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2011 Residential Codes Energy Use Savings

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TABLE OF CONTENTS

LIST OF TABLES

Exec Summary

Over the past thirty-plus years, the Pacific Northwest has successfully pursued state residential energy codes and building programs to create ever more efficient housing. Since its inception, NEEA has played a pivotal role in aiding states to deliver more effective and efficient energy codes. Under the Residential Codes – Energy Use Savings contract to NEEA, Ecotope quantified the energy use, energy savings, and incremental costs for a number of energy codes and efficient housing initiatives throughout the Northwest.

Specifically, the project included:

- Calculating energy use for new residences built to the current state energy codes in Oregon, Washington, Idaho, and Montana compared to the previous energy code.
- Estimating the incremental new construction costs of the current state energy codes in Oregon, Washington, Idaho, and Montana compared to the previous energy code.
- Comparing the current state energy code energy use to that used in the 6th Northwest Power Plan baseline house.
- Calculating a savings rate for houses built in Oregon in 2011 under the EnergyStar for Homes program.
- Providing comments on NEEA's influence on setting codes by reviewing a NEEA document on the topic (refer to Appendix A).
- Calculating the energy savings for gas heated houses built to various beyond code energy efficient programs in 2011.

The project was designed as a paper-to-paper comparison which uses the energy code or program specifications as calculation inputs. The energy use estimates are made with calibrated simulations and engineering models. Therefore, the project is a paper comparison of different energy code vintages and efficient housing programs. Code compliance rates were not taken into account in the study suggesting the energy savings reported are a likely upper bound of savings. Only a field study of actual construction practice and compliance, however, is able to make that determination.

Ecotope used the best information sources available and most current calculation procedures for the project. Updated approaches include a new version of SEEM, the energy use modeling tool, which more accurately models infiltration and ventilation. Further, Ecotope also evaluated all codes and standards within the same analytical context, updating older analyses as needed, so the results are internally consistent. Lastly, the analysis includes only regulated loads: space heating and cooling, water heating, lighting and ventilation. Loads not regulated by the code, including appliances and plug loads are excluded.

Overall, the project documented the savings potential for energy code improvements and beyond code efficiency programs throughout the Pacific Northwest. A particular interest and effort in the project was to estimate incremental energy savings and costs for the most recent round of state energy code changes. Table 1 shows the relevant energy codes.

Table 1. State by State Code History.

State	Code in 2011	Previous Code
Oregon	ORSC 2011	ORSC 2008
Washington	WSEC 2009	WSEC 2006
Idaho	IECC 2009	IECC 2006
Montana	IECC 2009 w/ MT amend.	IECC 2003 w/ MT amend.

Table 2 gives the estimated savings of the new code in each state on a per unit basis. The estimates are a weighted average of all construction types, heating system types, and climates in a given category and state. Further, the estimates consider both the electric and gas savings separately. For example, in Washington, for any single family residence constructed, the new code saved 842 kWh/year and 93 therm/year over the previous code. Overall in Washington, for any residency unit constructed, single family or multi family, the new code saved 731 kWh/year and 74 therms/year. The savings vary from state to state based on how much the code changed over the previous effective code, the local housing stock, and climate.

Table 2. Estimated Energy Savings per Unit Built – both Electric and Gas.

		Oregon	Washington	Idaho	Montana
Single Family	kWh/yr	115	842	888	912
	therm/yr	27	93	30	102
Multi Family	kWh/yr	240	362	153	717
	therm/yr	2	10	0	15
Overall	**kWh/yr**	**141**	**731**	**818**	**885**
	therm/yr	**22**	**74**	**28**	**90**

Table 3 provides estimates of weighted average incremental cost per unit built. The costs, in 2006 dollars, typically include, depending on the code, envelope measures, duct sealing, HVAC equipment upgrades, house sealing, and lighting upgrades. The numbers are designed to be the minimum cost necessary to achieve the code changes pertaining to energy consumption in the building.

Table 3. Incremental Cost per Unit Built.

		Oregon	Washington	Idaho	Montana
Single Family	2006 $s	$ 1,182	$ 1,573	$ 654	$ 2,488
Multi Family	2006 $s	$ 718	$ 3,824	$ 230	$ 1,128
Overall	**2006 $s**	**$ 1,086**	**$ 1,385**	**$ 614**	**$ 2,299**

1. Introduction

Over the past thirty-plus years, the Pacific Northwest has successfully pursued state residential energy codes and building programs to create ever more efficient housing. Since its inception, NEEA has played a pivotal role in aiding states to deliver more effective and efficient energy codes. Under the Residential Codes – Energy Use Savings contract to NEEA, Ecotope quantified the energy use, energy savings, and incremental costs for a number of energy codes and efficient housing initiatives throughout the Northwest.

Specifically, the project included:

- Calculating energy use for new residences built to the most current state energy codes in Oregon, Washington, Idaho, and Montana compared to the previously effective energy code.
- Estimating the incremental new construction costs of the most current state energy codes in Oregon, Washington, Idaho, and Montana compared to the previously effective energy code.
- Comparing the current state energy code energy use to that used in the 6th Northwest Power Plan baseline house.
- Calculating a savings rate for houses built in Oregon in 2011 under the EnergyStar for Homes program.
- Providing comments on NEEA's influence on setting codes by reviewing a NEEA document on the topic (refer to Appendix A).
- Calculating the energy savings for gas heated houses built to various beyond code energy efficient programs in 2011.

All of the work in the report is based on paper-to-paper comparisons of building specifications. The energy use and savings estimates are based on simulations and engineering models calibrated to measurements at various points but no field work was conducted nor measurements made in this study. In this way, the compliance rates with the building codes were assumed to be 100%. Therefore, this analysis is likely to produce an upper bound of energy savings, however, only a study on code compliance and realization rate will be able to determine that.

Ecotope made every effort in this project to use the best information sources and most current calculation procedures. Section 2, on methods, describes the sources and procedures used. Section 3 summarizes the findings while Section 4 presents conclusions.

2. Method

The process and methods employed in this project are similar across the majority of the tasks. Broadly, most tasks required estimating residential building energy use while another required estimating incremental new construction first costs. First, the energy use estimation methodology is summarized broadly because it applies to many tasks. Then, for each specific task, the exact methods used are described. In a subsequent section, we discuss the development of incremental cost estimates.

2.1. Energy Calculations

The analysis approach used is the same methodology approved by the Regional Technical Forum to estimate savings of the proposed 2011 ORSC[1]. Where necessary, it has been adapted to suit the investigated codes. Broadly, the analysis methodology is to develop a representative set of prototypical houses whose energy use can be estimated through simulation tools. These representative characteristics include climate, single or multi- family occupancy, house size, ground contact type (slab, crawl, or basement), and heating system type.

The building energy use was predicted by a combination of numerical simulations and engineering calculations. SEEM (Simplified Energy and Enthalpy Model) was used to simulate heating, cooling, and ventilation energy use. The program combines building shell characteristics, thermostat settings, occupant behavior inputs, descriptions of heating and cooling systems, and duct distribution efficiency to develop an overall estimate of energy requirements of a house. Additionally, engineering calculations calibrated by field studies were employed to determine the energy use for lighting and water heating. Lighting energy calculations were done using a lighting power density method corresponding to the level of regular and high efficacy lights required by the codes. This method assumes all lamps in the house operate 1.5 hours per day throughout the year[2]. Water heating energy was calibrated to the equivalent of 18 gals per day per occupant[3]. Single family occupancy is 2.5 people/house and multi-family is 1.7 people per unit.

New to this analysis, compared to previous, related work on residential codes delivered to NEEA on 3/01/2011 (Contract #40320) and on 12/22/2010 (Contract #40263), is an updated version of SEEM, the energy use modeling tool. The updated version more accurately models infiltration and ventilation for houses which has become especially relevant in the most recent code cycles.

Importantly, this analysis includes only regulated loads: space heating and cooling, water heating, lighting and ventilation. Loads not regulated by the code, including appliances and plug loads are excluded from the analysis. Since they are not regulated, there will be no savings from them year over year due to code changes.

[1] RTF Meeting 9/2010. http://www.nwcouncil.org/energy/rtf/meetings/2010/09/Default.htm
[2] RTF Meeting 9/2010: http://www.nwcouncil.org/energy/rtf/meetings/2010/09/Default.htm
[3] RTF provisionally approved savings measure: http://www.nwcouncil.org/energy/rtf/measures/measure.asp?id=176

SEEM (version 0.94), the residential energy-simulation program used for the analysis was developed by and for the Northwest Power and Conservation Council and the Northwest Energy Efficiency Alliance (NEEA), and written by Larry Palmiter of Ecotope. It is the simulation engine used to provide heating and cooling energy savings estimates for the residential sector in the Northwest Power Plan, for the Performance Tested Comfort System (PTCS) incentive program, as well as numerous other utility program offerings. SEEM is also used extensively to support state building energy code revisions including, most recently, the revised Washington State Energy Code and Oregon Residential Specialty Code.

The SEEM program consists of an hourly thermal, moisture (humidity), and infiltration simulation that interact with ducts, equipment, building shell and weather parameters to calculate the space conditioning requirements of the building. It is based on algorithms consistent with current American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), American Heating and Refrigeration Institute (AHRI), and International Organization for Standards (ISO) calculation standards. The simulation generates outputs used in this analysis; they include building heat loss (UA), heating equipment input energy, cooling equipment input energy, and ventilation equipment input energy.

The weather files used in all savings simulations are composite TMY weather files corresponding to the heating and cooling climate zones assigned to each Northwest county by the Northwest Power and Conservation Council. [4]

Four distinct building prototypes were used in the SEEM simulations: a 1344 ft^2 (square foot) ranch style home, a 2200 ft^2 split level home, a 2688 ft^2 home with a full conditioned basement, and 952 ft^2 unit in an eight-unit townhouse structure. These are standard analytical prototypes used by the Northwest Power and Conservation Council to develop and evaluate energy forecasts and conservation plans for the region's utilities. The 952 ft^2 prototype is a special case in this analysis which represents multifamily construction. The state codes regulate multifamily structures three stories or less which the 952 ft^2 prototype represents well. This type of construction has many shared walls so the overall heating load per unit is less than for a single family detached dwelling.

The 1344 ft^2, 2200 ft^2, and 952 ft^2 prototypes are split further into crawl space or slab-on-grade construction. Next, each prototype is assigned a weight in proportion to its frequency of occurrence in the building population. By creating a weighted average of prototypes, a single estimate is made to represent the energy use of constructing a new house in a given state. Accounting for the different ground contact possibilities there are five prototypes used to describe the single family house (1344 crawl and slab, 2200 crawl and slab, 2688 basement) and two prototypes used to describe multi-family construction (952 crawl and slab).

[4] http://www.nwcouncil.org/energy/rtf/zones/zonemapsx.htm

2.1.1. Four State Code Energy Usage and Savings

Ecotope estimated the site energy use and savings for houses built in Oregon, Washington, Idaho, and Montana under the energy codes effective in 2011. The energy use is compared against the previously effective energy code. The relevant codes are given in Table 1.

By referencing state building energy codes and housing characteristics surveys[5], Ecotope developed a picture of the new construction markets in each of the four states. The analysis was constructed in a way to produce energy use and savings for a given house using one of four space conditioning systems in a given climate in each state. The energy end-uses considered in the house were space heating, space cooling, ventilation, domestic water heating, and lighting. The analysis applies to site-built single family houses and multi-family dwellings three stories or less with independent mechanical systems (i.e. townhouses).

In general, code changes can include prescribed improvements of envelope insulation as well as lighting, heating and cooling efficiency. All of the state codes generally included improvements to envelope insulation in this code cycle. OR, WA, and MT had provisions increasing the house tightness. All states addressed duct sealing for those houses with forced-air systems. Lighting was regulated for the first time in WA, ID, and MT requiring 50% of all lights to be high efficiency (CFLs) which provides substantial electric savings. OR regulated lighting to that level in 2008 and did not increase the level in 2011.

Heating and cooling system efficiency baselines are set by the National Appliance Energy Conservation Act (NAECA) which required HSPF 7.7 / SEER 13 or better and AFUE of 0.78. Both OR and WA have provisions for increasing equipment efficiency over the federal level. Water heater efficiency standards are similarly regulated under NAECA. Likewise, the federal requirements for water heating equipment in 2011 were used in the analysis. Thus, the changes in energy use for each state are a diverse, complex, and interacting set of measures.

