Non-Residential Energy Savings From Northwest Energy Code Changes 2005-2008

Market Progress Evaluation Report

PREPARED BY

Northwest Energy Efficiency Alliance

REPORT #E09-204
DECEMBER 4, 2008

NORTHWEST
ENERGY
EFFICIENCY
ALLIANCE

www.nwalliance.org

529 SW Third Avenue, Suite 600
Portland, Oregon 97204
(tel) 503-827-8416 (fax) 503-827-8437

Non-Residential Energy Savings

From Northwest Energy Code Changes

2005-2008

Final Report

December 4, 2008

TABLE OF CONTENTS

Executive Summary

This report provides estimates of energy savings associated with regional commercial building code changes adopted between July 2005 and July 2008 and projects savings from the date of their implementation through 2028.

Each state in the Northwest has a unique energy code history, differing in code content as well as enforcement. Idaho adopted the 2006 IECC over the 2003 IECC resulting in significant changes to envelope and lighting. Montana intended to adopt the 2006 IECC but after some delay it was decided to wait and adopt the IECC 2009 when it is published. As a result no changes were made in Montana. Oregon made very few changes. Washington made limited changes that improved lighting and semi-heat space requirements. Some of these changes were very important with respect to energy savings, many more are clarifications, or codify existing official interpretations. Others have significant energy impacts in very specific situations that occur relatively infrequently.

Cumulative electric savings for the period from 2008 through 2027 for non-residential energy code changes enacted between July 2005 and July 2008 are 15.4 average megawatts. Cumulative gas savings are 2.9 million therms per year. Idaho made significant code changes and achieved the greatest savings per square foot although total savings are relatively small due to the small projected new floor area. Oregon had much smaller savings per square foot and somewhat small overall savings. Washington had moderate savings per square foot and large overall savings, making up 60% of the total. This is due to the much larger projected population growth. Montana had no savings.

The above mentioned energy savings are total regional savings attributable to all code changes in Idaho, Washington and Oregon. A separate report from the Cadmus Group (Codes and Standards Support Project MPER #2) addresses the degree of NEEA's influence upon these code changes.

Changes to maximum allowed LPD, lighting control requirements, and cooling equipment efficiency dominated electric savings within each state. The Washington commissioning code savings are very significant regionally. The lighting measures lead to large increases in gas use, while envelope and equipment measures lead to decreases with a net effect of reduced gas usage.

Introduction and Purpose of Report

The Northwest has been a leader in the adoption of progressive residential and commercial building energy codes. Over the last decade each state has adopted energy codes to improve the efficiency of new buildings. The Northwest Energy Efficiency Alliance (NEEA) has supported the adoption and implementation of energy codes in the region since 1996. At that time, non-residential energy codes existed in Montana, Oregon, and Washington but not Idaho. Since then Idaho adopted its first commercial building energy code, and all 4 states have significantly strengthened their codes.

Previously NEEA evaluated energy savings associated with regional non-residential code changes made between 1996 and 2004[1]. Specifically, it quantified changes that had been adopted with planned enforcement dates on or before July 2005. This report provides estimates of energy savings associated with regional non-residential code changes with enforcement dates between July 2005 and July 2008. Savings are projected from the date of their implementation through 2028.

[1] Residential code energy savings for the same period were estimated by the Northwest Power & Conservation Council.

As with any work of this nature, there is significant uncertainty with the savings estimates contained within. By necessity, only the primary code provisions are evaluated in this work. Many other code provisions have not been quantified, mostly due to expected small overall savings, or occasionally to uncertainty about current practice and application. Taken together these un-quantified provisions likely lead to significant additional savings. As such, this work forms a conservative estimate of energy savings resulting from code changes.

Background – Regional Code Adoptions 1996-2008

Each state in the Northwest has a unique energy code history, differing in code content as well as enforcement. The following sections contain chronologies of energy code adoptions by state.

Idaho

Idaho was the last state in the region to adopt a non-residential energy code. In 1996 it did not have an energy code, though the City of Idaho Falls and Kootenai County enacted the Northwest Energy Code (NWEC) in 1989 which included by reference ASHRAE 90.1-1989. In 1999, all state buildings were required to meet 90.1-1989. In 2002 the 2000 IECC was adopted for all state buildings. In 2003, the 2000 IECC was adopted for all buildings in the state. In spring 2004, the 2003 IECC was adopted for all buildings starting on January 1 2005. IECC 2006 was adopted in 2007 and became effective in January 2008.

Idaho Code Chronology			
Enactment Date	Enforcement Date	Description	Evaluated
1989	1989	City of Idaho Falls & Kootenai county adopted NWEC	
1999	1999	State buildings required to meet ASHRAE 90.1 1989.	
June 2002		Adopted 2000 IECC for state buildings	
Jan 2003		Adopted 2000 IECC for whole state.	
Jan 2005		Adopting 2003 IECC for whole state	
	Jan 2008	Adopting 2006 IECC for whole state	X

Montana

In 1992 Montana adopted the Model Energy Code (MEC) which referenced ASHRAE 90.1-1989. This code was the law of the land until summer 2004 when the 2003 IECC was adopted. Montana considered the adoption of the IECC 2006. With continued delay it was decided to wait for the 2009 IECC code. The state is planning opening consideration of this update as soon as the 2009 version is published.

Montana Code Chronology			
Enactment Date	Enforcement Date	Description	Evaluated
1992		ASHRAE 90.1-1989 (by reference in MEC).	
July 2004		Adopted 2003 IECC	
		2006 IECC - NOT ADOPTED	

Oregon

Oregon adopted a state-promulgated non-residential energy code applying only to the building envelope in 1978; this was expanded to include HVAC systems in 1980. A complete energy code was adopted in 1996. In 1998 slight changes were made, and in 1999 a high glazing path was added to allow up to 40% glass in Zone 1 (increased from 30%) and up to 33% in Zone 2 (increased from 25%). The windows required in the high glazing path were significantly improved so that overall thermal integrity was not compromised. In 2001 equipment efficiency tables were updated to reflect ASHRAE 90.1-1999 2001 values.

In 2003 major changes were made to the code. Lighting and HVAC were dramatically improved. Maximum lighting power density (LPD) requirements were reduced, minimum lighting controls increased, and HVAC language improved. In April 2004 further revisions were made to the Air Transport Factor (ATF) calculation, and in October 2004 additional requirements for window wall construction types were implemented. The 2007 Oregon code went into effect in October 2007. This code made small changes.

Oregon Code Chronology			
Enactment Date	Enforcement Date	Description	Evaluated
1978		Envelope only code	
1980		HVAC coverage added to code (1979 UBC)	
1996		Major non-residential code established.	
1998		Code update with limited changes. No changes to envelope or lighting components.	
1999		Added 40% window path, energy neutral	
Oct 2001		Updated equipment standards 90.1-99 (2001 values)	
Nov 2003		New Oregon Code - Changes in all areas including lighting LPD and equipment efficiency tables	
Mar-04		Slight revisions with significant change to the Air Transport Factor requirement and calculations.	
Oct-04		Slight revisions with significant increases in deemed to comply window traits for window wall components.	
April-07	April-07	New Oregon Code -	X

Washington

Washington adopted a state-promulgated energy code for non-residential buildings in 1986. An update in 1994 made it the most stringent in the region. Since that time it has undergone three code revision cycles and one emergency rule-making. Equipment efficiency was increased in 2001 to reflect the ASHRAE 90.1-1999 2001 values. Retail lighting requirements changed significantly in structure between 1996 and 2004 though the impact on average retail LPD is questionable.

A PACKAGE OF SIGNIFICANT PROPOSALS IN 2003 WOULD HAVE MADE SIGNIFICANT CHANGES TO THE CODE BUT WAS NOT ADOPTED. THE STATE BUILDING CODE COUNCIL RECOMMENDED A SIMILAR PACKAGE FOR ADOPTION IN NOVEMBER 2004 WHICH BECAME LAW IN JULY 2005. THE 2006 WASHINGTON ENERGY CODE WENT INTO EFFECT IN JULY 2007. THIS CODE MADE SIGNIFICANT CHANGES TO ENVELOPE AND LIGHTING.

