homes have ceiling fans

Average Customer Energy Consumption: (Reference 2)

- kWh annually: 9,000 roughly for a 2,000 square foot home
- Therms annually: 835

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