Both OR and WA codes provide a particular challenge for the analysis used in this project. In the 2008 ORSC, 2011 ORSC, and 2009 WSEC, there is a prescriptive set of building requirements plus a list of additional measures. The builder must select one or several items from the additional measure list. Through conversations with officials in both states, Ecotope has determined that the particular measure selected is not well known. Consequently, Ecotope has selected some of the most likely measures based on lowest cost. The choices have been supported by the Regional Technical Forum when used to analyze EnergyStar Homes savings

[5] Single-Family Residential New Construction Characteristics and Practices Study. March 27, 2007. Prepared for Northwest Energy Efficiency Alliance by RLW Analytics. http://neea.org/research/reportdetail.aspx?ID=191

Multi-Family Residential New Construction Characteristics and Practices Study. June 14, 2007. Prepared for Northwest Energy Efficiency Alliance by RLW Analytics. http://neea.org/research/reportdetail.aspx?ID=193

Baseline Characteristics of Residential Construction Practices: Idaho, Montana, Oregon and Washington , Market Research Report (01-095). December 2001. Prepared for Northwest Energy Efficiency Alliance by Ecotope. http://neea.org/research/reportdetail.aspx?ID=158 estimates. For WSEC 2009, we asserted houses would be built using Measure 1a which is the upgraded furnace (AFUE 92) and heat pump (HSPF 8.5). For ORSC 2008, we assumed a similar equipment upgraded to furnace AFUE 92 and heat pump HSPF 8.5. For ORSC 2011, we assumed the same equipment upgrade (Conservation Measure A) and the additional choice of building tightness to 6ACH50 and duct sealing (Envelope Enhancement Measure 5). A further special case is required for ORSC 2011 zonal resistance heated houses since they don't have ducts to be sealed or similar equipment upgrade possibilities. For those houses, we asserted Envelope Enhancement Measure 1 and Conservation Measure D. It must be stressed, however, that these are assumptions, albeit reasonable ones. Different assumptions about code compliance (or differential uptake of the additional measures in the marketplace) will lead to different savings estimates.

2.1.2. New Code Comparison to 6th Power Plan

Ecotope conducted a comparison of the currently extant state energy codes to the 6th Northwest Conservation and Electric Power Plan baseline house specifications to estimate electric savings. The relevant energy codes are found in:

- Oregon – ORSC 2011
- Washington – WSEC 2009
- Idaho – IECC 2009
- Montana – IECC 2009 with MT amendments

Ecotope referenced the 6th Power Plan supporting spreadsheets[6] and the previously described work on current state codes to make the energy use comparison. The 6th Plan describes the base case house characteristics in Appendix G[7]. For reference, the base case is summarized here. Table 4 describes the house shell.

[6] http://www.nwcouncil.org/energy/powerplan/6/supplycurves/default.htm
[7] http://www.nwcouncil.org/energy/powerplan/6/final/SixthPowerPlan_Appendix_G.pdf

Table 4. 6th Plan Base Case Efficiency Levels. Excerpt from Appendix G.

Appendix G: MCS Cost-effectiveness for Residences Sixth Power Plan

Table G-1: Base Case Efficiency Level Assumptions

Component	Site Built Homes	Manufactured Homes
Attic	R38 Standard Framing	R38 Intermediate Framing
Door	R5	R5
Floor	R30	R22
Infiltration	0.35 Air changes per hour	0.35 Air changes per hour
Joisted Vault	R30	R19
Slab-on-Grade (F-Value/linear foot of perimeter)	R10	Not Applicable
Trussed Vault	R38	R19
Wall	R19 Standard Framing	R19
Wall Below Grade (Interior)	R21	Not Applicable
Slab-below-Grade (F-Value/lin.ft. perimeter)	R10	Not Applicable
Window	Class 35 (U<0.35)	Class 50 (U<0.50)

Other house characteristics include lighting power density of 1.75 W/ft^2 (full incandescents), gas furnace AFUE at 78, heat pump HSPF of 7.7, air conditioning SEER of 13, an electric water heater tank base of EF-0.9 at 50 gallons, and unsealed duct systems.

After examining the supporting spreadsheets for the 6th Power Plan, we determined the best comparison between the plan and current state codes would be to run simulations for the 6th Plan with current techniques. Specifically, this involves running simulations using SEEM94 with the base case efficiency level assumptions listed in Table 2. The calculations for lighting energy use in the 6th Plan assumed 2 hrs per day of on time. Recent changes show 1.5 hrs per day is a more typical number[8]. In all, our approach assures that we can conduct a valid comparison using the most up-to-date modeling assumptions.

Ecotope used the same prototype single family houses found in the plan: 1344 ft^2, 2200 ft^2, and 2688 ft^2. We re-weighted the Power Plan prototypes to match the estimates used in our state code analysis. That re-weighting better reflects recent housing trends[9]. Multi-family housing presented more of a departure because the 6th Plan used different model prototypes. To assure a valid comparison to our results, we used the 952 ft^2 prototype as had been used in the previous code work.

[8] RTF Meeting 9/2010: http://www.nwcouncil.org/energy/rtf/meetings/2010/09/Default.htm

[9] Single-Family Residential New Construction Characteristics and Practices Study. March 27, 2007. Prepared for Northwest Energy Efficiency Alliance by RLW Analytics. http://neea.org/research/reportdetail.aspx?ID=191

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2.1.3. Oregon EnergyStar Homes Usage and Savings

For the 2011 program year, Ecotope calculated the savings resulting from the regional Northwest EnergyStar for Homes (NWESH) program for Oregon. The baseline energy use for these houses is the Oregon residential energy code effective in 2011 which was developed using the methods in section 2.1.1. To determine the energy savings, Ecotope constructed new simulations representing the EnergyStar Homes specification. The relevant EnergyStar specification, Builder Option Package (BOP), was developed and approved in 2008.[10] It was effective in Oregon through the end of 2011. The BOP included a base set of prescriptive requirements and then four alternative pathways from which to build a compliant house. The multiple pathways somewhat complicates the analysis since, although similar, they yield different levels of savings. Ecotope's approach was to use the actual number of EnergyStar homes built in OR in 2011 to determine the weighting appropriate to each pathway.

Table 5. OR EnergyStar Houses Built in 2011

BOP Pathway	Label	#	%
2009 OR BOP 1 - Ducts Inside	BOP1d	8	1.0%
2009 OR BOP 1 - Envelope Upgrade	BOP1a	748	93.3%
2009 OR BOP 1 - On Demand Water Heater	BOP1b	30	3.7%
2009 OR BOP 2	na	1	0.1%
OR High Performance Home BOP	na	15	1.9%
2011 Total Certified Homes		802	100.0%

Fluid Market Strategies, who oversees the EnergyStar program database, provided a list of the construction pathways which is shown in Table 5. The table clearly shows the most popular pathway is the "Envelope Upgrade". Secondary paths are the "Demand Water Heater" option and placing "Ducts Inside". Almost no houses were built using BOP 2 which is for electric zonal resistance construction. Therefore, we did not model this scenario. The last BOP is the OR High Performance Home which was selected less than 2% of the time. The specifications will produce more savings than for those of any BOP 1 but we, again, elected not to model the scenario due to the small number of cases.[11]

2.1.4. Additional Gas/AC House Savings

In addition to the state energy codes, there are several, active "beyond code" efficient housing programs in the Northwest. These programs have specifications designed to produce houses with even lower energy uses than code levels. Specifically, Ecotope estimated the energy savings of several, beyond code programs for gas heated houses with air conditioning. The program list included:

[10] http://www.nwcouncil.org/energy/rtf/meetings/2008/02/Oregon%20EnergyStar_RevisedBOP_020508.ppt

[11] In subsequent analysis, it may be desirable to account for energy savings from these buildings. Ecotope recommends simply counting the High Performance Houses as regular EnergyStar Homes. This will be a small underestimate of their energy savings.

- EnergyStar Washington
- Built Green 5 Star Washington
- EnergyStar Oregon
- NAHB (Built Green) 4 Star / EnergyStar Idaho and Montana
- NAHB (Built Green) 5 Star Idaho and Montana

Ecotope provided savings estimates for EnergyStar in WA, OR, ID, and MT. Through independent research and discussions with NEEA, we determined that the NAHB 5 Star specification does not exist in ID and MT (or not in any form from which reliable energy savings can be calculated) and that the BuiltGreen 5 Star Washington specification was not prescriptive enough to guarantee reliable energy savings. The BuiltGreen 5 Star spec, however, does require the EnergyStar spec in Washington to be met, however, so, at minimum, the EnergyStar savings can be used in that case.

To determine the energy savings, Ecotope referenced earlier analysis conducted for the Regional Technical Forum. The relevant documents are available on the RTF website.[12] For clear reference, Ecotope consolidated the appropriate data from that analysis within the current delivered spreadsheet for this project. The savings for the WA, ID, and MT come directly from the RTF workbook, while the OR savings are linked to the current analysis.

2.2. Incremental Costs

Ecotope developed cost estimates for the changes in the codes that pertained to energy consumption in the house. These typically included, depending on the code, envelope measures, duct sealing, HVAC equipment upgrades, house sealing, and lighting upgrades.

The costs are calculated separately for single and multi-family construction and further divided between electric and gas. The costs are split on fuel type to allow for cost-effectiveness calculations of electric and gas savings. Some costs, such as those associated with lighting, clearly apply to the electric savings. Other costs, such as those for envelope improvements, that reduce both gas heating and electric cooling requirements, are divided into gas and electric categories based on a 0.9 / 0.1 split. In other words, 90% of the envelope upgrade cost is applied to gas heating and 10% to electric cooling. The 90/10 split roughly reflects the energy use and savings split between heating and cooling across the Northwest. For heat pump or zonal resistance houses, there is no ambiguity, and all costs are clearly electric.

The costs are developed for a given set of prototype houses built up from individual measures. For example, the individual measures can include items like roof and wall insulation. The cost of upgrading the envelope then is calculated by multiplying the prototypical roof area by the insulation upgrade cost per unit area and so on for each construction component. The component costs are summed to create a full cost for the prototype. For a full development of the cost estimates, refer to section 173.2.

[12] http://www.nwcouncil.org/energy/rtf/measures/measure.asp?id=147

The individual measure cost estimates were based on a number of sources which primarily include the Northwest Power Council's 6th Power Plan Appendix G,[13] the Energy Trust of Oregon's 2010 Resource Assessment,[14] and various measure analyses from the RTF.[15]

[13] http://www.nwcouncil.org/energy/powerplan/6/default.htm
[14] http://energytrust.org/library/reports/021611_ResourceAssessment.pdf
[15] http://www.nwcouncil.org/energy/rtf/measures/Default.asp

3. Findings

3.1. Energy Use and Savings Findings

There are copious outputs for this analysis, best displayed in spreadsheets, which accompany this document. During the course of the project, the output spreadsheets were expanded as more tasks were completed. Please refer to "**Appendix B**" which accompanies this report as the source for outputs.

Of note, some commonalities across all the spreadsheets include the following. Gas furnace houses are modeled with gas water heaters. Electrically heated houses are modeled with electric water heaters. Therefore, for gas houses without cooling, the electricity end uses consist of lighting, air handler energy, and ventilation. These are relatively small loads when compared to the totals for houses with heat pumps or zonal resistance heat.

3.1.1. Four State Energy Code Usage and Savings

In the output spreadsheet, on the tabs "2011 Code Energy Consumption sf" and "2011 Code Energy Consumption mf", the total energy use for each of four system types is displayed by climate in each of the four states. There are three heating zones and three cooling zones producing a total of nine climates. Energy consumption is displayed for all code years considered. Additionally, the site use of electricity and gas is tabulated in parallel tables.

Importantly, this analysis and output reflects the most up to date modeling methods and techniques. As such, it differs from previous analyses. Therefore, the energy use estimates should only be compared among this spreadsheet and not between other analyses. Notably, previous analyses used different assumptions on hot water use and ventilation which have recently been improved upon. Additionally, the current version of SEEM produces differing output from older versions. Critically, this does not invalidate previous analyses which still stand on their own as coherent projects.

Of note in the current round of code revisions is the impact that house tightness and ventilation play in the codes. In some states (WA & OR), the levels of mechanical ventilation are regulated. When combined with changes to house tightness levels, this can lead to more electricity use to run the ventilation fans in the new codes compared to the old codes. In other words, there can be negative savings for this particular energy end use.

There are some interesting outputs of the analysis which warrant explanation.

- Electricity use for some gas furnace houses in OR 2011 increases over 2008. The 2011 code provisions (under Envelope Enhancement Measure 5) call for more ventilation which requires more electricity than was present in the 2008 code. Other changes in the code do not make up the difference so there is a slight negative savings on gas heated houses. The 2005-2008 code cycle included a jump from 0% CFLs to 50% CFLs but no broad increase occurred in 2011. In generally, energy use can be expected to decrease 5-

10% across the board in Oregon.

- Washington code improvements are significant especially for therm savings due to the increased HVAC equipment efficiency. Other significant sources of savings are from a change to 50% CFLs and mandatory duct sealing and house tightening.

- Idaho code improvements are somewhat moderate compared to the rest because there were no changes to HVAC equipment efficiency and only minor changes to the envelope. Lighting improved from 0% to 50% CFLs and duct sealing was required. Interestingly, in the multi-family case, the decrease in internal heat gains caused by the adoption of better lighting causes increases the heating requirement in 2009 vs 2006 which shows up as negative therm savings.