Washington Code Chronology			
Enactment Date	Effective Date	Description	Evaluated
1986		First state non-residential code.	
1994		Second state non-residential code.	
1997		Code cycle revision. Expanded default values, no change to envelope requirements, equipment efficiency tables, or LPD requirements.	
2000		Code cycle revision. Expanded default values and changed retail lighting paths. No change in envelope or equipment efficiency requirements	
July 2001		Emergency changes. Equipment efficiency tables updated to 90.1-1999 2001 format and values. No changes in LPD requirements envelope.	

2003		Editorial changes, essentially the same as 2001 Second edition.	
July 2005		Building Code Council recommended changes (Nov 2004). Significant LPD changes. (Evaluated in other work, Kennedy & Baylon, May 2004)	
	July 07	State 2006 Energy Code.	X

Seattle

Seattle has the most stringent code in the region. With each Washington State code revision, the City of Seattle adopts amendments strengthening the code. The amendments are tailored to the Seattle building stock and its political climate. By law they must be equal to or better than state code. Typically they have been significantly more stringent with regards to building envelope, HVAC, and lighting. The 2002 Seattle amendments included the following major requirements: ASD drives on motors with variable loads including fan powered boxes, decreased lighting power densities, and increased envelope insulation. The 2006 Seattle amendments included significant economizer changes.

The impact of the Seattle amendments are not quantified here since this work is focused on state code changes. The 2002 Seattle amendments were estimated in other work (Kennedy, Baylon 2002) and included in the 1996-2004 evaluation.

National Energy Appliance Conservation Act (NAECA)

The NAECA is a manufacturing standard with jurisdiction over small (< 5 tons) air conditioners and heat pumps. The only significant change to mechanical efficiency requirements during the 2005-2008 window is the NAECA efficiency increase on small air-conditioners and heat pumps. Washington and Oregon adopted these increased levels in the state energy codes thus making them an installation standard as well. The IECC, and by extension Idaho, has not adopted these levels.

The impact of the manufacturing standard over a period of years presumably is the same as an installation standard. So over a year or two Idaho and Montana will see equipment generally meeting this requirement. For the same reason it is hard to attribute savings in Washington and Oregon to the state codes.

This change is evaluated in all 3 states with other code changes. However, energy savings themselves are difficult to attribute to state energy code changes since the NAECA manufacturing standard is a significant driving force.

Methodology and Data Sources

Between July 2005 and July 2008 energy code activity was somewhat limited. Idaho adopted the 2006 IECC over the 2003 IECC resulting in significant changes to envelope and lighting. Montana made no code changes during the period despite efforts to adopt the 2006 IECC. Oregon made almost no changes. Washington made limited changes that improved lighting and semi-heat space requirements. Some of these changes were very important with respect to energy savings, many more are clarifications, or codify existing official interpretations. Others have significant energy impacts in very specific situations that occur relatively infrequently.

The first step of this project was to identify all code changes since the last code evaluation (Kennedy 2005). They were then prioritized by anticipated magnitude of energy savings, reviewed by NEEA and then decisions were made as to which should be estimated. Every energy code change from 2006 through 2008 is listed by state in appendices A through D. The evaluation method column indicates whether it has been included in this energy savings evaluation. If not, the reasoning for exclusion is presented in the comment field.

Many code changes have not been evaluated in this work. Typically they impact a limited number of buildings or system types. Individually they are not important, but taken together they represent additional savings not captured in these estimates.

Two basic quantification methods, described below, were used to calculate savings estimates. Savings for each code measure were estimated with one of these methods and then were normalized by floor area for each building type/state combination. State and regional savings were then calculated by multiplying the per square foot savings with floor area projections from the 2008 Northwest Power Planning Council medium growth forecast[2].

It is important to note that savings here are not a direct code to code comparison. Current pre-code saturations of equipment are accounted for. In some cases this significantly diminishes savings.

Simulation Method

The DOE2.1e Building Energy Use Simulation program was used to determine baseline energy usage and savings from incremental changes in the primary performance variables -- lighting LPD, equipment efficiency, and envelope component efficiency requirements. Eleven building prototypes were used to represent the general building stock. These were primarily derived from the BPA regional prototypes that were based on regional audit data. Two other prototypes were derived from prototypes developed by the State of Washington.

[2] Supporting data files from: Sixth Northwest Electric Power and Conservation Plan, Northwest Power and Conservation Council, Document 2008

Prototype Descriptions

Building Type	Original Source	Baseline System/Fuel
Office – Large	from BPA 89 vintage	VAV – Series boxes, electric reheat
Office – Medium	from WSEO	VAV – non-fan powered boxes. Gas boiler
Office – Small	from BPA 89 vintage	Package single zone, gas heat
Retail – Large	from BPA 89 vintage	Package single zone, gas heat
Retail – Small	from BPA 89 vintage	Package single zone, gas heat
Grocery	from BPA 89 vintage	Package single zone, gas heat
School	from BPA 89 vintage	Unit ventilators & package single zone, gas boiler
School – Elementary	from WSEO	Two pipe fan coil, gas boiler
Warehouse	from BPA 89 vintage	Package single zone, gas heat & gas unit heaters
Hospital	from BPA 89 vintage	VAV and CV reheat. HW reheat, gas boiler.
Restaurant - Sit Down	from BPA 89 vintage	Package single zone, gas heat

Key traits of the prototypes such as heat loss rate and lighting level were altered to represent baseline 2005 construction standards. Baseline characteristics for each prototype were derived from averages of regional audit data (see Data Sources). For example, baseline lighting level is not the code LPD but an average of the as-found building LPDs which results in a level generally better than code. Since the most recent data is from buildings built prior to 2005 codes used as a base for this work, traits were modified, before averaging, to comply with the energy codes as of 2005. For example, the prototype office lighting power density (LPD) was the average office LPD found in the audited buildings except where the audited value was less than the code base used in this work. In which case, the code value was used.

The code characteristics were determined from the audit data. Each aspect of the audited building was compared with the new codes to determine what changes would make the building comply with the new codes. These new conditions were averaged to derive an average code characteristic for each parameter.

Lost in this method is the impact of significant changes in system types or building configuration in the future. The world is seen through the lens of the audit data which reflects the design choices of the past.

Energy savings were determined by comparing results from models using baseline characteristics with those using code characteristics. The Boise ID, Missoula MT, Portland OR and Seattle WA TMY2 weather sites were used to represent Idaho, Montana, Oregon, and Washington respectively.

Results were calculated for electric, gas, and heat pump heat from the default system using simplified conversion factors. These results were averaged using regional heating fuel saturation to arrive at typical savings for each simulation.

Defining the Savings Increment

The definition of savings increment under the simulation method is critical. For measures that involve performance criteria, such as maximum LPD, the chosen increment has a significant impact on savings. Three scenarios have been used in previous work. All three are based upon applying the scenario logic to a sample of real buildings to determine the individual impacts of code changes, averaging the individual impacts by climate and building type, and then modeling the average impacts to determine savings. Assumed in all scenarios is that the actual starting building characteristics are from buildings representing construction under the base code.

Scenario 1 looks at the savings from direct application of the most recent code as a code official would. It assumes that buildings not meeting the current code will just meet it and buildings already better than code will not change. In the case of LPD, the savings increment is the difference between the building LPD and the new code LPD; if the building LPD is already better than the new code there are no savings. The assumption is that buildings will move to the new code level but not beyond which makes this the most conservative estimator. It has been called the “first year savings” in some of the previous code potential work.

Scenario 2 assumes that future buildings will pass the current code by the same margin that recent buildings passed the code at the time they were built. It assumes a building built to the base code that is X% better or worse than base code would be X % better or worse than the current code if it were built now or in the future. Unlike Scenario 1, a building will show savings even if it is already better than the new code.

