

DEEMED SAVINGS TECHNICAL ASSUMPTIONS

Product: Insulation Rebate

Residential natural gas and/or electric customers receive a cash rebate for installing insulation in their existing single-family home or one-to-four unit property.

Algorithms:

Attic insulation and bypass sealing natural gas savings (Dth)	$= (1 / (2 + RatticE) - 1 / (2 + RatticN)) \times SFAI \times Dth_Per_SF_Attic$
Attic insulation and bypass sealing electric savings (Heating and Cooling) - Customer kWh	$= (1 / (2 + RatticE) - 1 / (2 + RatticN)) \times SFAI \times (Heating_kWh_Per_SF_Attic + Cooling_kWh_Per_SF_Attic)$
Attic insulation and bypass sealing savings - Customer kW	$= Customer\ kWh / (Hours_Electric\ Heating + Hours_Electric\ Cooling)$
Air sealing and weather-stripping natural gas savings (Dth) 2012 only	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. 25% reduction = 7.4 Dth
Air sealing and weather-stripping savings - (Heating and Cooling) - Customer kWh 2012 Only	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.
CFM_Natural_Winter_Before (or After)	$= CFM50_Before \times 1/N_Winter$ $= CFM50_After \times 1/N_Winter$
CFM_Natural_Summer_Before (or After)	$= CFM50_Before \times 1/N_Summer$ $= CFM50_After \times 1/N_Summer$
Air sealing and weather-stripping natural gas savings (Dth) 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. $= (CFM_Natural_Winter_before - CFM_Natural_Winter_after) \times ATF \times HDD \times 24\ hours/day / 0.78\ Eff / 1,000,000\ BTU/Dtherm$
Air 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 = $(CFM_Natural_Summer_before - CFM_Natural_Summer_after) \times ATF \times CDD \times 24\ hours/day / COP / 3412$ Heating = $(CFM_Natural_Winter_before - CFM_Natural_Winter_after) \times ATF \times HDD \times 24\ hours/day / COP / 3412$

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Wall insulation natural gas savings (Dth)	= $Dth_Per_SF_Wall \times SFWI$
Wall insulation savings (Heating and Cooling) - Customer kWh	= $kWh_Per_SF_Wall \times SFWI$
Electric Energy Savings - Generator kWh	= $Customer\ kWh / (1 - TDLF)$
Electric Demand Savings - Generator kW	= $Customer\ kW \times CF / (1 - TDLF)$

Variables:

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
SFAI	= Square footage of attic insulation added, provided by customer
SFWI	= Square footage of wall insulation added, provided by customer
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 savings 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	= Dth savings 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	= kWh savings 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.
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.

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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 3 for Summer and Winter N Factors
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%
Transmission Distribution Loss Factor (TDLF)	Transmission Distribution Loss Factor = 7.7%, the percentage loss of electricity as it flows from the power plant to the customer.
Net-to-Gross Factor (NTG)	= We will use 89% for the NTG for gas and electric projects. (Reference 3)
Non-Energy O&M savings	= Operation and Maintenance savings are assumed to be zero for the insulation rebates.
Energy O&M savings	= Energy O&M savings will be calculated by measure for the portion of energy savings attributed to a fuel not served by Xcel Energy. The energy savings will be converted into a cost savings based on Xcel utility rates.

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 only)	1521	908	444	NA
Cooling Air Sealing and Weatherstripping Customer kWh (2012 only)	NA	5	3	0

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Table 2: Measure lives and incremental costs

Type of insulation:	Measure life:	Incremental cost:
Attic insulation and bypass sealing	20 years (Reference 1)	Will use actual Costs
Air sealing and weather-stripping	10 years (Reference 1)	Will use actual Costs
Wall insulation	20 years (Reference 1)	Will use actual Costs

Table 3: N Factors for determining Air Sealing air change rates:

No. Stories	Summer N Factor			Winter N Factor		
	Front Range	Western Slope	Mountains	Front Range	Western Slope	Mountains
1	20.5964443	19.70269391	19.24868917	14.10839516	15.70890621	14.86381765
2	18.09842437	17.74736798	15.7625844	11.06840836	12.11602593	11.28339038
3	16.85202121	16.89930072	13.90965443	9.50814917	10.30767892	9.517098862

Table 4: 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

Needed from Customer/Vendor/Administrator for Calculations:

Heating System Fuel - gas or electric?

Elec Heating System Type - Elec Resistance, Air Side Heat Pump (ASHP), Ground Source Heat Pump (GSHP)

Elec Cooling System Type - Conv AC, Evap Cooling; ASHP, GSHP

Blower Door Test-in CFM50

Blower Door Test-out CFM50

Climate Zone (Front Range, Western Slope, or Mountains)

Number of Stories in Home

Conditioned Square Footage

Was attic insulation and bypass sealing completed?

Attic insulation square footage

Attic insulation existing R value

Post insulation attic R value

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Was air sealing and weather stripping completed?

Was wall insulation completed?

Wall insulation square footage

Cost of attic insulation

Cost of air sealing and weather sealing

Cost of wall insulation

Assumptions:

For attic insulation, we will use actual existing R values for the baseline and actual complete R values for the high efficiency.

The baseline home **for 2012** had an existing ACH natural of 0.60 and the change case had a 25% reduction to 0.45 ACH natural.

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 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.

Energy modeling with Energy Gauge

For attic insulation calculations, the 2 added to the existing and new insulation R values represents the air film and insulative properties of the ceiling structure.

For wall insulation calculations we have assumed that there is no insulation in the wall or the wall contains one inch or less of insulation or is not positioned correctly and therefore is not effectively insulating the wall.

The savings were calculated by computer modeling of a typical residential home in the Denver metro area. The hypothetical modeled home was created with the most common characteristics from our Residential Home Energy Use Study in 2006 and adjusted so its calculated energy consumption was close to the overall average of Public Service's gas heated homes in the metro area. The savings from adding ceiling insulation was determined by changing the characteristic in the model and recalculating the resulting gas consumption and similarly with insulating walls and reducing air infiltration.

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.

Materials for adding ceiling insulation could be fiberglass batts, loose blown fiberglass/rock wool and other similar materials or blown cellulose.

Typically, insulators will install a similar material to those already in place. The key factor is that the contractor has installed sufficient materials to meet the final "R value" required (38 in most areas and up to 49 in others).

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	Specifics	Dth/yr-home
Attic Insulation	R19 to R38/R49*	5.9
Air Sealing Tier 1	Min 10% Reduction	4.2
Air Sealing Tier 2	Min 25% Reduction	7.4
Air Sealing Tier 3	Min 33% Reduction	10.3
Wall Insulation	Empty Cavity to R11	32.3

*IECC 2006 may require R49 in mountain areas

Changes From 2011:

Modified Air Sealing calculation method and established tiers of achievement.

References:

1. California Measurement Advisory Committee (CALMAC) Protocols, Appendix F (www.calmac.org/events/APX_F.pdf).
2. 2005 Residential Home Use Study MN - Xcel Energy Market Research
3. National Energy Efficiency Best Practices Study - Residential Single-Family Comprehensive Weatherization Best Practices Report from December 2004.