- In Montana, there are significant savings across the board as the state moves from the 2003 to 2009 IECC. Moreover, the MT specific amendments to the IECC act to increase the energy savings. Notably changes include improvements in window U-values, underfloor insulation, basement wall insulation, house tightening, and a change from 0% to 50% CFLs.

3.1.2. Comparison to 6th Power Plan

In the spreadsheet, on the tabs "6thPlan-2011Code_comparison", the electric and gas site energy savings for each of four system types is displayed in each of the four states. There are three heating zones and three cooling zones producing a total of nine climates. The savings are calculated for the state code effective in 2011 relative to the Power Plan base efficiency level assumptions.

In general, the relevant improvements in the state codes over the Plan include:

- Lighting power density decrease to 1.1 W/ ft^2 (50% CFLs)
- House envelope improvements (except ID)
- House tightness improvements (except ID)
- HVAC system efficiency upgrades (except ID)
- Duct sealing

In no case did we observe improvements in the water heating so no energy savings was attributed to that end use.

Significant analytical outputs and findings include:

- One of the most significant efficiency improvements over the Plan base level assumptions is the change in lighting from 0% CFLs to 50% CFLs. This produces the majority of the electricity savings shown for all of the gas furnace houses in all states for both single and multi family.

- The most significant savings over the Plan are in OR and WA. Both of those codes include improvements to HVAC system efficiency, duct sealing, house infiltration reduction, and envelope insulation improvements.

- Montana shows the second-most significant savings. The code there does not require HVAC equipment efficiency improvements but does require duct sealing, house infiltration reduction, and envelope insulation improvements.

- Idaho presents a curious case which shows little improvement over the 6th Plan base level assumptions. In some cases, Idaho shows electric savings but these often come at the expense of more gas for heating. This particular feature is due to the change in lighting efficiency levels. Higher lighting efficiency reduces the electricity needed for lighting and simultaneously reduces the heating gains from those lights going into the house. To make up the difference, more heating energy is required from either the furnace, heat pump, or resistance heaters. Further, the 6th Plan base line assumes an R-5 door and R-21 insulation for basement walls. The ID code requires only an R-2 door and R-19 basement wall insulation. These are small differences but do contribute to the total. Lastly, the ventilation requirement under the Idaho code (the IECC 2009) effectively increases the infiltration rate over the base case contributing once again to an increased heating load.

3.1.3. Oregon EnergyStar Usage and Savings

In the spreadsheet, the tab “OR_EnergyStar_2011” displays the electric and gas site energy use and savings for each of three system types. There are three heating zones and three cooling zones producing a total of nine climates. The savings are calculated relative to the Oregon state residential energy code effective in 2011.

3.1.4. Additional Gas/AC House Savings

The tab “GasAC_EStar_NW_2011” on the output spreadsheet displays the electric and gas site energy savings for gas heated houses with air conditioning. There are three heating zones and three cooling zones producing a total of nine climates. The savings are calculated relative to the residential energy code effective in each state in 2011.

3.2. Incremental Cost Findings

The costs, which are incremental over the previous code, are given in 2006 $s and are provided in the “**Appendix B**” spreadsheet on the “Code Incremental Cost” tab. Further, the tab “CostData” shows how the costs were developed for each line item in the “Code Incremental Cost” table. Lastly, the cost estimates in this analysis were shown to generally agree with a previous analysis of the Washington State Energy Code 2009 cost effectiveness report[16] prepared for the WA State Building Code Council.

[16] https://fortress.wa.gov/ga/apps/sbcc/File.ashx?cid=850

4. Conclusions

Ecotope conducted a broad analysis to assist NEEA in quantifying its impact on energy savings due to increasing code stringency in the residential sector. The analysis focused on following areas:

- quantifying code electric consumption and savings in ID, MT, OR, and WA for single family and multifamily houses by heating system type and climate zone;
- quantifying code incremental first costs for single and multifamily houses under each current state code of the previous code by gas and electric end uses;
- quantifying 2011 code energy savings for single family and multifamily houses versus the 6th Power Plain in ID, MT, OR, and WA by heating system type and climate zones;
- quantifying 2011 EnergyStar homes savings rate for Oregon by heating system type and climate zone;
- assisting NEEA in assessing its influence over state energy codes;
- quantifying 2011 "beyond code" energy efficient house programs.

The energy use estimates are made with calibrated simulations and engineering calculations using the energy code or program specifications as inputs. Therefore, the project is a paper-to-paper comparison of different energy code vintages and efficient housing programs. Code compliance rates were not taken into account in the study suggesting the energy savings reported here are a likely upper bound of savings. Only a field study of actual practice and compliance, however, is able to make that determination.

Ecotope used the best information sources available and most current calculation procedures for the project. Updated approaches include a new version of SEEM, the energy use modeling tool which more accurately models infiltration and ventilation for houses which has become especially relevant in the most recent code cycles. Further, Ecotope also evaluated all codes and standards within the same analytical context so the results are internally consistent. Lastly, the analysis includes only regulated loads: space heating and cooling, water heating, lighting and ventilation. Loads not regulated by the code, including appliances and plug loads are excluded from the analysis.

The copious outputs from the analysis are all provided in the workbook accompanying this document titled "**Appendix B**."

Appendix A

The following appendix contains a document (prepared by David Cohan entitled "Recommendations for Naturally Occurring Baselines, Locally Incented Savings, And Net Market Effects for Energy Codes and Standards.") and a review of that document. The document was provided to Ecotope via email on September 30, 2011. David Baylon subsequently reviewed and commented on it. He provided those comments to David Cohan via email on October 20, 2011. The rest of this appendix reprints David Baylon's comments. It has been edited for grammar and clarity but the recommendations remain the same.

Recommendations for Naturally Occurring Baselines, Locally Incented Savings And Net Market Effects for Energy Codes and Standards
by David Cohan, NEEA

This paper describes the underlying logic for estimates of naturally occurring baselines, locally incented savings and net market effects for codes and standards.

SECTION 1: ENERGY CODES

Naturally Occurring Baseline (NOB)

Definition: What would have occurred in the absence of both NEEA and its funders *while NEEA was active in the market*. Because energy codes and standards existed long before NEEA was created, the italicized portion of the definition is critical.

The NOB for energy codes is complicated because it is different for different time periods and in different states. There are two time periods, roughly split at 2008. Before 2008, there was almost no influence on the development of the codes outside the in-state administrative rulemaking processes. Starting in 2008, and continuing today, state legislatures have taken an active role in determining the direction of codes, going so far in Oregon as to state a specific increase in code stringency that had to be met in the next code cycle. At the federal level, US DOE had an explicit goal of increasing the International Energy Conservation Code (IECC, adopted in Montana and Idaho) by 30%.

Each state has had a different history with codes, reflected in the level of stringency that has been achieved over time. Because of this, descriptions are provided by state. Note that the following discussions largely address only code development and adoption. Following the proposed NOB estimate for each state I offer an estimate of the percentage of code training funded by NEEA. The percentage of code training funded by NEEA generally aligns with the percentage of code development and adoption funded by NEEA so no modifications of the NOB recommendation were required to incorporate the training funding perspective.

Washington

Washington has been recognized for 30 years as a national leader in developing energy-saving codes. Since NEEA's creation there have been four primary sources of funding for this work: NEEA, the City of Seattle (a NEEA funder through Seattle City Light), US DOE and, for the past two years, the WA Department of Commerce. Funds from US DOE have fluctuated wildly over the years but even in the highest years probably represented less than 30% of the total. A reasonable average for the whole period might be 15%. The Department of Commerce contribution, spread over the whole period might raise this to 20%.

In 2009, the WA legislature passed SB 5854 which requires that building energy use be reduced by 70% by 2031, starting in 2013. While this has not yet affected any codes it will be the driving force in Washington energy code development for the next twenty years. NEEA was only minimally involved with the passage of 5854 so one could argue that the future NOB is 100%. At the same time, the development of the actual code change proposals and participation on technical advisory groups will continue to rely heavily on NEEA funding. There is also a difficult question of how much the passage of SB 5854 depended on the many years of success Washington has had with codes; success largely funded by NEEA for the past ten years. Beyond that, it is very unclear how the Department of Commerce will achieve the mandate set out in SB 5854 without external funding for the development and defense of code change proposals. The Department essentially has one person working on energy codes and his scope of work is broader than just the codes.

Conclusion/Recommendation: The NOB for Washington should be set at 20% for 1997-2012 and at 50% starting in 2013.

E&T: NEEA funds at least 80% of the education and training in Washington.

Oregon

Oregon has also been an acknowledged, long-time national leader in energy codes. For many years, the Oregon Department of Energy did virtually all the energy code-related work in the state. Since 1997, funding for that work came mainly from NEEA with varying amounts from US DOE. A reasonable breakout for the period 1997-2007 would be 80% NEEA, 20% US DOE.

In 2008, the Oregon legislature passed SB 79 which required a 10% increase in residential energy code stringency and a 15% increase in commercial stringency prior to Jan 1, 2012. This directly impacted the development of the 2010 commercial and 2011 residential energy codes. Additionally, SB 79 instructs the building codes administrator to "consider the target standards described in the Architecture 2030 organization's 2030 Challenge". The administrator has publicly interpreted this to mean that the Oregon Building Codes Division (BCD) should achieve zero energy buildings in code by 2030. NEEA was involved in many of the discussions leading up to the passage of SB 79.

Prior to the 2010 and 2011 codes, it is safe to say that virtually all increases in Oregon energy codes were due to NEEA or its funders. NEEA provided a large majority of the development work for the 2010 commercial code and was a key player in a collaborative that developed the 2011 residential code. Starting with the 2013 commercial code, BCD will be a major driver in increasing energy code stringency. (This assumes the current administrator stays in his position. He is extremely supportive of energy efficiency. His successors may have different viewpoints.)

Conclusion/Recommendation: The NOB for Oregon should be set at 0% for 1997-2009 and at 33% starting in 2010.

E&T: Prior to 2010, NEEA funded 100% of the energy code training in the state. In 2010, BCD offered state-wide trainings with very substantial input from NEEA contractors on curriculum development and delivery. As of 2010, the Energy Trust of Oregon is also actively participating in delivering code training.

Idaho

In 2001, Idaho adopted its first-ever state-wide energy code. Parties involved in that effort stated that it would never have happened without NEEA funding. Since then, Idaho has adopted each succeeding version of the IECC, always with NEEA funding providing the resources to make that occur and frequently with NEEA contractors driving state policy decisions that maintain the momentum to adopt new codes. A small amount of US DOE funding has been obtained over the years.

No legislation has been passed in Idaho specific to adopting energy codes at a specified level but the work of US DOE and many other efficiency advocates at the national level has been instrumental in creating new, increasingly stringent versions of the IECC which have been adopted in the state. Idaho has consistently adopted the IECC without amendments. The state is unique in having a small but influential group of building officials that has championed energy efficiency over the years.

Conclusion/Recommendation: The NOB for Idaho should be set at 0% for 2001-2008 and at 20% starting in 2009.

E&T: NEEA funds almost all energy code training in the state.

Montana

In 2003, Montana adopted the first update to its state-wide energy code since 1989. NEEA funding played a role in that though a much stronger driver was the code administrator pushing a policy for the state to adopt the current version of all building codes. The current code administrator has the same philosophy and up to the most recent adoption of the 2009 IECC which occurred in 2010, there has been little opposition in the state. NEEA and its contractors participate in the adoption hearings but the arguments are mainly around minor amendments rather than whether the code will be adopted.

Conclusion/Recommendation: The NOB for Montana should be set at 70%.

E&T: NEEA funds a large amount of the energy code training in the state but Northwestern Energy and the Department of Labor & Industry also provide training.

SECTION 2: FEDERAL STANDARDS

Background

NEEA participated in the US DOE standards rulemaking processes for the first few years of its existence, then stopped completely from ~2002 through 2008, a hiatus which coincided with a time of extremely low federal standards activity. Starting in 2009, increased funder interest in standards and increased opportunities at the federal level prompted NEEA to begin participating again through a contractor who was then hired as a full-time employee in July 2010.

Naturally Occurring Baseline (NOB)

The Naturally Occurring Baseline for NEEA's standards work is quite high for three reasons. First, the largest influence by far on the efficacy of attempts to have more efficient federal standards adopted is the United States president. This was starkly shown in the transition from the Bush administration to the Obama administration. Under Bush, almost nothing happened (in fact the advocates filed and won a lawsuit charging that the administration was not meeting its legal obligations to run rulemaking processes) whereas activity skyrocketed the day Obama came to power and appointed Steven Chu as his Secretary of Energy.