This proportional shift in the population performance fits with past response to lighting code changes. Scenario 2 assumes that technology will give designers the tools they need to exceed code by a similar amount in the future as they did previously. It therefore implicitly assumes technology increments are always available. In reality, just because a new code is 5% better than the old one does not mean that there are, say, commercially available windows that are 5% better than what the builder was previously using.

Another assumption of Scenario 2 is that the base code is not too out of alignment with current practice. If the audited buildings are 25% better than code just because the code is lax in that area it is hard to see that practices will change when the code improves 15%.

Scenario 3 looks at the difference between the codes directly. The sample buildings are used only to determine system types and basic building geometry. Code savings are assumed to be the difference between the old code and the new one. Using an LPD example once again, if the old code required a 1.4 w/sqft LPD and the new code requires 1.2 w/sqft the savings for all lighting is 0.2 w/sqft. This is the most generous scenario and is often used in code comparisons.

Application of the Savings Scenarios

This work uses Scenario 1 to evaluate envelope code requirements as these tend to be prescriptive and buildings are therefore most likely to just comply with code.

For lighting power density all three scenarios have serious deficiencies. Scenario 1 is too obviously conservative even with its 100% code compliance assumption. Scenarios 2 and 3 give unreasonable results where the base code has very high maximum LPD values which do not represent current practice well. High base code LPDs result in large savings compared to when a base code is closer to current practice. If current practice is the result of desired light levels and not the code then this savings is illusory.

To address this situation “Code+5%”, a modified version of Scenario 1, was developed and used to evaluate lighting LPD changes. It assumes that buildings surpassing the new code by 5% will not change, and that everything else will improve to exceed current code by 5%. This scenario addresses the fact that new buildings will typically beat code by some margin; in terms of savings potential it falls midway between Scenarios 1 and 2. As outlined above this scenario assumes 100% compliance with the energy code. However, without changes in code enforcement non-compliance is unlikely to change from the base code conditions. To remedy this, an LPD adjustment was made so that the same amount of code non-compliance as currently exists is assumed in the scenario LPD. This was done by subtracting the base code to actual LPD difference from the scenario LPD for all sites where the actual LPD was higher than the base code.

The average difference between the actual building LPDs and the code plus 5% LPD, with the code compliance adjustment, was then averaged by building type and state and used as the modeled lighting power density shift in the savings predictions.

Scenario 2 was used for savings from equipment cooling efficiency and heat pump heating efficiency. The equipment efficiency base code is more closely aligned with current practice making scenario 2 a good measure of savings.

Engineering Method
Measures such as motor control and lighting control improvements were evaluated using a simplified engineering approach. Savings are calculated as a fraction of total use or of a specific end use, as determined from the prototype simulations, or through engineering calculations. The savings are modified to account for the applicability of the code language to given building or system types, and for the current saturation of the technology. Total saturation is assumed. All applicable buildings without a particular required technology are assumed to install it. To minimize double counting, end use consumption was taken from simulations that incorporated code characteristics for LPD, UA, and HVAC performance.

Data Sources
The primary characteristics data was derived from data collected as part of the Baseline Characteristics of the 2002-2004 Non-Residential Sector study (Ecotope 2008)[3]. This data was used to determine HVAC equipment type, performance, and associated minimum code performance, building lighting power densities (LPD) and associated code maximum LPD, and building envelope characteristics and geometry. The study buildings were built to the standards current during the 2001 code year. As such they do not necessarily comply with the 2005 codes used as the base for this work. Adjustments were made where appropriate.

Calculations and Assumptions

This section presents the calculation details for each code change evaluated.

Lighting Power Density
Idaho and Washington implemented changes in LPD requirements. The changes were not across the board and involved adjustments up or down to various categories. Washington decreased lighting allowances in schools, medical facilities, lodging, small offices spaces, and most institutional space. Allowances were increased in sit down dining and theaters. Idaho decreased lighting allowances in dining, other medical, and courthouses. Lighting allowances increased in laundry, workshops and repair facilities.

Savings for these changes are simulation predicted using the regional prototypes and local new building lighting data. The increments modeled were determined for each state by applying the 2005 and 2008 energy codes to buildings audited in the NEEA Baseline study (2002-2004 construction year). The difference in the resulting LPD was modeled. For each building, data at a tenant level of detail is used to determine how the codes would be applied.

The table below provides the summary LPD results for the chosen scenario applied to data found in the NEEA Baseline study (excluding Washington data as it had no overall LPD code change). The “Ending LPD” column is the average LPD of the audit buildings that would result if the scenario savings were realized.

[3] http://www.nwalliance.org/resources/reportdetail.asp?RID=134

Lighting Data Summary by State (w/sqft). NEEA Baseline

State	Obs	Avg. Actual LPD	Code LPD (w/sqft)		Ending LPD (w/sqft)		Delta LPD (w/sqft)
			2005 Code (tenant value)	2008 Code (tenant value)	2005 Code	2008 Code	
ID	64	0.90	1.09	1.08	0.82	0.81	-0.0089
MT	29	1.13	1.13	1.11	0.95	0.95	0.0000
OR	108	1.09	1.15	1.15	0.96	0.96	0.0000
WA	146	1.16	1.23	1.15	1.03	0.99	-0.0396
Total	347	1.10	1.18	1.14	0.98	0.95	-0.0226

The next table presents the same data by building type. This is for illustration only. The underlying data set has no statistical significance at these levels of detail.

Lighting Data Summary by Building Type (w/sqft). NEEA Baseline

State	Obs	Avg. Actual LPD	Code LPD (w/sqft)		Ending LPD (w/sqft)		Delta LPD (w/sqft)
			2005 Code (building value)	2008 Code (building value)	2005	2008	
Assembly	8	1.05	1.05	1.04	0.96	0.96	-0.0053
College	15	1.16	1.20	1.14	1.11	1.06	-0.0464
Education	61	1.05	1.25	1.17	1.02	1.00	-0.0170
Grocery	18	1.57	1.57	1.57	1.40	1.40	0.0000
Health Services	16	1.36	1.17	1.10	1.10	1.04	-0.0641
Hospital	25	1.25	1.38	1.22	1.14	1.09	-0.0534
Institution	24	1.10	1.01	0.99	0.90	0.89	-0.0107
Office – Large	12	0.96	1.02	1.00	0.87	0.87	0.0000
Office – Small	14	1.09	1.01	1.00	0.94	0.93	-0.0076
Other	9	0.85	1.29	1.30	0.82	0.82	-0.0012
Residential/Lodging	18	1.23	1.31	1.06	1.05	0.92	-0.1323
Restaurant / Bar	8	1.45	1.47	1.42	1.24	1.24	0.0048
Retail - Large	47	1.46	1.57	1.57	1.33	1.33	-0.0009
Retail - Small	31	1.36	1.65	1.58	1.28	1.25	-0.0296
Warehouse	41	0.59	0.74	0.75	0.47	0.47	-0.0005

Envelope Measures

Idaho had major changes in envelope requirements. Washington had two minor changes, and Oregon made no changes. Idaho and Montana are utilizing the IECC which underwent a major restructuring between the 2003 and 2006 versions. Idaho adopted the new 2006 version with it's changes. Most significantly minimum component efficiency is no longer strongly tied to glazing fraction. In the 2003 version low glazing fraction buildings were allowed to install significantly lower performing windows and opaque insulation. This is no longer the case. Somewhat offsetting this is a reduction in the stringency of the code for high glazing fraction buildings. The net effect is a 4-5% reduction in building heat loss rate for the buildings observed in the most recent baseline study.

The climate zone divisions changed significantly as well but the impact of this is more or less neutral. Washington made a significant change for semi-heated buildings and also added language to specifically cover intermediate floor edges. This later factor is probably a reduction in the letter of the code, but addresses a piece of the building envelope that likely was ignored in most cases.

Savings for these changes were simulated using the regional prototypes and data from regional building surveys. The increments modeled in Idaho are determined by applying the 2005 and 2008 energy codes to buildings audited in the NEEA Baseline study (2002-2004 construction year). For each building, shell data is used to determine how the codes would be applied. The difference in simple code compliance with the 2005 versus 2008 codes (Scenario 1) was chosen as the increment of choice. The increment of non-compliance is not evaluated since it is the difference between the codes that is being evaluated.

Savings from the Washington semi-heat change is evaluated individually.

Envelope Data Summary by State (UA/sqft). NEEA Baseline

State	Obs	Avg. Heat Loss (ua/sqft	Code Heat loss Rate (UA/sqft)		Delta UA (UA/sqft)
			2005 Code	2008 Code	
ID	64	0.205	0.204	0.195	-0.009
MT	29	0.161	0.148	0.148	0.000
OR	108	0.163	0.151	0.151	0.000
WA	146	0.177	0.166	0.165	-0.001
Total	347	0.177	0.168	0.166	-0.002

Heating and Cooling Equipment

Changes made to the codes in the 2005-2008 period are extremely limited. All states adopted codes that implement the ASHRAE 1999 equipment efficiency standards including the 2001 performance values prior to evaluation window of this work. The only significant change is the NAECA manufacturing standard that increased efficiency on small air-conditioners and heat pumps. Washington and Oregon adopted these increased levels in the energy code. The impact of the manufacturing standard over a period of years presumably is just the same as an installation standard so this increment is evaluated in all 4 states. However, energy savings themselves are difficult to attribute to energy code changes since the actual driver is the NAECA.

Savings for this change have been simulation predicted using the regional prototypes and energy efficiency rating (EER) increments determined for real building characteristics. The increments modeled are determined by applying the 2005 and 2008 energy codes to equipment audited in the NEEA Baseline (2002-2004 construction year). The average equipment improvement by building type is modeled in each state with local climate.

The savings increment assumes that future EER will pass code by the same margin as the current EER passes the 2005 code (Scenario 2). Here the more consistent code increment makes Scenario 2 a good choice.

Savings for the heat pump heating efficiency improvement are estimated with an engineering calculation based upon the simulation predicted heating energy use, the estimated electric input ratio (EIR) increment, and the baseline determined applicability.

Savings Methodology – Individual Measures

Semi-Heated Space – Higher Insulation Requirements (Washington only)

Washington changed the semi-heated space provisions so that semi-heated spaces were only exempt from wall insulation requirements rather than be exempt from all but reduced roof insulation requirements. Semi-heated spaces in the NEEA Baseline study generally had windows and skylights that complied with code any way. So the main changes were increased roof insulation and better doors. Simulations were done assuming an insulation jump from R11 to R20 in roof and improved doors. Saturation of semi-heated buildings that already had higher roof insulation was estimated to be 30%. Savings also assume that the spaces are really semi-heated which mostly they were in Washington.

Unit Heater Intermittent Ignition Devices & Power Vent

Washington adopted requirements requiring all unit heaters to have intermittent ignition devices (IID), and power burner or vent dampers. This is a significant step since these measures greatly increase seasonal efficiency, which is not regulated in commercial equipment.

Savings are difficult to quantify exactly. A natural draft furnace with a pilot light is assumed to have a seasonal efficiency of 64% (Kennedy et all, 1995). An IID, power draft, low loss unit is assumed to have a 78% seasonal efficiency (Kennedy et all, 1995). Equipment data from the 2005 Baseline indicates gas unit heaters heat 8.7% of total floor area. This percent was used to determine the impacted floor area. Current saturation could be very high. Work for the mid-90's indicated a 50% saturation of power draft equipment and this value is used here.

Temperature Reset (WA)

Code changes reduced the threshold for requiring hot and cold-water loops to have temperature reset from 600kBtuH to 300kBtuH. Exemptions for variable flow water loops and <100F heat pump loops were retained. The size band and loop language limiting application to non-VFD, non-heat pump loops significantly limits applicability and savings.

Based upon the 2005 Baseline study, hot water loops serve 25% of the floor area and cold-water loops serve 20%. Of these 9.8% and 6.0% are in the size range covered by this code provision. Of these, 50% and 30% already had VFD drives. The current saturation of VFDs in these systems is very uncertain due to the limited number of systems.

Savings were assumed to be 9% of heating and cooling energy use respectively based upon extensive work conducted by Minneapolis State energy office long ago. Discussion in WNG Demand side savings 1995.

Demand Control Ventilation (WA & OR)

Washington adopted a provision requiring demand control ventilation in HVAC systems serving spaces larger than 500sf with design occupant loads greater than 40 people per 1000. This requirement is only for systems with mechanical outside air control or systems greater than 3000cfm. Additional exceptions to this requirement include systems with heat recovery; systems with total air flow less than 1200cfm, and multi-zone systems.

Oregon adopted language in its 2004 code requiring DCV in spaces with design occupancies greater than 50 people per 1000sf but limited to systems with more than 1500cfm of ventilation air. There are no other exceptions in the Oregon language.

DCV was simulated in the School and Restaurant prototypes in the multipurpose area and dining area respectively. ASHRAE 62 ventilation levels were established. The DCV impact was estimated to reduce ventilation air 50%.

Heat Pump Loop Valves and VFD (WA)

Washington code adds language requiring heat pump loops (HPLP) to have bypass valves/controls for cooling towers, and for loops with pump HP > 10 hp two-way valves are required on the heat pumps. Combined with the requirement for having VFDs on variable loads this essentially forces VFD pump motors on heat pump loops. The 2005 Baseline did not gather adequate information to answer this point completely. The presence of bypass valves was not recorded. HPLPs served 3.6% of total floor area. Of HPLPs with pump HP over 10 horsepower (98.5%), 56% already have VFD.

Savings for this measure were established using an engineering calculation assuming VFDs would save 50% of pumping energy. Pumping energy was estimated assuming cooling capacity of 30btu/sf and a heat pump delta-T of 10 degrees (2/3rd HPLP, 1/3 ground source) to get design loop flow of 0.006 GPM/SF. Energy requirements were estimated assuming 0.085 HP/GPM which is the average from the 2005 Baseline systems, loop operation of 3500 hours, and that motor efficiency and standard oversize cancel.

A significant uncertainty is the baseline prevalence of pump staging and the exact strategy employed, whether the staged pumps are truly staged or simply backup pumps. Audit data indicates multiple pumps serve most pump loops.

Cooling Tower VFD (WA)

Cooling towers with more than 10 total fan horsepower are required to have VFD or staged pony motor. Savings for this measure were established using an engineering calculation assuming VFDs would save 50% of fan energy. Tower presence and fan capacity were determined using 2005 Baseline data and engineering assumptions. Basically tower HP per SF was calculated assuming cooling capacity of 30 Btu/SF, a tower design temperature difference of 10 degrees, and 0.04HP per GPM which is the average from the 2005 Baseline. Energy savings assume the loop operates at 5000 hours, motor efficiency and oversize cancel, and VFD savings of 50%.

ERV Requirements in High OA Fraction Systems (ID)

The 2006 IECC incorporated Energy recovery is now required for systems with design supply CFM greater than 5000 and an outdoor air fraction greater than 70%. Exceptions include all hood systems less than 15000 CFM, VAV or compensating hood systems of any size, and system serving heat only spaces with design requirements less than 60F.

In the baseline study there was one system in ID and MT that might have systems that qualify for this requirement. One facility with systems that likely would have qualified would likely say it was designed to be <60F (home improvement store), and another was associated with a painting outfit. This measure was not evaluated.

Economizer (ID)

Economizer requirement system capacity threshold was reduced to systems greater than 54,000 Btuh from 65,000Btuh.

Savings for this measure were modeled in the small office and small retail prototypes. A non-integrated, single sensor, 65°F changeover, 80% maximum air fraction economizer was modeled. The average percent reduction in cooling energy use for these buildings was used to extend savings to other building types.