Second, virtually all advocates for more efficient standards work with the Appliance Standards Awareness Project (ASAP) which has three full-time employees and coordinates efforts among the advocates, serves as a discussion forum and does much of the political lobbying to Congress associated with standards. ASAP would exist with or without NEEA and would cover all of the federal rulemaking proceedings regardless of whether NEEA participated. At the same time, ASAP relies almost completely on its network of advocacy groups to cover the rulemakings and NEEA's addition of a staff member who is extremely experienced with the DOE process and highly regarded by other advocates was a powerful addition to the resources ASAP could work with[17]. The value of his participation has been explicitly acknowledged by the executive director of ASAP on multiple occasions.

Third, the federal rulemaking process is run exclusively by US DOE which establishes the ground rules, determines which information is used and not used in analyses and, perhaps most important, establishes the efficiency levels (usually 5-7 of them, referred to as Test Standard Levels) to be considered in a given rulemaking. The range of options in a rulemaking is therefore pre-determined and in many – though not all – cases, the politically and technically realistic range of outcomes is much smaller, often just two or three of the TSLs. What is normally determined in a rulemaking, therefore, is an incremental difference in the final TSL, though this can still equate to very large energy savings.

On the other side of the coin, there are several reasons why the NOB should clearly be less than 100%. First, NEEA and the Council are the only two Northwest entities that participate in the federal standards rulemaking processes. The Northwest often has its own perspective on individual rulemakings and these would not all be represented without NEEA's involvement. Second, the total number of advocates involved in standards is amazingly small – a few dozen, with an even smaller number being engaged full time. NEEA and the Council participated in more than ten rulemakings in 2010 which gave us an influence far exceeding our size. Finally, the Northwest, and NEEA in particular, has a long history of being a national leader in efficiency and collecting data market penetration of efficient products. On several occasions, this experience and data has been critical in US DOE's willingness to support a higher TSL, again showing that the Northwest's participation in the rulemaking process gives us a disproportionate influence on the outcomes.

Conclusion/Recommendation: The NOB for standards should be set at 80%.

A NOTE ON MEASURE LIFE

I understand that the cost-effectiveness committee has taken a position that we claim savings for only 5 years after a code or standard is adopted based on an assumption that the market would have moved on its own to the stringency level achieved by the new code/standard. I believe there is little evidence to support this position and a large body of evidence that contradicts it. This policy should be re-visited at the next cost-effectiveness committee meeting.

[17] Note that individual advocates do not represent ASAP in rulemakings nor is their typically a full consensus on the advocacy communities' position in a given rulemaking. ASAP, however, is acknowledged by everyone as the central organizer for advocates.

Review of
Recommendations for Naturally Occurring Baselines, Locally Incented Savings AndNet Market Effects for Energy Codes and Standards
By David Baylon, Ecotope

I reviewed your piece on code savings attribution. From Ecotope's third-party perspective, I believe the general accounting is correct but have the following specific comments to add to give more nuance to the attribution question. I have addressed each of the subtopics in categories below.

Naturally Occurring Baseline

The role of energy (and energy efficiency) agencies in the Pacific Northwest has been very decisive to developing energy codes throughout the region. Prior to 1997, Bonneville Power Administration (BPA) spent many millions of dollars on code development and compliance incentives. This was a regional effort which was unambiguously transferred to NEEA. To say that the baseline in 1997 is "naturally occurring" would discount the role of these efforts over the previous decades. It should be pointed out that BPA's funding for this work was part of its obligation under the Northwest Power Act and so the utilities of the region, through their BPA bills, supported this effort as surely as the current system supports NEEA who, in turn, supports the regional code development.

Washington

As I understand this, the assumption is that the NEEA funding is proportional to the NEEA influence. Thus if USDOE gave 20% of the funding it is responsible for 20% of the improvement in any one time period. I'm not sure that make sense, especially when its funding is in the form blocs that support a variety of activities. Indeed the DOE funding does not have any impact on the development of a viable code proposal. A viable code proposal is actually the result of several parties supported largely by the region's electric utilities. I do not believe that this combination is aided by the DOE funding. One could argue that a portion of Chuck Murray's salary, at the Washington Department of Commerce, is supported by DOE funding but, most of his, and all of the Washington State University Energy Office personnel involved in the process were funded by NEEA. If we count John Hogan from Seattle City Light, whose involvement is crucial, as part of this package, I would submit that the fraction of the last code revisions that are separate from the support of NEEA is probably zero. This is especially true since the base of the Washington code is the result of decades of consensus and diplomacy without which there would be no Washington State Energy Code (we would have Idaho). It is this infrastructure that BPA, NEEA, and the electric utilities built, and it is this infrastructure that is responsible for the stringency of the Washington code. Therefore, we can recommend giving little to no attribution to DOE funding and instead allocating it to NEEA.

Oregon

I think your assessment of the Oregon situation is reasonable especially for the pre-2009 period. The issue in Oregon is the question of how much funding is actually coming from the state in the period after 2009. For Oregon, this is more of an administrative process so the politics are much different from Washington but, to the extent Oregon has to develop its own code provisions, the question becomes: Is the state of Oregon doing it or are consultants and experts funded by NEEA doing it? NEEA has a better sense of that than anyone but I would be very surprised if the Oregon legislature, through the Oregon Building Codes Division, is providing an approximation of even one third of the resources that NEEA is.

Idaho

I don't think there is a significant debate that, without NEEA's support, there wouldn't be an energy code to speak of in Idaho. As it is, the International Energy Conservation Code (IECC) is the standard and the fact that the state adopts it on a reasonably current basis is, again, the responsibility of NEEA. If anything, NEEA broke the stranglehold of the builder lobby on the code by providing technical expertise and information, as well as market data. In this sense, the support for the code is provided in large part by NEEA. I am not sure how much of the code consensus depends on these efforts but, likely, most of it does. I am worried that the building officials would be somewhat vulnerable, particularly when current practice deviates from the code requirements, as might occur as the IECC gets more stringent. In that event, the NEEA role would be pivotal. I suppose that I agree that in the current environment NEEA has viable partners so for the period when they are active it is reasonable that they be given some of the credit—20% seems a bit high though.

Montana

To the extent the code mandated different construction practices than was common in Montana without a code, the responsibility probably goes to NEEA. The problem here is that so little of the state uses any code, the importance of training and especially builder training is crucial. In effect, the code is like some sort of market transformation program applied to code provisions. In the residential sector, all of that comes from NEEA. In the non-residential sector, things are a little better but the effort to keep the code current with the ever-evolving IECC has been challenging. It may be difficult to see but I think the role of the region and the utilities is very important. I doubt we would have much of a code in the Montana residential sector without it. The fact that code compliance in Montana is largely voluntary suggests the role of NEEA and, indirectly, NEEA's member utilities, is much greater than 30%.

Federal Standards

I'm not sure what 20% NEEA influence means in this case. Given the complexities of the national standards development process, I doubt it is that high but I have no real basis for any estimate.

Measure Life Estimation

The "measure life" for code provisions is meant to assess the amount of time a provision lasts and creates energy savings before standard practice catches up to the code and the savings then become irrelevant. I agree that the time it takes for standard practices to catch up to or exceed code is very debatable but it has to be some number of years. We know, for example, the use of the highly inefficient, T-12 linear fluorescent lamps largely vanished between 1990 and 1998. The code probably is responsible for that. To the extent the base lighting changed, influenced by higher efficiency code levels, it became reasonable to move to that practice as a base. It is true that the evidence of what would happen if the lighting code was rescinded is not really available; however, I think the absence of the code would have resulted in no actual changes in practice (no lighting efficiency improvements). A similar case could be made for lower U-value vinyl windows. In a mere five years, vinyl drove out residential aluminum windows. The code for windows had to be updated or else it would be irrelevant. Indeed, the gas code in Washington was not updated for 5 more years resulting in a decline in other envelop component improvements as the vinyl windows replaced insulation in the trade-off calculations.

The standard code life used in the 1980s and 1990s was seven years. This was meant to reflect the occupation of the original owner or tenant. There was relatively little evidence in the commercial sector that this was the right number but it was the mean residency time of households throughout the US. On another measure, there was essentially no change in the residential code in Washington between 1991 and 2001. There was essentially no change in the nonresidential code between 1994 and 2001. Oregon's residential code was a breakthrough in 1993 but remained largely unchanged until the 2007 code cycle. By that standard the measure life of the code is probably closer to ten years than five or seven.

		OR	WA	ID	MT	NW
Single Family	kWh/yr	91	647	804	785	
	therm/yr	21	71	28	88	
Multi Family	kWh/yr	49	84	14	100	
	therm/yr	0	2	0	2	
Overall	kWh/yr	141	731	818	885	
	therm/yr	22	74	28	90	

Energy Savings both Electricity and Gas

		Oregon	**Washington**	**Idaho**	**Montana**
Single Family	kWh/yr	115	842	888	912
	therm/yr	27	93	30	102
Multi Family	kWh/yr	240	362	153	717
	therm/yr	2	10	0	15
Overall	kWh/yr	141	731	818	885
	therm/yr	22	74	28	90

Incremental Costs

		Oregon	**Washington**	**Idaho**	**Montana**
Single Family	2006 $s	$ 1,182	$ 1,573	$ 654	$ 2,488
Multi Family	2006 $s	$ 718	$ 3,824	$ 230	$ 1,128
Overall	2006 $s	$ 1,086	$ 1,385	$ 614	$ 2,299

Code	Year Code Effective	Heating System	State	Heating system Weights (2011)	Single Family Whole Home Code Electric Energy Consumption (kWh/Home)									Single Family Whole Home Code Gas Energy Consumption (therms/Home)								
					Heating Zone 1			Heating Zone 2			Heating Zone 3			Heating Zone 1			Heating Zone 2			Heating Zone 3		
					Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3
2008 OR res specialty code	2008	Gas	OR	26%	1,728	1,728	1,728	1,908	1,908	1,908	2,042	2,042	2,042	608	608	608	804	804	804	951	951	951
2008 OR res specialty code	2008	Gas_AC	OR	56%	2,218	2,685	3,300	2,340	2,807	3,422	2,430	2,898	3,512	613	613	613	811	811	811	957	957	957
2008 OR res specialty code	2008	HP	OR	9%	10,967	11,407	11,987	15,234	15,675	16,254	18,845	19,285	19,865	0	0	0	0	0	0	0	0	0
2008 OR res specialty code	2008	Zonal	OR	9%	12,297	12,297	12,297	16,500	16,500	16,500	19,464	19,464	19,464	0	0	0	0	0	0	0	0	0
2011 OR res specialty code	2011	Gas	OR		1,890	1,890	1,890	2,054	2,054	2,054	2,180	2,180	2,180	577	577	577	756	756	756	892	892	892
2011 OR res specialty code	2011	Gas_AC	OR		2,330	2,743	3,284	2,443	2,856	3,396	2,528	2,941	3,482	584	584	584	767	767	767	905	905	905
2011 OR res specialty code	2011	HP	OR		10,096	10,507	11,044	13,387	13,798	14,336	16,390	16,801	17,339	0	0	0	0	0	0	0	0	0
2011 OR res specialty code	2011	Zonal	OR		11,090	11,090	11,090	14,945	14,945	14,945	17,648	17,648	17,648	0	0	0	0	0	0	0	0	0
2006 WSEC	2007	Gas	WA	55%	2,497	2,497	2,497	2,653	2,653	2,653	2,780	2,780	2,780	644	644	644	839	839	839	999	999	999
2006 WSEC	2007	Gas_AC	WA	28%	3,011	3,469	4,082	3,081	3,519	4,107	3,166	3,605	4,192	650	650	650	846	846	846	1,006	1,006	1,006
2006 WSEC	2007	HP	WA	13%	11,643	12,103	12,717	15,355	15,795	16,385	18,752	19,192	19,782	0	0	0	0	0	0	0	0	0
2006 WSEC	2007	Zonal	WA	4%	12,735	12,735	12,735	16,468	16,468	16,468	19,360	19,360	19,360	0	0	0	0	0	0	0	0	0
2009 WSEC	2011	Gas	WA		1,872	1,872	1,872	1,998	1,998	1,998	2,112	2,112	2,112	540	540	540	672	672	672	793	793	793
2009 WSEC	2011	Gas_AC	WA		2,256	2,634	3,136	2,347	2,714	3,204	2,424	2,791	3,281	547	547	547	681	681	681	804	804	804
2009 WSEC	2011	HP	WA		9,883	10,282	10,811	12,453	12,841	13,357	15,064	15,452	15,968	0	0	0	0	0	0	0	0	0
2009 WSEC	2011	Zonal	WA		12,138	12,138	12,138	15,435	15,435	15,435	18,234	18,234	18,234	0	0	0	0	0	0	0	0	0
2006 IECC	2008	Gas	ID	7%	2,535	2,535	2,535	2,718	2,718	2,718	2,864	2,864	2,864	708	708	708	938	938	938	1,122	1,122	1,122
2006 IECC	2008	Gas_AC	ID	80%	2,981	3,446	4,076	3,095	3,554	4,176	3,193	3,652	4,273	715	715	715	947	947	947	1,131	1,131	1,131
2006 IECC	2008	HP	ID	7%	12,303	12,770	13,401	16,715	17,176	17,799	20,615	21,076	21,698	0	0	0	0	0	0	0	0	0
2006 IECC	2008	Zonal	ID	7%	13,748	13,748	13,748	18,098	18,098	18,098	21,394	21,394	21,394	0	0	0	0	0	0	0	0	0
2009 IECC	2011	Gas	ID		1,834	1,834	1,834	2,001	2,001	2,001	2,135	2,135	2,135	683	683	683	891	891	891	1,060	1,060	1,060
2009 IECC	2011	Gas_AC	ID		2,196	2,601	3,149	2,300	2,700	3,238	2,391	2,791	3,329	693	693	693	906	906	906	1,077	1,077	1,077
2009 IECC	2011	HP	ID		11,094	11,502	12,051	15,026	15,428	15,968	18,549	18,951	19,491	0	0	0	0	0	0	0	0	0
2009 IECC	2011	Zonal	ID		13,400	13,400	13,400	17,730	17,730	17,730	21,048	21,048	21,048	0	0	0	0	0	0	0	0	0
2003 IECC with amendments	2005	Gas	MT	32%	2,654	2,654	2,654	2,831	2,831	2,831	2,967	2,967	2,967	652	652	652	875	875	875	1,047	1,047	1,047
2003 IECC with amendments	2005	Gas_AC	MT	54%	3,032	3,433	3,998	3,153	3,554	4,119	3,244	3,645	4,210	658	658	658	884	884	884	1,055	1,055	1,055
2003 IECC with amendments	2005	HP	MT	7%	11,611	12,015	12,581	15,694	16,098	16,664	19,214	19,617	20,184	0	0	0	0	0	0	0	0	0
2003 IECC with amendments	2005	Zonal	MT	7%	13,314	13,314	13,314	17,762	17,762	17,762	21,025	21,025	21,025	0	0	0	0	0	0	0	0	0
2009 IECC with amendments	2011	Gas	MT		2,033	2,033	2,033	2,181	2,181	2,181	2,302	2,302	2,302	587	587	587	772	772	772	924	924	924
2009 IECC with amendments	2011	Gas_AC	MT		2,367	2,711	3,190	2,468	2,812	3,291	2,550	2,894	3,373	595	595	595	784	784	784	937	937	937
2009 IECC with amendments	2011	HP	MT		10,178	10,524	11,005	13,521	13,867	14,349	16,508	16,854	17,335	0	0	0	0	0	0	0	0	0
2009 IECC with amendments	2011	Zonal	MT		12,096	12,096	12,096	16,041	16,041	16,041	19,129	19,129	19,129	0	0	0	0	0	0	0	0	0