Applicability was derived from 2005 Baseline data. Floor area served by DX equipment is combined with percent of DX units in size range without economizer. The equipment in this size range is 9.8% of DX equipment and the portion with economizer is 65% so the combined fraction averages 3.4%. Air side capacity information is very limited for non-DX systems. No chiller source or WSHPs are reported in this size range without economizer but this is fairly suspect. Some additional savings is likely, though between floor area served by DX (50%), 20% of floor area without cooling, and water side economizers the remaining potential units are limited.

Transformers (Washington only)

Washington code changed to require all distribution transformers to meet minimum efficiency levels equivalent to NEMA TP-1. Savings from this measure are near constant per transformer and do not vary significantly with actual electric use. Even so many authors have estimated energy savings to be 1% of use. One percent is used here.

Applicability is limited to buildings with 480V or higher electrical service where transformers are installed as part of the building. Building types assumed to be impacted are large office, large retail, and hospital. Modern office buildings often have 1 or 2 transformers per floor.

In the 2001 SCL New Construction Survey all transformers were found to be standard units, so current saturation for this measure in Washington is assumed to be zero.

Commissioning

Washington code requires all new buildings to have a commissioning plan and to have equipment control and sequence of control commissioned. Recent code changes have strengthened the language of this section, increasing the number of specific tests and explicitly requiring test and balance. Quantifying savings for this are essentially a very significant guess. The result has an outsized impact on overall savings because of the amount of floor area built in Washington and the applicability of this to nearly all floor area.

Estimating commissioning energy savings is uncertain at best. Some changes lead to better energy efficiency others to better ventilation at the expense of energy. In addition, the longevity of energy savings is very uncertain. Many of the items found during new building commissioning would be found in a less timely way without commissioning. The NEEA Commissioning in Public Buildings project estimated energy savings from intensive third party commissioning of new buildings at 0.96 kWh/sqft. The previous code evaluation assumed the previous would achieve 10% of the savings found in that work (0.096kWh/sqft). This evaluation assumes the improved language will save 5% more. This represents 26% of all regional electric savings and 20% of all gas savings.

Results

For each code provision analyzed, the simulation and engineering calculations produced estimates of energy savings per square foot by building type and state. These were multiplied by the applicable new construction square footage in each state as forecast in the Power Planning Council’s medium growth scenario to create average state and measure energy savings estimates. The Council’s forecast provides square footage estimates for each year through 2028; estimates for code savings were therefore calculated separately for each year through 2028.

Since the purpose of this report is to estimate future energy savings associated with code changes enacted between 2005 and 2008 it was necessary to determine a starting date for the impacts. Changes in all states were made at the end of the period. Oregon and Washington code changes went into effect in June 2007, and Idaho in January 2008. We have therefore assumed energy savings start in 2008 for Idaho, Oregon, and Washington.

For illustrative purposes, the “Annual Energy Savings by State” table below presents energy savings attributed to all the code changes assuming the Council forecast population for 2009. This is the first full year that all 2005-2008 code changes will be enforced though it is also forecast to have significantly more construction than future averages. Total regional savings for that year are 1.06 average megawatts of electricity and 19,654 mmBtu of gas. Floor area normalized regional savings are 0.16 kWh/sqft of electricity and 0.33 kBtu/sqft of gas.

Savings per square foot are largest in Idaho where significant changes were made but total savings are relatively small due to the small projected floor area. Likewise, total savings are relatively large in Washington due to the much larger projected new floor area.

Annual Energy Savings by State						
State	Normalized Savings		2009 New Floor Area Estimate (millions)	Sector Savings		
	Electric	Gas		Electric		Gas
	kWh/sqft	kBtu/sqft		mWh	aMW	mmBtu
Idaho	0.30	0.73	6.58	1,981	0.23	4,826
Montana	-----	-----	3.59	-----	-----	-----
Oregon	0.07	0.12	17.93	1,193	0.14	2,131
Washington	0.19	0.40	31.68	6,151	0.70	12,697
Total	0.16	0.33	59.78	9,325	1.06	19,654

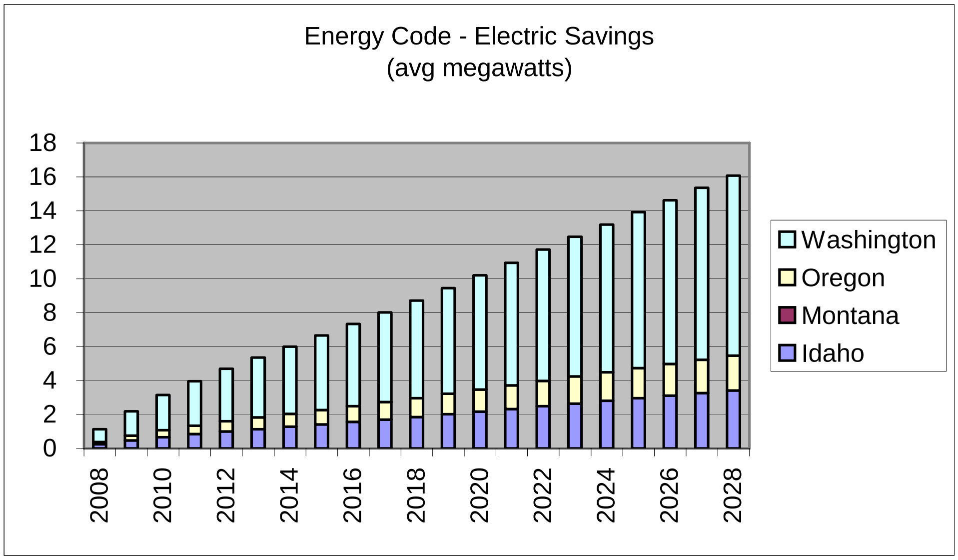
The next table presents a more detailed breakout of the 2009 energy savings by state and code provision. Electric savings within each state are dominated by the main LPD changes to the code, lighting control changes, and ASHRAE 90.1 equipment changes. Because of the large amount of new construction in Washington, the commissioning measure is also significant. The lighting measures lead to large increases in gas use, while envelope and IID measures lead to decreases. Overall, gas usage is decreased.

2009 Energy Savings by State and Measure					
	Normalized Savings		Sector Savings		
	Electric	Gas	Electric		Gas
	KWh/sqft	kBtu/sqft	mWh	avg MW	mmBtu
Idaho					
LPD Changes	0.04		278	0.03	(520)
Envelop Changes	0.17	0.81	1,133	0.13	5,346
EER Changes[1]	0.06	-	386	0.04	-
HP HSPF Changes[1]	0.03	-	169	0.02	-
Economizer	0.00	-	15	0.00	-
ID Total	**0.30**	**0.73**	**1,981**	**0.23**	**4,826**
Montana					
No Changes	-	-	-	-	-
MT Total	**0.00**	**0.00**	**0**	**0.00**	**0**
Oregon					
LPD Changes	-	-	-	-	-
EER Changes[1]	0.05	-	838	0.10	-
HP HSPF Changes[1]	0.02	-	288	0.03	-
Demand Control Ventilation	0.00	0.12	66	0.01	2,131
OR Total	**0.07**	**0.12**	**1,193**	**0.14**	**2,131**
Washington					
LPD Changes	0.03		1,034	0.12	(4,349)
Envelop Changes	-	-	-	-	-
EER Changes[1]	0.04	-	1,119	0.13	-
HP HSPF Changes[1]	0.02	-	501	0.06	-
Semi-Heated Space Requirement	0.00	0.00	0	0.00	31
Water System Temperature Reset	0.00	0.01	0	0.00	225
IID, Power Vent Requirement for All	-	0.08	-	-	2,391
1432.2.2 HPLP Bypass Valves	0.01	-	407	0.05	-
Cooling Tower VFD	0.00	-	38	0.00	-
Demand Control Ventilation	0.01	0.32	268	0.03	10,157
Commissioning	0.09	0.13	2,784	0.32	4,243
Transformers - TP-1	0.01	-	411	0.05	-
WA Total	**0.21**	**0.40**	**6,562**	**0.75**	**12,697**

1 - savings are from improved efficiency levels of the NAECA changes. These are improvements in regional efficiency but can not be directly attributed to state energy codes.

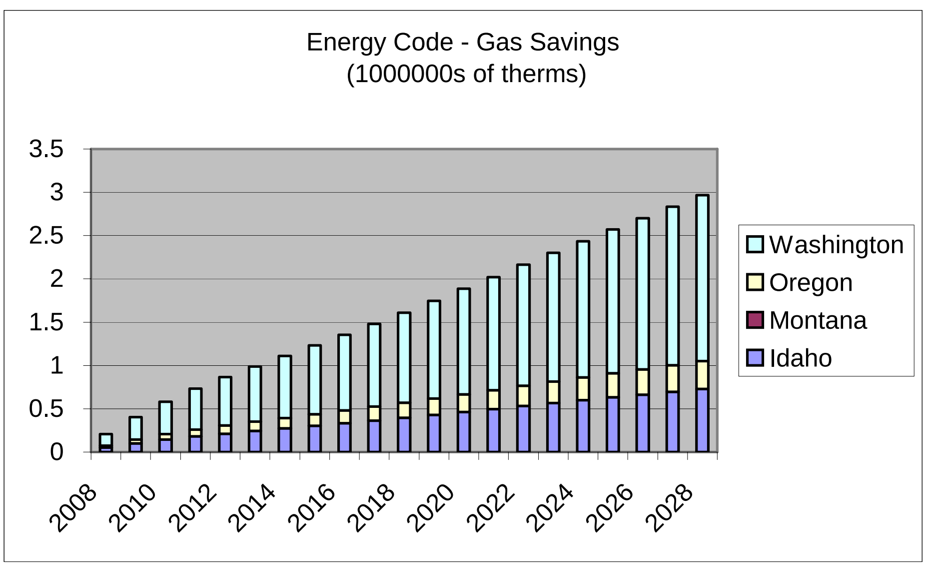
Cumulative electric savings for the period from 2008 through 2028 are presented in Figure 1. Under the Council's medium forecast the regional non-residential energy code changes enacted between 2005 and 2008 are set to capture 16.1 average megawatts over the 21-year period from 2008 through 2028.

Figure 1



Cumulative gas savings of 3.0 million therms for the period from 2008 through 2028 are presented in Figure 2.

Figure 2



The following tables present the annual energy savings by year and state. Savings are those acquired in the given year. The total column presents both the per year and cumulative savings.

Code Energy Savings - Average Megawatts per Year

Year	Idaho	Montana	Oregon	Washington	Total	
					Per Year	Cumulative
2004	-	-	-	-	-	-
2005	-	-	-	-	-	-
2006	-	-	-	-	-	-
2007	-	-	-	-	-	-
2008	0.24	-	0.14	0.74	1.13	1.1
2009	0.23	-	0.14	0.70	1.06	2.2
2010	0.20	-	0.12	0.63	0.96	3.1
2011	0.17	-	0.10	0.54	0.81	4.0
2012	0.16	-	0.09	0.48	0.73	4.7
2013	0.14	-	0.09	0.44	0.67	5.4
2014	0.14	-	0.08	0.43	0.65	6.0
2015	0.14	-	0.09	0.44	0.66	6.7
2016	0.14	-	0.09	0.44	0.67	7.3
2017	0.14	-	0.09	0.45	0.68	8.0
2018	0.15	-	0.09	0.46	0.70	8.7
2019	0.16	-	0.09	0.49	0.74	9.5
2020	0.16	-	0.10	0.50	0.75	10.2
2021	0.16	-	0.09	0.48	0.73	10.9
2022	0.16	-	0.10	0.51	0.77	11.7
2023	0.16	-	0.10	0.50	0.75	12.5
2024	0.15	-	0.09	0.48	0.73	13.2
2025	0.15	-	0.09	0.48	0.72	13.9
2026	0.15	-	0.09	0.47	0.71	14.6
2027	0.15	-	0.09	0.48	0.73	15.4
2028	0.15	-	0.09	0.47	0.71	16.1
Total	3.4	0.0	2.1	10.6	16.1	

Code Energy Savings - Average Therms per Year (1,000,000's)

Year	Idaho	Montana	Oregon	Washington	Total	
					Per Year	Cumulative
2004	-	-	-	-	-	-
2005	-	-	-	-	-	-
2006	-	-	-	-	-	-
2007	-	-	-	-	-	-
2008	0.05	-	0.02	0.13	0.21	0.2
2009	0.05	-	0.02	0.13	0.20	0.4
2010	0.04	-	0.02	0.11	0.18	0.6
2011	0.04	-	0.02	0.10	0.15	0.7
2012	0.03	-	0.01	0.09	0.14	0.9
2013	0.03	-	0.01	0.08	0.12	1.0
2014	0.03	-	0.01	0.08	0.12	1.1
2015	0.03	-	0.01	0.08	0.12	1.2
2016	0.03	-	0.01	0.08	0.12	1.4
2017	0.03	-	0.01	0.08	0.13	1.5
2018	0.03	-	0.01	0.08	0.13	1.6
2019	0.03	-	0.01	0.09	0.14	1.7
2020	0.03	-	0.02	0.09	0.14	1.9
2021	0.03	-	0.01	0.09	0.14	2.0
2022	0.03	-	0.02	0.09	0.14	2.2
2023	0.03	-	0.02	0.09	0.14	2.3
2024	0.03	-	0.01	0.09	0.13	2.4
2025	0.03	-	0.01	0.09	0.13	2.6
2026	0.03	-	0.01	0.08	0.13	2.7
2027	0.03	-	0.01	0.09	0.13	2.8
2028	0.03	-	0.01	0.09	0.13	3.0
Total	0.73	0.0	0.32	1.92	2.97	

Bibliography

Baylon, D. and M. Kennedy. 2008. ***Baseline Characteristics of the 2002-2004 Non-Residential Sector: Idaho, Montana, Oregon, and Washington***. Ecotope for the Northwest Energy Efficiency Alliance, Portland, OR.

M. Kennedy. 2005. Non-Residential Energy Savings From Northwest Energy Code Changes 1996-2004. For the Northwest Energy Efficiency Alliance, Portland, OR.

Baylon, D., M. Kennedy, and S. Borrelli. 2000. ***Baseline Characteristics of the Non-Residential Sector in Idaho, Montana, Oregon, and Washington***. Ecotope for the Northwest Energy Efficiency Alliance, Portland, OR.

Baylon, David, Aaron Houseknecht, Jonathon Heller & Les Tumidaj. 1997. ***Compliance with the 1994 Washington State Nonresidential Energy Code (NREC)*** Ecotope for the Utility Code Group.

EPA study Occupancy Sensor Simulations and Energy Analysis for Commercial Buildings, Lighting Research Center Rensselaer Polytechnic Institute, 2000

Kennedy, M. and D. Baylon. 2004. ***Potential Energy Savings of Proposed Washington Non-Residential Energy Code.*** Ecotope, Seattle WA.

Kennedy, M. and D. Baylon. 2001. ***Survey of Energy Efficiency in Seattle's New Non-Residential Buildings: 1995-2000.*** Ecotope for Seattle City Light, Seattle WA.

Kennedy, M. 1998. ***Comparison of Proposed Idaho and ASHRAE 90.1 Non-Residential Codes***. For Battelle Pacific Northwest Laboratory, WA.

Kennedy, Mike, J. Hanford, A. Houseknecht and D. Baylon. 1995. ***Demand-Side Energy Savings in WNG Firm Commercial Sector***. For Washington Natural Gas, Seattle, WA.