- 2011 code savings rate for multifamily homes by he
- 2011 code savings rate for single-family homes by l
- 2011 Code incremental first costs

- 2011 code energy savings rates vs. the Power Plar
- 2011 Energy Star homes savings rate for Oregon b

					HZ1CZ1	HZ1CZ2	HZ1CZ3	HZ2CZ1	HZ2CZ2	HZ2CZ3	HZ3CZ1	HZ3CZ2	HZ3CZ3	HZ1CZ1	HZ1CZ2	HZ1CZ3	HZ2CZ1	HZ2CZ2	HZ2CZ3	HZ3CZ1	HZ3CZ2	HZ3CZ3
Energy Savings					Single Family Electricity Savings (kWh/yr) per House									Single Family Therm Savings (therm/yr) per House								
					Heating Zone 1			Heating Zone 2			Heating Zone 3			Heating Zone 1			Heating Zone 2			Heating Zone 3		
Current Code	Previous	System	State		Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3
2011 OR res specialty code	2008 OR res	Gas	OR		-163	-163	-163	-147	-147	-147	-138	-138	-138	31	31	31	48	48	48	59	59	59
2011 OR res specialty code	2008 OR res	Gas_AC	OR		-112	-58	16	-102	-48	25	-98	-44	30	28	28	28	44	44	44	52	52	52
2011 OR res specialty code	2008 OR res	HP	OR		871	901	943	1,847	1,876	1,918	2,455	2,484	2,526	0	0	0	0	0	0	0	0	0
2011 OR res specialty code	2008 OR res	Zonal	OR		1,207	1,207	1,207	1,555	1,555	1,555	1,817	1,817	1,817	0	0	0	0	0	0	0	0	0
2009 WSEC	2006 WSEC	Gas	WA		625	625	625	654	654	654	668	668	668	104	104	104	167	167	167	206	206	206
2009 WSEC	2006 WSEC	Gas_AC	WA		755	835	946	734	805	903	742	813	911	103	103	103	164	164	164	202	202	202
2009 WSEC	2006 WSEC	HP	WA		1,761	1,822	1,906	2,902	2,954	3,027	3,688	3,740	3,813	0	0	0	0	0	0	0	0	0
2009 WSEC	2006 WSEC	Zonal	WA		597	597	597	1,034	1,034	1,034	1,126	1,126	1,126	0	0	0	0	0	0	0	0	0
2009 IECC	2006 IECC	Gas	ID		701	701	701	717	717	717	729	729	729	25	25	25	47	47	47	62	62	62
2009 IECC	2006 IECC	Gas_AC	ID		785	845	927	795	854	937	802	861	944	22	22	22	41	41	41	54	54	54
2009 IECC	2006 IECC	HP	ID		1,208	1,268	1,350	1,689	1,748	1,831	2,065	2,125	2,207	0	0	0	0	0	0	0	0	0
2009 IECC	2006 IECC	Zonal	ID		349	349	349	369	369	369	346	346	346	0	0	0	0	0	0	0	0	0
2009 IECC with amendments	2003 IECC wi	Gas	MT		620	620	620	650	650	650	666	666	666	65	65	65	103	103	103	123	123	123
2009 IECC with amendments	2003 IECC wi	Gas_AC	MT		665	723	808	685	742	827	694	752	837	63	63	63	100	100	100	118	118	118
2009 IECC with amendments	2003 IECC wi	HP	MT		1,433	1,491	1,576	2,173	2,231	2,315	2,706	2,764	2,849	0	0	0	0	0	0	0	0	0
2009 IECC with amendments	2003 IECC wi	Zonal	MT		1,218	1,218	1,218	1,721	1,721	1,721	1,895	1,895	1,895	0	0	0	0	0	0	0	0	0

Code	Year Code Effective	Heating System	State	Heating system Weights (2011)	Multi Family Whole Home Code Electric Energy Consumption (kWh/Home)								
					Heating Zone 1			Heating Zone 2			Heating Zone 3		
					Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3
2008 OR res specialty code	2008	Gas	OR	26%	896	896	896	1,045	1,045	1,045	1,155	1,155	1,155
2008 OR res specialty code	2008	Gas_AC	OR	56%	1,143	1,332	1,585	1,238	1,427	1,680	1,306	1,495	1,748
2008 OR res specialty code	2008	HP	OR	9%	4,753	4,931	5,170	6,119	6,297	6,536	7,260	7,438	7,677
2008 OR res specialty code	2008	Zonal	OR	9%	4,794	4,794	4,794	6,255	6,255	6,255	7,255	7,255	7,255
2011 OR res specialty code	2011	Gas	OR		932	932	932	1,069	1,069	1,069	1,173	1,173	1,173
2011 OR res specialty code	2011	Gas_AC	OR		1,157	1,325	1,548	1,244	1,412	1,635	1,310	1,478	1,701
2011 OR res specialty code	2011	HP	OR		4,491	4,658	4,881	5,528	5,696	5,918	6,458	6,625	6,847
2011 OR res specialty code	2011	Zonal	OR		4,431	4,431	4,431	5,794	5,794	5,794	6,722	6,722	6,722
2006 WSEC	2007	Gas	WA	55%	1,216	1,216	1,216	1,345	1,345	1,345	1,450	1,450	1,450
2006 WSEC	2007	Gas_AC	WA	28%	1,495	1,686	1,943	1,565	1,749	1,997	1,630	1,814	2,062
2006 WSEC	2007	HP	WA	13%	5,086	5,278	5,536	6,294	6,479	6,728	7,372	7,557	7,806
2006 WSEC	2007	Zonal	WA	4%	5,027	5,027	5,027	6,334	6,334	6,334	7,302	7,302	7,302
2009 WSEC	2011	Gas	WA		907	907	907	1,014	1,014	1,014	1,108	1,108	1,108
2009 WSEC	2011	Gas_AC	WA		1,126	1,284	1,495	1,198	1,353	1,560	1,257	1,412	1,619
2009 WSEC	2011	HP	WA		4,427	4,595	4,816	5,285	5,448	5,667	6,104	6,268	6,486
2009 WSEC	2011	Zonal	WA		4,701	4,701	4,701	5,878	5,878	5,878	6,803	6,803	6,803
2006 IECC	2008	Gas	ID	7%	1,259	1,259	1,259	1,417	1,417	1,417	1,540	1,540	1,540
2006 IECC	2008	Gas_AC	ID	80%	1,469	1,662	1,926	1,566	1,758	2,019	1,643	1,834	2,096
2006 IECC	2008	HP	ID	7%	5,407	5,601	5,865	6,957	7,149	7,411	8,300	8,493	8,755
2006 IECC	2008	Zonal	ID	7%	5,530	5,530	5,530	7,162	7,162	7,162	8,351	8,351	8,351
2009 IECC	2011	Gas	ID		957	957	957	1,103	1,103	1,103	1,219	1,219	1,219
2009 IECC	2011	Gas_AC	ID		1,121	1,294	1,527	1,211	1,383	1,614	1,284	1,455	1,686
2009 IECC	2011	HP	ID		5,048	5,222	5,456	6,513	6,685	6,917	7,804	7,977	8,208
2009 IECC	2011	Zonal	ID		5,469	5,469	5,469	7,135	7,135	7,135	8,367	8,367	8,367
2003 IECC with amendments	2005	Gas	MT	32%	1,229	1,229	1,229	1,380	1,380	1,380	1,494	1,494	1,494
2003 IECC with amendments	2005	Gas_AC	MT	54%	1,470	1,660	1,918	1,565	1,756	2,014	1,636	1,827	2,085
2003 IECC with amendments	2005	HP	MT	7%	5,226	5,418	5,676	6,676	6,868	7,127	7,899	8,090	8,349
2003 IECC with amendments	2005	Zonal	MT	7%	5,276	5,276	5,276	6,849	6,849	6,849	7,947	7,947	7,947
2009 IECC with amendments	2011	Gas	MT		934	934	934	1,059	1,059	1,059	1,159	1,159	1,159
2009 IECC with amendments	2011	Gas_AC	MT		1,155	1,312	1,525	1,234	1,392	1,605	1,297	1,455	1,668
2009 IECC with amendments	2011	HP	MT		4,645	4,803	5,016	5,847	6,005	6,219	6,897	7,055	7,269
2009 IECC with amendments	2011	Zonal	MT		4,731	4,731	4,731	6,072	6,072	6,072	7,061	7,061	7,061

Code	Heating System	State	Multi Family Whole Home Code Gas Energy Consumption (therms/Home)								
			Heating Zone 1			Heating Zone 2			Heating Zone 3		
			Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3
2008 OR res specialty code	Gas	OR	232	232	232	298	298	298	345	345	345
2008 OR res specialty code	Gas_AC	OR	235	235	235	302	302	302	350	350	350
2008 OR res specialty code	HP	OR	0	0	0	0	0	0	0	0	0
2008 OR res specialty code	Zonal	OR	0	0	0	0	0	0	0	0	0
2011 OR res specialty code	Gas	OR	224	224	224	285	285	285	330	330	330
2011 OR res specialty code	Gas_AC	OR	228	228	228	291	291	291	337	337	337
2011 OR res specialty code	HP	OR	0	0	0	0	0	0	0	0	0
2011 OR res specialty code	Zonal	OR	0	0	0	0	0	0	0	0	0
2006 WSEC	Gas	WA	240	240	240	307	307	307	358	358	358
2006 WSEC	Gas_AC	WA	244	244	244	312	312	312	364	364	364
2006 WSEC	HP	WA	0	0	0	0	0	0	0	0	0
2006 WSEC	Zonal	WA	0	0	0	0	0	0	0	0	0
2009 WSEC	Gas	WA	212	212	212	259	259	259	299	299	299
2009 WSEC	Gas_AC	WA	215	215	215	264	264	264	305	305	305
2009 WSEC	HP	WA	0	0	0	0	0	0	0	0	0
2009 WSEC	Zonal	WA	0	0	0	0	0	0	0	0	0
2006 IECC	Gas	ID	272	272	272	356	356	356	420	420	420
2006 IECC	Gas_AC	ID	277	277	277	364	364	364	428	428	428
2006 IECC	HP	ID	0	0	0	0	0	0	0	0	0
2006 IECC	Zonal	ID	0	0	0	0	0	0	0	0	0
2009 IECC	Gas	ID	274	274	274	353	353	353	415	415	415
2009 IECC	Gas_AC	ID	279	279	279	362	362	362	426	426	426
2009 IECC	HP	ID	0	0	0	0	0	0	0	0	0
2009 IECC	Zonal	ID	0	0	0	0	0	0	0	0	0
2003 IECC with amendments	Gas	MT	255	255	255	336	336	336	394	394	394
2003 IECC with amendments	Gas_AC	MT	259	259	259	342	342	342	401	401	401
2003 IECC with amendments	HP	MT	0	0	0	0	0	0	0	0	0
2003 IECC with amendments	Zonal	MT	0	0	0	0	0	0	0	0	0
2009 IECC with amendments	Gas	MT	230	230	230	296	296	296	347	347	347
2009 IECC with amendments	Gas_AC	MT	234	234	234	302	302	302	354	354	354
2009 IECC with amendments	HP	MT	0	0	0	0	0	0	0	0	0
2009 IECC with amendments	Zonal	MT	0	0	0	0	0	0	0	0	0