Mahone, D., C. Chappell, O. Howlett, D. Dohrmann, and F. Rubinstein. (to be published). ***Effectiveness of Bi-Level Switching in Offices, Retail Space and Classrooms.*** Heschong Mahone Group Inc. Fair Oaks, CA.

Optimal Energy, Inc. 2004. ***Documentation of the Northwest Energy Efficiency Alliance Efforts to Support Energy Codes and Participate in the Federal Standards Setting Process***. Optimal Energy, Inc. Bristol VA.

Appendix A. New ID/MT Code Provisions IECC 2003-IECC 2006

IECC Code Provision Changes 2003 to 2006			
Section	**Description**	**Comment**	**Evaluation Method**
Envelope			
Section 301 - Climate Zones	Climate zones in ID and MT reduced from 6 to 2.	More or less energy neutral depending upon starting 2003 climate zone.	Envelope inpacts evaluated in DOE2 will be derived using respective climate zones.
Table 502 - Building Envelop Requirements	Major changes to structure of prescriptive requirements. Glazing fraction no longer changes required component insulation values. A few component u-value requirements are relaxed.	Change results in significant improvement in code requirements for low and medium glazed buildings, and slight reduction in highly glazed buildings. Based upon the glazing levels in the baseline analysis net impact is a strengthening of the code.	Envelope inpacts evaluated in DOE2 will be derived using component requirements determined for glazing distribution found in Baseline 2005.
502.4.4 - Outdoor Air Intakes	Motorized dampers are now required on all air inlets and exhausts in buildings 3 or more stories tall.	Obviously good practice but no data on actual practice.	Not Evaluated.
502.5 - Moisture Control	Vapor barrier now required.	Energy neutral.	Not Evaluated.
Mechanical			
503.2.2 Shutoff Damper Controls:	System sizing limits now have exceptions for back up systems/capacity	Energy neutral.	Not Evaluated.
503.2.4.4 - Outdoor air intakes	Outdoor air supply and exhausts must now have motorized dampers if the building 3 or more stories and the flow is greater than 300cfm.	Obviously good practice but no data on actual practice.	Not Evaluated.
503.2.6 Energy Recovery Ventilation Systems:	Energy recovery is now required for systems with design supply cfm>5000 and an outdoor air fraction > 70%. Exceptions include all hood systems <15000 cfm, VAV or compensating hood systems of any size, and system serving heat only spaces with design requirements < 60F.	Small number of applicable areas.	Not Evaluated
503.2.7.1.3 High pressure Duct systems:	Leak testing required for duct and plenum systems > 3” with a specified maximum leakage rate (CL) of 6.	Very few high pressure duct systems seen in baseline.	Not Evaluated.
503.3.1 Economizers:	Economizer requirement threshold reduced from systems with cooling capacity greater than 65,000 Btuh to 54,000 Btuh.	very small change	Economizer savings will be modeled on retail and office. Will look at baseline data to see how many systems fall into this category.
503.4.2 Variable Air Volume Control	VFD or equivalent requirement for VAV system lowered from 25HP to 10HP.	baseline found VFD to be standard practice on all variable fan systems.	Not Evaluated.
503.4.2 Variable Air Volume Control	VAV systems now required to have pressure reset if DDC system has control of VAV boxes.	Worth while change that is very difficult to evaluate.	Not Evaluated
503.4.3.4 Part Load Controls	Simple systems path hydronic systems between 300kBtu and 600kBtu are	Change is only for simple systems which limits this to 2	Not Evaluated.

IECC Code Provision Changes 2003 to 2006			
	now required to have part load control with temperature or flow reset. Complex path has threshold is 300kBtu in both codes.	pipe fan coils.	
504.7 Pools	New section. Pools now required to have: time clock control of pump and heaters, vapor retarding cover, Jacuzzis require R12 cover.	Small number of pools	Not Evaluated.
Lighing			
502.2.2 Additional Controls	Removed exceptions so that areas with one lumininare, areas with OS control, and corridoors, storerooms, restrooms and public lobbies must comply with automatic shut off requirement.		Not Evaluated
505.2.2.2 Automatic lighting shutoff.	Removed option that seemed to imply manual sweeps ("occupant intervention") complied with the automatic shut off requiements. Added option so that occupancy sensors clearly comply. Also added list of exempted spaces including sleeping units, patient care areas, and where automatic shutoff would "endanger occupant safety or security".		Not Evaluated
505.2.4 Exterior lighting controls	Clarified requirement. Also eliminated language that said all lighting intended for 24hour operation was exempt but added specific exemptions for parking structures.		Not Evaluated.
505.5.2 Interior lighting power	Consolidates building method and tenant area method into single method. No lighting power allowance changes.	Energy neutral.	Not Evaluated.
505.5.2 Interior lighting power Table - old footnote a.	Removed foot note that allowed an additonal 1watt per sf of lit space for decorative lighting in theaters, churches, lobbies, library, hotels, exercise centers, dining, conference centers and banking/financial institutions	This has minor impact on most buildings though almost all buildings have at least a lobby with a few lights that could be argued to be "decorative". This allowance was definitely used in calculations reviewed in this work. Only one building moves from not-passing to passing by taking it into account.	Evaluated together with lighting power.
505.5.2 Interior lighting power Table - old footnote b.	Romoved footnote that allowed an additional 0.35 watt per sf for areas where the primary task was viewing video display terminals. This applied to classrooms, medical/clinical care, museums, and office areas.	This has a large impact on the code requirement for offices and some other computer intensive areas. It was not clear that this allowance was every used.	Not Evaluated
505.5.2 Interior lighting power Table - old footnote d.	Romoved footnote that allowed an additional 1.0 watt per sf for "emergency, recovery, medical supply and pharmancy space: within medical and clinical care facilities.	Impacts small portion of the health care sector. Areas were not deliniated this fine as part of the baseline so evaulation would be difficult.	Not Evaluated.
505.6.1 Exterior building grounds lighing	Efficacy of lights changed from requiring line voltage lamps to be greater than 45 lumens/watt to requiring lamps over 100watts to be 60lumens/watt. Amount of exterior lighting changed from unlimited to having specific maximum lighting power densities.	Not clear whether this improves or degrades the overall efficiency of exterior lighting	Not Evaluated.
505.6.2 Exterior building lighting power	Previously unlimited. Now has specific lighting power allowances.	Number of categories in new lighting calcultion make it difficult to apply to audit data. Given allowances it is hard to see that this will reduce exterior lighting in very many instances.	Not Evaluated.

Appendix B. 2007 Oregon Code Provisions

Oregon Code Provision Changes 2004 to 2007			
Section	**Description**	**Comment**	**Evaluation Method**
Mechanical			
1317.3 Economizer Cooling	Added exemption that allows server rooms to have waterside economizers that meet 100% of the load at 45db/40wb rather than 50db/45wb with the general waterside exception. The server room community claims this is actually what it is happening so it is just codify reality.		Not Evaluated
1317.13 Additions and alterations.	Added exceptions so added equipment doesn't need economizer in existing server rooms up to 600kBtu or in new server rooms up to 240kBtu.		Not Evaluated
Table 13-L Cooling efficiency table.	Cooling efficiency for AC units 5 tons and less increased from 10 to 13SEER. Increased EER for other equipment delayed from Oct 2007 to Oct 2010 and in some cases has slightly different levels.		DOE simulation on average values from baseline.
Table 13-M Heat pump efficiency table.	Efficiency for HP units 5 tons and less increased from 10 to 13SEER and from 6.8 to 7.7HSPF. Increased EER and heating COP for other equipment delayed from Oct 2007 to Oct 2010 and in some cases has slightly different levels up and down.		DOE simulation on average values from baseline.
Lighting			
1313.2 Luminaire Wattages	Track fixture wattage increased from 37.5 to 50 watts per foot. Current limiter or transformer ratings are still allowed if installed		Not Evaluated
1313.4.1 Tenant Space Power Allowance Method	Garage and canopy lighting is now considered separately from interior lighting.		Not Evaluated
1313.4.2 Space by Space Method	Garage and canopy lighting is now considered separately from interior lighting.		Not Evaluated
1313.5 Exterior Lighting	Deleted text indicating garage and canopy lighting considered part interior lighting.		Not Evaluated

Appendix C. 2006 Washington Code Provisions

Washington Code Provision Changes 2004 to 2006 (adopted June 2007)			
Section	**Description**	**Comment**	**Evaluation Method**
Envelope			
10-5A Default Metal stud walls	Expanded Default Metal Stud Wall configurations	Greatly expanded choices for metal stud wall configuration.	Not evaluated
1005 Above Grade Walls: Table 10.5A	Metal Frame Stud walls default values changed. Net is 10% increase for R19 wall U-factors.	Does not change requirement or wall needed to meet requirement.	Not evaluated
1005 Above Grade Walls: Table 10.5A	Added default table for peripherial edges of intermediate floors	Making this explcit probably improved building requirements as this area was probably not treated as wall area previously. However, current practice for this is very difficult to characterized.	Not Evaluated.
1005 Above Grade Walls: Table 10.6.	Small reduction in small business default u-values for wood vinyl windows with 3/8” and ½” gaps, 0.1 or better low e and argon.	Vast majority of buildings would not qualify for this table.	Not evaluated
1310.2 Semi-Heated Space	Semi-heated space exception is restricted to non-electric heat spaces.	Larger unheated spaces were all gas heated in the 2006 Baseline. Smaller areas such as sprinkler rooms might be impacted.	Not evaluated
1310.2 Semi-Heated Space	Semi-heated space exception changed from requirement for roof insulation only (reduced at that), to language that only excepts the the walls and requires all other components to meet code.	This will required better doors, windows, and floor insulation for semi-heated spaces. Hard to sort out impact on baseline buildings. Reviewing buildings most have R11 roof insulation, no wall insulation, and un-inuslated doors. Windows and skylights are typically adequate to meet code.	DOE2 on increased roof insulation and insulated doors. Check to see that ua matches sector change
1314.4 Recessed Lighting Fixtures	Added requirement for can lights in exterior envelop to be airtight.	Energy savings from reduced infiltration. Savings limited by limited number of faciliities with this sort of lighting.	Not evaluated
Mechanical			
1411.1 HVAC Equipment Performance Requirements – General	All unit heaters must have electronic ignition and flue damper.	This saves a lot of energy though significant quantities of equipment were already equipment with these items	Estimate based upon baseline equipment saturation and warehouse heating energy use.
1412.4 Setback and Shut-off	Thermostat requirements expanded to include ability to remember program when power is lost, and to have easily accessible manual override. Two new exceptions are added for: 1) systems with occupancy sensor shut off, and 2) for systems with timers with maximum 2 hour settings.	Great idea but not clear it will save energy.	Not evaluated
1412.4.1 Dampers	Requires dampers on stair and elevator shaft smoke relief openings.		Not evaluated
1412.8 Ventilation Controls for High Occupancy Areas	New section adding requirement for demand control ventilation for spaces larger than 500sf with design occupant loads greater than 40 people per 1000. This requirement is only for systems with mechanical outside air control or systems greater than 3000cfm. Exceptions include systems with erv’s, or cfm<1200cfm. And multizone systems.	this is close to standard practice.	Modeled

Washington Code Provision Changes 2004 to 2006 (adopted June 2007)			
Section	**Description**	**Comment**	**Evaluation Method**
1416 Mechanical Systems Commissioning	Commissioning requirements are significantly changed to require a great deal of specific activities. Simple systems require a commissioning plan, test and balance, functional tests, and commissioning reports. Air and water test and balance is required for all buildings.	Enforcement is the key here	Estimate based upon simulated energy use and assumed savings.
1432.2.2 Hydronic Systems	Hydronic systems reset requirement threshold reduced from 600kBtu to 300kBtu. Exceptions added for steam systems, systems with VFD, and systems with 100F or lower heating (hplp).	Three percent of all boiler capacity is in the size range impacted by this language. Only 3.6% of chiller capacity in all 4 states are in this range..	Engineering Calculation
1432.2.2 Hydronic Systems	Adds requirements for heat pump loops to have bypass valves/controls for cooling towers. For loops with pump HP > 10 hp two-way valves are required on the heat pumps so the loop is run as variable.	Small number of systems. Baseline did not gather adequate information to answer this point. Of HPLPs with HP > 10 most loops have VFD. Two 10HP loops are CV.	Engineering Calculation
1433 Economizers	Exception added for chilled water terminals with chiller with eff 10% better than code as long as total with econo is <480kBtu or 20%.	This brings water side economizers into the same arrangement as air side economizers. This looks like it might be energy negative in that an economizer would save more than 10% in this class of equipment. This also has the effect of doubling the allowance of water side economizer	Not evaluated.
1438 Variable Flow Systems	Variable flow systems > 10 HP now required to have VFD rather the IV or VFD. Also, if VAV system with DDC control of boxes, pressure reset is required.		Not evaluated
1438.1 Cooling Towers	Cooling towers with total fan > 10HP required to have VFD or staged pony motor.		Engineering Calculation
Table 14 Equipment Efficiency Tables	Equipment Efficiency changed where NAECA is applicable. Otherwise only changes are the adoption of 2010 values adopted.	Future values should be evaluated when they are actually implemented. Many of the 2010 values were slated to go into effect in 2007 but were delayed.	Not evaluated
Lighting			
1513.5 Automatic Shut-Off Controls, Exterior	added requirement for photocell and timeclock where lights are not needed overnight.		Not Evaluated.
1513.6.1 Occupancy Sensors	added provision to have allow dual light level control for stairwell occupancy sensors.	Stair wells are generally considered part of the egress lighting system and are therefore exempted from the automatic lighting provision. If stairwells are forrced to implement shutoff then this OS reduces savings but really it makes it possible to encourage and enforce reduced lighting in stairwells.	Not Evaluated.
1514 Exit Signs	New section requiring all exit signs to use less than 5 watts	From Baseline this will not change standard practice at all. Only one building in the 4 state area had exit lights that would be impacted by this.	Not Evaluated.
1521 Prescriptive Interior Lighting Requirements	prescriptive path exit language simplified. Exit lights are counted unless they are LED. This section is crazy.		Not Evaluated
1530 Lighting Power Allowance	Installed wattage now includes: maximum lamp input wattage for ballasted fixtures rather than the installed lamp, exit lights (before they were exempt if below 5 watts), low voltage track no longer has the 25w/ft option – the transformer watts must be used.		Not Evaluated

Washington Code Provision Changes 2004 to 2006 (adopted June 2007)			
Section	**Description**	**Comment**	**Evaluation Method**
1532 Exterior Lighting Power Allowance	adds provision requiring 100w lumenaires to have efficacy> 60lumens/watt. Totally changes lighting calculation to one with much more detailed categories and allowances and many exemptions. Not clear new values are better. Parking lots and facades are 0.05watts/sf lower but many areas (walkways, canopyes, entrances) now get large allowance.	Limiting this to lights over 100 watts pretty much means it does nothing as all lamps over 100 watts currently have efficacies over 60.	Not Evaluated
1540 Transformers	New section with transformer TP1 requirement.	Savings	Savings calculated
Table 15-1 Unit Lighting Power Allowance	categories and light levels changed.		DOE2 simulation on average LPD from baseline buildings
Table 15 footnote 7	small office allowance reduced from 1.2w/sf to 1.1w/sf	Baseline did not catalog spaces adequately to explicitly handle this but decided to use OFFCL coding. Some buildings did not break out offcl and offop and those won't get credit. Also, some closed office may well be larger than 150sf.	DOE2 simulation on average LPD from baseline buildings with adjustments based upon SCL area ratios.
Table 15 footnote 9	court lighting allowance only allowed in facilities seating more than 5000 people.		Not Evaluated