Energy Savings

Current Code	Previous	System	State	Multi Family Electricity Savings (kWh/yr) per House								
				Heating Zone 1			Heating Zone 2			Heating Zone 3		
				Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3
2011 OR res specialty code	2008 OR res spe	Gas	OR	-36	-36	-36	-24	-24	-24	-17	-17	-17
2011 OR res specialty code	2008 OR res spe	Gas_AC	OR	-14	7	37	-7	14	44	-3	17	47
2011 OR res specialty code	2008 OR res spe	HP	OR	261	272	289	591	602	619	802	813	830
2011 OR res specialty code	2008 OR res spe	Zonal	OR	363	363	363	461	461	461	533	533	533
2009 WSEC	2006 WSEC	Gas	WA	309	309	309	331	331	331	342	342	342
2009 WSEC	2006 WSEC	Gas_AC	WA	369	401	448	366	395	437	373	401	443
2009 WSEC	2006 WSEC	HP	WA	659	684	720	1,010	1,031	1,062	1,268	1,289	1,320
2009 WSEC	2006 WSEC	Zonal	WA	326	326	326	456	456	456	499	499	499
2009 IECC	2006 IECC	Gas	ID	303	303	303	314	314	314	321	321	321
2009 IECC	2006 IECC	Gas_AC	ID	348	368	398	355	375	406	359	379	410
2009 IECC	2006 IECC	HP	ID	359	379	409	444	464	494	496	516	546
2009 IECC	2006 IECC	Zonal	ID	61	61	61	26	26	26	-16	-16	-16
2009 IECC with amendments	2003 IECC with a	Gas	MT	294	294	294	321	321	321	335	335	335
2009 IECC with amendments	2003 IECC with a	Gas_AC	MT	315	348	393	331	364	409	339	372	417
2009 IECC with amendments	2003 IECC with a	HP	MT	582	615	660	830	863	908	1,002	1,035	1,080
2009 IECC with amendments	2003 IECC with a	Zonal	MT	546	546	546	776	776	776	886	886	886

Current Code	System	State	Multi Family Therm Savings (therm/yr) per House								
			Heating Zone 1			Heating Zone 2			Heating Zone 3		
			Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3
2011 OR res specialty code	Gas	OR	7	7	7	12	12	12	14	14	14
2011 OR res specialty code	Gas_AC	OR	7	7	7	11	11	11	13	13	13
2011 OR res specialty code	HP	OR	0	0	0	0	0	0	0	0	0
2011 OR res specialty code	Zonal	OR	0	0	0	0	0	0	0	0	0
2009 WSEC	Gas	WA	28	28	28	47	47	47	59	59	59
2009 WSEC	Gas_AC	WA	28	28	28	47	47	47	59	59	59
2009 WSEC	HP	WA	0	0	0	0	0	0	0	0	0
2009 WSEC	Zonal	WA	0	0	0	0	0	0	0	0	0
2009 IECC	Gas	ID	-2	-2	-2	3	3	3	5	5	5
2009 IECC	Gas_AC	ID	-3	-3	-3	1	1	1	3	3	3
2009 IECC	HP	ID	0	0	0	0	0	0	0	0	0
2009 IECC	Zonal	ID	0	0	0	0	0	0	0	0	0
2009 IECC with amendments	Gas	MT	25	25	25	40	40	40	48	48	48
2009 IECC with amendments	Gas_AC	MT	25	25	25	40	40	40	47	47	47
2009 IECC with amendments	HP	MT	0	0	0	0	0	0	0	0	0
2009 IECC with amendments	Zonal	MT	0	0	0	0	0	0	0	0	0

- 2011 code savings rate for multifamily homes by heating s
- 2011 code savings rate for single-family homes by heating
- 2011 Code incremental first costs

- 2011 code energy savings rates vs. the Power Plan (poss
- 2011 Energy Star homes savings rate for Oregon by heati

					1	2	3	4
	Incremental cost per unit (2006 $s)				**Single Family**		**Multi Family**	
	Current Code	**Previous**	**System**	**State**	Elec	Gas	Elec	Gas
2	2011 OR res specialty code	2008 OR res specialty code	Gas	OR	$ -	$ 1,088	$ -	$ 812
1	2011 OR res specialty code	2008 OR res specialty code	Gas_AC	OR	$ 109	$ 979	$ 81	$ 731
3	2011 OR res specialty code	2008 OR res specialty code	HP	OR	$ 1,088	$ -	$ 812	$ -
4	2011 OR res specialty code	2008 OR res specialty code	Zonal	OR	$ 2,190	$ -	$ 663	$ -
6	2009 WSEC	2006 WSEC	Gas	WA	$ 59	$ 1,603	$ 26	$ 1,230
5	2009 WSEC	2006 WSEC	Gas_AC	WA	$ 220	$ 1,442	$ 149	$ 1,107
7	2009 WSEC	2006 WSEC	HP	WA	$ 1,212	$ -	$ 806	$ -
8	2009 WSEC	2006 WSEC	Zonal	WA	$ 912	$ -	$ 506	$ -
10	2009 IECC	2006 IECC	Gas	ID	$ 59	$ 615	$ 26	$ 393
9	2009 IECC	2006 IECC	Gas_AC	ID	$ 121	$ 554	$ 65	$ 354
11	2009 IECC	2006 IECC	HP	ID	$ 675	$ -	$ 419	$ -
12	2009 IECC	2006 IECC	Zonal	ID	$ 375	$ -	$ 119	$ -
14	2009 IECC with amendments	2003 IECC with amendments	Gas	MT	$ 59	$ 2,450	$ 26	$ 1,291
13	2009 IECC with amendments	2003 IECC with amendments	Gas_AC	MT	$ 304	$ 2,205	$ 155	$ 1,162
15	2009 IECC with amendments	2003 IECC with amendments	HP	MT	$ 2,509	$ -	$ 1,317	$ -
16	2009 IECC with amendments	2003 IECC with amendments	Zonal	MT	$ 2,209	$ -	$ 1,017	$ -

State Energy Codes Compared to the 6th Power Plan Baseline

Base Case	Code Year for Comparison	Heating System	State	Heating system Weights	Single Family Whole Home Code Electric Energy Savings (kWh/Home)									Single Family Whole Home Code Gas Energy Savings (therms/Home)								
					Heating Zone 1			Heating Zone 2			Heating Zone 3			Heating Zone 1			Heating Zone 2			Heating Zone 3		
					Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3
6th Plan Base Case Efficiency Levels	2011	Gas	OR		603	603	603	620	620	620	629	629	629	84	84	84	134	134	134	167	167	167
	2011	Gas_AC	OR		706	772	860	717	782	870	722	788	876	82	82	82	130	130	130	161	161	161
	2011	HP	OR		2,054	2,054	2,054	2,520	2,520	2,520	2,881	2,881	2,881	0	0	0	0	0	0	0	0	0
	2011	Zonal	OR		1,778	1,848	1,940	2,766	2,836	2,928	3,397	3,467	3,560	0	0	0	0	0	0	0	0	0
	2011	Gas	WA		636	636	636	689	689	689	712	712	712	120	120	120	216	216	216	266	266	266
	2011	Gas_AC	WA		759	845	961	792	888	1,017	806	902	1,031	119	119	119	214	214	214	263	263	263
	2011	HP	WA		1,937	2,004	2,094	3,631	3,709	3,812	4,659	4,737	4,840	0	0	0	0	0	0	0	0	0
	2011	Zonal	WA		951	951	951	2,071	2,071	2,071	2,371	2,371	2,371	0	0	0	0	0	0	0	0	0
	2011	Gas	ID		681	681	681	698	698	698	703	703	703	-12	-12	-12	11	11	11	19	19	19
	2011	Gas_AC	ID		797	850	923	818	877	959	821	880	962	-16	-16	-16	6	6	6	11	11	11
	2011	HP	ID		822	875	948	1,252	1,311	1,393	1,470	1,529	1,611	0	0	0	0	0	0	0	0	0
	2011	Zonal	ID		-380	-380	-380	-301	-301	-301	-452	-452	-452	0	0	0	0	0	0	0	0	0
	2011	Gas	MT		605	605	605	630	630	630	641	641	641	43	43	43	75	75	75	90	90	90
	2011	Gas_AC	MT		684	745	830	701	761	847	708	768	853	41	41	41	72	72	72	85	85	85
	2011	HP	MT		1,243	1,303	1,388	1,858	1,918	2,003	2,289	2,349	2,435	0	0	0	0	0	0	0	0	0
	2011	Zonal	MT		932	932	932	1,332	1,332	1,332	1,406	1,406	1,406	0	0	0	0	0	0	0	0	0

Base Case	Code Year for Comparison	Heating System	State	Heating system Weights	Multi Family Whole Home Code Electric Energy Savings (kWh/Home)									Multi Family Whole Home Code Gas Energy Savings (therms/Home)								
					Heating Zone 1			Heating Zone 2			Heating Zone 3			Heating Zone 1			Heating Zone 2			Heating Zone 3		
					Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3
6th Plan Base Case Efficiency Levels	2011	Gas	OR		292	292	292	304	304	304	311	311	311	20	20	20	35	35	35	44	44	44
	2011	Gas_AC	OR		345	371	407	353	378	414	356	382	418	19	19	19	34	34	34	43	43	43
	2011	HP	OR		695	695	695	826	826	826	927	927	927	0	0	0	0	0	0	0	0	0
	2011	Zonal	OR		636	663	701	964	991	1,029	1,172	1,199	1,237	0	0	0	0	0	0	0	0	0
	2011	Gas	WA		317	317	317	359	359	359	376	376	376	32	32	32	61	61	61	76	76	76
	2011	Gas_AC	WA		372	406	455	395	432	484	405	443	495	32	32	32	61	61	61	76	76	76
	2011	HP	WA		700	726	764	1,214	1,243	1,285	1,540	1,569	1,611	0	0	0	0	0	0	0	0	0
	2011	Zonal	WA		425	425	425	768	768	768	875	875	875	0	0	0	0	0	0	0	0	0
	2011	Gas	ID		271	271	271	277	277	277	276	276	276	-29	-29	-29	-31	-31	-31	-36	-36	-36
	2011	Gas_AC	ID		359	372	396	366	380	406	365	379	405	-30	-30	-30	-33	-33	-33	-38	-38	-38
	2011	HP	ID		81	94	118	24	38	64	-80	-66	-40	0	0	0	0	0	0	0	0	0
	2011	Zonal	ID		-495	-495	-495	-641	-641	-641	-816	-816	-816	0	0	0	0	0	0	0	0	0
	2011	Gas	MT		279	279	279	300	300	300	309	309	309	14	14	14	25	25	25	30	30	30
	2011	Gas_AC	MT		327	360	405	340	373	418	345	378	423	14	14	14	25	25	25	30	30	30
	2011	HP	MT		484	516	561	666	699	744	778	810	856	0	0	0	0	0	0	0	0	0
	2011	Zonal	MT		401	401	401	565	565	565	617	617	617	0	0	0	0	0	0	0	0	0

2011 EnergyStar Homes Built in Oregon

Code / Specification	Year Code Effective	Heating System	State	Heating system Weights	Single Family Whole Home Electric Energy Consumption (kWh/Home)									Single Family Whole Home Gas Energy Consumption (therms/Home)								
					Heating Zone 1			Heating Zone 2			Heating Zone 3			Heating Zone 1			Heating Zone 2			Heating Zone 3		
					Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3
2011 OR res specialty code	2011	Gas	OR		1,890	1,890	1,890	2,054	2,054	2,054	2,180	2,180	2,180	577	577	577	756	756	756	892	892	892
2011 OR res specialty code	2011	Gas_AC	OR		2,330	2,743	3,284	2,443	2,856	3,396	2,528	2,941	3,482	584	584	584	767	767	767	905	905	905
2011 OR res specialty code	2011	HP	OR		10,096	10,507	11,044	13,387	13,798	14,336	16,390	16,801	17,339	0	0	0	0	0	0	0	0	0
2011 OR res specialty code	2011	Zonal	OR		11,090	11,090	11,090	14,945	14,945	14,945	17,648	17,648	17,648	0	0	0	0	0	0	0	0	0
OR EnergyStar Spec (2008 BOP)		Gas	OR		1,327	1,327	1,327	1,503	1,503	1,503	1,634	1,634	1,634	544	544	544	716	716	716	844	844	844
OR EnergyStar Spec (2008 BOP)		Gas_AC	OR		1,732	2,122	2,634	1,852	2,242	2,754	1,940	2,330	2,842	551	551	551	727	727	727	856	856	856
OR EnergyStar Spec (2008 BOP)		HP	OR		8,433	8,825	9,339	11,154	11,546	12,060	13,709	14,102	14,616	0	0	0	0	0	0	0	0	0
OR EnergyStar Spec (2008 BOP)		Zonal	OR	n/a										0	0	0	0	0	0	0	0	0

Energy Savings					Single Family Electricity Savings (kWh/yr) per House									Single Family Therm Savings (therm/yr) per House								
					Heating Zone 1			Heating Zone 2			Heating Zone 3			Heating Zone 1			Heating Zone 2			Heating Zone 3		
Specification	Code Base	System	State		Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3
OR EnergyStar Spec (2008 BOP)	2011 OR res specialty	Gas	OR		563	563	563	551	551	551	546	546	546	33	33	33	39	39	39	48	48	48
OR EnergyStar Spec (2008 BOP)	2011 OR res specialty	Gas_AC	OR		598	621	650	590	613	642	588	611	640	34	34	34	39	39	39	49	49	49
OR EnergyStar Spec (2008 BOP)	2011 OR res specialty	HP	OR		1,663	1,682	1,705	2,233	2,252	2,275	2,681	2,700	2,723	0	0	0	0	0	0	0	0	0
OR EnergyStar Spec (2008 BOP)	2011 OR res specialty	Zonal	OR	n/a										0	0	0	0	0	0	0	0	0

2011 EnergyStar Homes built with Gas Furnace and Air Conditioners in WA, OR, ID, and MT

Energy Savings

Single Family Electricity Savings (kWh/yr) per House

Specification	Code Base	System	State	Heating Zone 1			Heating Zone 2			Heating Zone 3		
				Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3
EnergyStar WA 2011 - Envelope Path	2009 WSEC	Gas_AC	WA	1,062	1,077	1,105	995	1,010	1,038	937	952	980
EnergyStar WA 2011 - Ducts Inside Path	2009 WSEC	Gas_AC	WA	1,044	1,059	1,094	980	995	1,030	924	939	974
EnergyStar WA 2011 - Equipment Upgrade Path	2009 WSEC	Gas_AC	WA	996	984	975	921	909	900	854	842	833
EnergyStar WA 2011 - Simple Average	2009 WSEC	Gas_AC	WA	1,034	1,040	1,058	965	971	989	905	911	929
OR EnergyStar Spec (2008 BOP)	2011 OR res specialty code	Gas_AC	OR	598	621	650	590	613	642	588	611	640
EnergyStar ID+MT 2011	2009 IECC	Gas_AC	ID	548	599	696	587	639	736	622	673	770
EnergyStar ID+MT 2011	2009 IECC	Gas_AC	MT	548	599	696	587	639	736	622	673	770

Single Family Therm Savings (therm/yr) per House

Specification	Heating Zone 1			Heating Zone 2			Heating Zone 3			Source
	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	Cooling Zone 1	Cooling Zone 2	Cooling Zone 3	
EnergyStar WA 2011 - Envelope Path	104	104	104	128	128	128	148	148	148	http://www.nwcouncil.org/energy/rtf/measures/res/EStarNWSFHomes_WAIDMT_FY10v2_0.xls
EnergyStar WA 2011 - Ducts Inside Path	102	102	102	130	130	130	153	153	153	
EnergyStar WA 2011 - Equipment Upgrade Path	100	100	100	112	112	112	119	119	119	
EnergyStar WA 2011 - Simple Average	102	102	102	123	123	123	140	140	140	
OR EnergyStar Spec (2008 BOP)	34	34	34	39	39	39	49	49	49	Current Analysis
EnergyStar ID+MT 2011	169	169	169	225	225	225	273	273	273	http://www.nwcouncil.org/energy/rtf/measures/res/EStarNWSFHomes_WAIDMT_FY10v2_0.xls
EnergyStar ID+MT 2011	169	169	169	225	225	225	273	273	273	

Change Applies to the Following State Codes:

					Oregon 2011				Washington 2009				Idaho 2009				Montana 2009				Single Family OR	Single Family WA	Single Family ID	Single Family MT	Multi Family OR	Multi Family WA	Multi Family ID	Multi Family MT
Component	Base Level	New Code Level	Cost 2006 $s $/ft2 component area or $/unit	Source	gfac	gfnc	hp	zonl	gfac	gfnc	hp	zonl	gfac	gfnc	hp	zonl	gfac	gfnc	hp	zonl	Component Area or Unit Count	Component Area or Unit Count	Component Area or Unit Count	Component Area or Unit Count	Component Area or Unit Count	Component Area or Unit Count	Component Area or Unit Count	Component Area or Unit Count
Envelope																												
Ceiling	R-38	R-49 Ceiling Insulation	0.22	Building America Kentlake Highlands (Kent, WA) Quadrant Homes Study					1	1	1	1									1736	1714	1727	1568	476	476	476	476
Wall	R-19 Std	R-21 Std Wall	0.15	6th Plan Appendix G									1	1	1	1	1	1	1	1	2116	2078	2102	1836	621	621	621	621
Wall	R-21 Std	R-21 Std Wall + R5 Foam Sheathing	0.87	6th Plan Appendix G				1													2116	2078	2102	1836	621	621	621	621
Floor	R-21 Std	R-30 Floor	0.41	6th Plan Appendix G. Assert same as R-30 to R-38													1	1	1	1	1649	1568	1613	1568	476	476	476	476
Window	U-0.35	Window U-0.32	0.00	Competitve as base window				1	1	1	1	1					1	1	1	1	359	360	360	372	124	124	124	124
Window	U-0.35	Window U-0.30	0.89	6th Plan Appendix G				1													359				124			
Air Sealing & Ventilation																												
ACH Single Family	Assumed Average 7 ACH 50	Tested Infiltration to 6 ACH50 in WA No change in ID 4ACH50 in MT Tested Infiltration to 6 ACH50 in OR	1	ResWXSF_FY10v2_1.xls, at $.18/ft^2 per 1ACH50 reduction. Then applied to baseline housing stock characteristics.	$788	$788	$788	$0	$476	$476	$476	$476	$0	$0	$0	$0	$1,232	$1,232	$1,232	$1,232	1	1	1	1	0	0	0	0
ACH Multi Family	Assumed Average 7 ACH 50	Tested Infiltration to 6 ACH50 in WA No change in ID 4ACH50 in MT Tested Infiltration to 6 ACH50 in OR	1	ResWXSF_FY10v2_1.xls, at $.18/ft^2 per 1ACH50 reduction. Then applied to baseline housing stock characteristics.	$512	$512	$512	$0	$376	$376	$376	$376	$0	$0	$0	$0	$703	$703	$703	$703	0	0	0	0	1	1	1	1
HVAC System																												
Duct Sealing	Unsealed	Duct Sealing to PTCS levels	300	1) Building Science Corp and Building America Study, survey of 16,000+ homes http://www.nchh.org/Portals/0/Contents/Read_This_Before_You_Ventilate.pdf 2) 6th Plan Appendix G Table G-12.	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	0	1	1	1	1	1	1	1	1
Furnace	0.8	Furnace Upgrade to 92AFUE	450	ETO Resource Assessment 2010					1	1	0	0										1				1		
Heat Pump	7.7 HSPF	Heat Pump HSPF Upgrade to 8.5	0	RTF August 2010 Mtg. No incremental cost because market average purchase of HSPF is 8.5							1											1				1		
Lighting																												
LPD	0% CFLs	CFLs - 50%. Cost is for whole house (not per lamp).	59	[EStarLighting_ExistingFY10v1_5 (7).xls]Bulb AssumptionsDirect'!$B$9					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.43	0.43	0.43	0.43
LPD	50% CFLs	CFLS - 75%. Cost is for whole house (not per lamp).	30	[EStarLighting_ExistingFY10v1_5 (7).xls]Bulb AssumptionsDirect'!$B$9				1													1				0.43			

	Oregon 2011				Washington 2009				Idaho 2009				Montana 2009			
Total Cost By HVAC Type and State	gfac	gfnc	hp	zonl	gfac	gfnc	hp	zonl	gfac	gfnc	hp	zonl	gfac	gfnc	hp	zonl
Single Family Costs (elec)	$ 109	$ -	$ 1,088	$ 2,190	$ 220	$ 59	$ 1,212	$ 912	$ 121	$ 59	$ 675	$ 375	$ 304	$ 59	$ 2,509	$ 2,209
Single Family Costs (gas)	$ 979	$ 1,088	$ -	$ -	$ 1,442	$ 1,603	$ -	$ -	$ 554	$ 615	$ -	$ -	$ 2,205	$ 2,450	$ -	$ -
Multi Family Costs / Unit (elec)	$ 81	$ -	$ 812	$ 663	$ 149	$ 26	$ 806	$ 506	$ 65	$ 26	$ 419	$ 119	$ 155	$ 26	$ 1,317	$ 1,017
Multi Family Costs / Unit (gas)	$ 731	$ 812	$ -	$ -	$ 1,107	$ 1,230	$ -	$ -	$ 354	$ 393	$ -	$ -	$ 1,162	$ 1,291	$ -	$ -

Dollar Deflators & Adjustors

2011$:2006$	1.121
2010$:2006$	1.096
2008$:2006$	1.047
20011$:2009$	1.047

Split Costs into Gas and Elec Fractions For Combined Measures	
Gas Fraction	0.9
Elec Fraction	0.1

Afloorcor (ft^2)	Afloorext (ft^2)	Aextwall (ft^2)	Aceiling (ft^2)	AwinN (ft^2)	AwinE (ft^2)	AwinS (ft^2)	AwinW (ft^2)	Afloor
1344	0	1184	1344	50	50	50	50	
2200	200	2210	1784	91	91	91	91	
2688	0	1480	1344	101	101	101	101	
952	0	621	476	31	31	31	31	476

Final Prototype Weights for Single Family

		ID	MT	OR	WA
c1344	1344	0.03	0.03	0.04	0.04
s1344	1344	0.01	0.02	0.00	0.01
c2200	2200	0.62	0.28	0.85	0.71
s2200	2200	0.25	0.23	0.04	0.13
b2688	2688	0.08	0.44	0.06	0.11
	Total	2202	2367	2192	2208

Final Prototype Weights for Multi Family

		ID	MT	OR	WA
c0952	952	0.45	0.64	0.81	0.76
s0952	952	0.55	0.36	0.19	0.24

Single Family

	Ceiling	Floor	Wall	Window
c1344	1344	1344	1184	202
s1344	1344	1344	1184	202
c2200	1784	1784	2210	364
s2200	1784	1784	2210	364
b2688	1344	0	1480	403

Weighted Component Areas By State (ft^2)

	ID	MT	OR	WA
Ceiling	1727	1568	1736	1714
Floor	1613	982	1649	1568
Wall	2102	1836	2116	2078
Window	360	372	359	360
CFA	2202	2367	2192	2208

Multi Family

	Ceiling	Floor	Wall	Window
c0952	476	476	621	124
s0952	476	476	621	124

Weighted Component Areas By State (ft^2)

	ID	MT	OR	WA
Ceiling	476	476	476	476
Floor	476	476	476	476
Wall	621	621	621	621
Window	124	124	124	124
CFA	952	952	952	952

Lighting Costs

	Lumens/Watt	Cost per Watt
Incandescent	13	$ 0.010
CFL	54	$ 0.175

% CFLs	Floor Area	Total Lumens	LPD (W/sq.ft)	Incandescent installed Wattage	CFL Insta	Inc. Cost	CFL Cost	Total Cos	Incremental	Annual O&M
0	2202	48171	1.75	3854	0	$ 38.54	$ -	$ 38.54		
0.5	2202	48171	1.10	1927	450	$ 19.27	$ 78.7	$ 97.9	$ 59	$ (14)
0.75	2202	48171	0.80	963	674	$ 9.63	$ 118.0	$ 127.7	$ 30	$ (7)

CFL Measure Lif 7.6 years
Incandescent Lif 1.37 years

Weighting Inputs Tables

SINGLE-FAMILY RESIDENTIAL
NEW CONSTRUCTION
CHARACTERISTICS AND
PRACTICES STUDY
Final Report
March 27, 2007
Prepared for: NEEA

MULTI-FAMILY RESIDENTIAL
NEW CONSTRUCTION
CHARACTERISTICS AND
PRACTICES STUDY
Final Report
June 14, 2007
Prepared for: NEEA

SF Table 104 p86	Percentage of Heating Systems by Fuel Type within Type of Heating System					
		Gas	Elec	Pellet	Propane	n
	all types	82.4%	13.3%	0.1%	4.3%	604
central	all central	85.4%	10.2%		4.5%	577
	FAF	93.1%	2.2%		4.7%	526
	HP w supp		100.0%			37
	HPw/o sup	49.6%	50.4%			6
	Hydronic	84.0%			16.0%	8
Space	all space	24.4%	75.1%	1.5%		27
	baseboards		100.0%			6
	fireplace	100.0%				4
	floor	51.2%	48.8%			2
	pellet			100.0%		1
	wall	8.7%	91.3%			14

Gas FAF	Elec	
Gas+Prop	Elec	Elec Sys #
86.7%	13.3%	80
89.9%	10.2%	59
97.8%	2.2%	12
0.0%	100.0%	37
49.6%	50.4%	3
100.0%	0.0%	0
24.4%	75.1%	20
0.0%	100.0%	6
100.0%	0.0%	0
51.2%	48.8%	1
0.0%	0.0%	0
8.7%	91.3%	13

Space vs Central Elec Split		25%
		73%
HP vs COP 1 Resistance	HP	50%
	COP1	50%

MF Table 90

	System Typ	200
Central	All Central	74
	FAF	38
	HP	10
	Hydronic	26
Space	All Space	126
	Baseboard	48
	Fireplace	6
	Wall Unit	72

Gas FAF	0.32
HP	0.05
Zonal	0.63

	ID	**MT**	**OR**	**WA**
Gas	0	0	0.13	0.24
Gas_AC	0.32	0.32	0.19	0.08
HP	0.05	0.05	0.05	0.05
Zonal	0.63	0.63	0.63	0.63

MF Table 79

	Have AC	Non HP Central AC
ID	91%	45%
MT	80%	39%
OR	44%	19%
WA	24%	8%

Cental AC	
Yes	55%
No	45%

SF Table 105 p86	Percentage of Heating Systems by Fuel Type by State 2006				
	Gas	Elec	Pellets	Propane	n
ID	90%	3%	0.4%	6%	179
MT	100%				18
OR	82%	17%		0.5%	178
WA	77%	16%		6%	229
Overall	82%	13%	0.1%	4%	604

	Gas	HP	ER	
ID Breakout	86.0%	7.0%	7.0%	100.0%
MT Breakout	86.0%	7.0%	7.0%	100.0%
OR Breakout	82.5%	9.0%	8.5%	100.0%
WA Breakout	83.0%	12.9%	4.0%	100.0%

SF Table 93 p79

	Percentage of Houses with AC
ID	86.8%
MT	61.4%
OR	65.4%
WA	41.4%

System Weights

	Gas	**Gas_AC**	**HP**	**Zonal**	sumchk
ID	6.2%	79.8%	7.0%	7.0%	100.0%
MT	31.6%	54.4%	7.0%	7.0%	100.0%
OR	26.1%	56.4%	9.0%	8.5%	100.0%
WA	54.5%	28.5%	12.9%	4.0%	100.0%

OR			
	SF	MF	Climate
HZ1CZ1	0.816	0.184	0.464
HZ1CZ2	0.660	0.340	0.314
HZ1CZ3	0.923	0.077	0.066
HZ2CZ1	0.939	0.061	0.136
HZ2CZ2	0.971	0.029	0.018
HZ2CZ3	0.000	0.000	0.000
HZ3CZ1	1.000	0.000	0.001
HZ3CZ2	0.000	0.000	0.000
HZ3CZ3	1.000	0.000	0.002

OR	SF	HZ1CZ1	HZ1CZ2	HZ1CZ3	HZ2CZ1	HZ2CZ2	HZ2CZ3	HZ3CZ1	HZ3CZ2	HZ3CZ3
Gas	26.1%	0.099	0.054	0.016	0.033	0.004	0.000	0.000	0.000	0.001
Gas_AC	56.4%	0.214	0.117	0.034	0.072	0.010	0.000	0.001	0.000	0.001
HP	9.0%	0.034	0.019	0.005	0.011	0.002	0.000	0.000	0.000	0.000
Zonal	8.5%	0.032	0.018	0.005	0.011	0.001	0.000	0.000	0.000	0.000
	MF									
Gas	12.8%	0.011	0.014	0.001	0.001	0.000	0.000	0.000	0.000	0.000
Gas_AC	19.2%	0.016	0.020	0.001	0.002	0.000	0.000	0.000	0.000	0.000
HP	5.0%	0.004	0.005	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Zonal	63.0%	0.054	0.067	0.003	0.005	0.000	0.000	0.000	0.000	0.000

WA

Apportionment of 2010 to housing + climates			
	SF	**MF**	**Climate**
HZ1CZ1	**0.751**	**0.249**	**0.742**
HZ1CZ2	**0.890**	**0.110**	**0.028**
HZ1CZ3	**0.997**	**0.003**	**0.088**
HZ2CZ1	**1.000**	**0.000**	**0.014**
HZ2CZ2	**0.656**	**0.344**	**0.127**
HZ2CZ3	**0.000**	**0.000**	**0.000**
HZ3CZ1	**1.000**	**0.000**	**0.001**
HZ3CZ2	0	**0.000**	0
HZ3CZ3	0	0	0

WA	SF	HZ1CZ1	HZ1CZ2	HZ1CZ3	HZ2CZ1	HZ2CZ2	HZ2CZ3	HZ3CZ1	HZ3CZ2	HZ3CZ3
Gas	54.5%	0.303	0.013	0.048	0.008	0.045	0.000	0.001	0.000	0.000
Gas_AC	28.5%	0.158	0.007	0.025	0.004	0.024	0.000	0.000	0.000	0.000
HP	12.9%	0.072	0.003	0.011	0.002	0.011	0.000	0.000	0.000	0.000
Zonal	4.0%	0.022	0.001	0.004	0.001	0.003	0.000	0.000	0.000	0.000
	MF									
Gas	0.24	0.044	0.001	0.000	0.000	0.010	0.000	0.000	0.000	0.000
Gas_AC	0.08	0.015	0.000	0.000	0.000	0.004	0.000	0.000	0.000	0.000
HP	0.05	0.009	0.000	0.000	0.000	0.002	0.000	0.000	0.000	0.000
Zonal	0.63	0.117	0.002	0.000	0.000	0.028	0.000	0.000	0.000	0.000

ID

Apportionment of 2010 to HOUSING + CLIMATES			
	SF	**MF**	**Climate**
HZ1CZ1	**0.000**	**0.000**	**0.000**
HZ1CZ2	**0.000**	**0.000**	**0.000**
HZ1CZ3	**0.970**	**0.030**	**0.397**
HZ2CZ1	**0.370**	**0.630**	**0.068**
HZ2CZ2	**0.946**	**0.054**	**0.330**
HZ2CZ3	**1.000**	**0.000**	**0.041**
HZ3CZ1	**0.807**	**0.193**	**0.111**
HZ3CZ2	**1.000**	**0.000**	**0.052**
HZ3CZ3	0	**0.000**	0.000

ID	SF									
Gas	6.2%	0.000	0.000	0.024	0.002	0.019	0.003	0.006	0.003	0.000
Gas_AC	79.8%	0.000	0.000	0.307	0.020	0.249	0.033	0.072	0.041	0.000
HP	7.0%	0.000	0.000	0.027	0.002	0.022	0.003	0.006	0.004	0.000
Zonal	7.0%	0.000	0.000	0.027	0.002	0.022	0.003	0.006	0.004	0.000
	MF									
Gas	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas_AC	0.32	0.000	0.000	0.004	0.014	0.006	0.000	0.007	0.000	0.000
HP	0.05	0.000	0.000	0.001	0.002	0.001	0.000	0.001	0.000	0.000
Zonal	0.63	0.000	0.000	0.007	0.027	0.011	0.000	0.014	0.000	0.000

MT

Apportionment of 2010 to HOUSING + CLIMATES			
	SF	**MF**	**Climate**
HZ1CZ1	0	0	0
HZ1CZ2	0	0	0
HZ1CZ3	0	0	0
HZ2CZ1	**1.000**	**0.000**	**0.050**
HZ2CZ2	**1.000**	**0.000**	**0.008**
HZ2CZ3	**0.000**	**0.000**	**0.000**
HZ3CZ1	**0.831**	**0.169**	**0.807**
HZ3CZ2	**0.980**	**0.020**	**0.134**
HZ3CZ3	**0.000**	**0.000**	**0.000**

MT	SF									
Gas	31.6%	0.000	0.000	0.000	0.016	0.002	0.000	0.212	0.042	0.000
Gas_AC	54.4%	0.000	0.000	0.000	0.027	0.004	0.000	0.365	0.072	0.000
HP	7.0%	0.000	0.000	0.000	0.004	0.001	0.000	0.047	0.009	0.000
Zonal	7.0%	0.000	0.000	0.000	0.004	0.001	0.000	0.047	0.009	0.000
	MF									
Gas	0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Gas_AC	0.32	0.000	0.000	0.000	0.000	0.000	0.000	0.044	0.001	0.000
HP	0.05	0.000	0.000	0.000	0.000	0.000	0.000	0.007	0.000	0.000
Zonal	0.63	0.000	0.000	0.000	0.000	0.000	0.000	0.086	0.002	0.000

Fraction either SF or MF

	SF	MF
OR	0.794	0.206
WA	0.768	0.232
ID	0.906	0.094
MT	0.861	0.139

	OR	WA	ID	MT
SF	0.794	0.768	0.906	0.861
MF	0.206	0.232	0.094	0.139

System	**State**	**SF**	**MF**	**SF**	**MF**	SF	MF	
Gas	OR	26%	13%	**0.207**	**0.026**	$ 1,088	$ 812	1086.251
Gas_AC	OR	56%	19%	**0.448**	**0.039**	$ 1,088	$ 812	
HP	OR	9%	5%	**0.071**	**0.010**	$ 1,088	$ 812	
Zonal	OR	9%	63%	**0.068**	**0.130**	$ 2,190	$ 663	
Gas	WA	55%	24%	**0.419**	**0.055**	$ 1,662	$ 1,256	
Gas_AC	WA	28%	8%	**0.219**	**0.019**	$ 1,662	$ 1,256	
HP	WA	13%	5%	**0.099**	**0.012**	$ 1,212	$ 806	
Zonal	WA	4%	63%	**0.031**	**0.146**	$ 912	$ 506	
Gas	ID	6%	0%	**0.056**	**0.000**	$ 675	$ 419	
Gas_AC	ID	80%	32%	**0.723**	**0.030**	$ 675	$ 419	
HP	ID	7%	5%	**0.063**	**0.005**	$ 675	$ 419	
Zonal	ID	7%	63%	**0.063**	**0.059**	$ 375	$ 119	
Gas	MT	32%	0%	**0.272**	**0.000**	$ 2,509	$ 1,317	
Gas_AC	MT	54%	32%	**0.468**	**0.044**	$ 2,509	$ 1,317	
HP	MT	7%	5%	**0.060**	**0.007**	$ 2,509	$ 1,317	
Zonal	MT	7%	63%	**0.060**	**0.088**	$ 2,209	$ 1,017	

Cost Per 1ACH50 0.18 $/ft^2 <--from ResSFWX measure sheet
House Area Ave 2294 ft^2
Blower Door Test Cost $300

Regional #s from RLW 2007 Study

Not enough data in RLW study for MT homes, so assume regional baseline.
KEMA Estar 2010 report somewhat substantiates this.

		# Units at ACH Level						% at ACH Level				
	ACH50	NW	WA	OR	ID	MT		NW	WA	OR	ID	MT
	3	6	3	2	1	na		0.024	0.035	0.017	0.022	0.024
	4	22	8	7	6			0.087	0.093	0.059	0.133	0.087
	5	63	26	20	17			0.248	0.302	0.168	0.378	0.248
	6	54	24	20	10			0.213	0.279	0.168	0.222	0.213
	7	46	14	23	9			0.181	0.163	0.193	0.200	0.181
	8	36	9	24	1			0.142	0.105	0.202	0.022	0.142
	9	18	2	16	0			0.071	0.023	0.134	0.000	0.071
	10	9	0	7	1			0.035	0.000	0.059	0.022	0.035
Total		254	86	119	45			1.000	1.000	1.000	1.000	1.000

Target ACH50		6	6	7	4
	Weighted Cost to get to Target ACH				
	NW	WA	OR	ID	MT
3					
4					
5					0.045
6					0.077
7		0.029	0.035	0.000	0.098
8		0.038	0.073	0.004	0.102
9		0.013	0.073	0.000	0.064
10		0.000	0.042	0.012	0.038
Total		0.080	0.222	0.016	0.423
	House Area				
	Single	2208	2192	2367	2202
	Multi	952	952	952	952
	Total Cost				
	Single	$476	$788		$1,232
	Multi	$376	$512		$703