

Commercial Sector Savings Analysis: Adopted 2010 Washington State Energy Code

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The purpose of this report is to present the energy and cost impacts of the Washington State Energy Code (WSEC) proposal for 2010 as approved by the State Building Code Council (SBCC). This analysis is confined to the “non-residential” code changes in chapters 13, 14, and 15 of the WSEC.

The analysis of the non-residential sector was based on detailed building simulations using DOE 2.2. These simulations were applied to a suite of prototypical buildings that were used for the analysis of the Northwest Power Plan for the last 15 years and focuses on those building types where major energy use or major square footage are available. The prototypes used in this analysis included offices, groceries, retail, restaurants, warehouses, schools, and hospital/healthcare. In addition, other categories such as assembly, churches, and smaller end uses are subsumed in the “other” category. The analysis approach used here has been standardized in this region over the last 20 years as a method for analyzing the complexity of the commercial sector for energy efficiency impacts.

The base building characteristics were developed using a large number of detailed building audits conducted in 2007. The characteristics observed in these buildings were the basis for describing the incidence of efficient lighting and mechanical equipment in current construction practice as well as building size, construction types, and mechanical and electrical system designs used in the state in recently constructed buildings. This study focused on buildings permitted from 2002 to 2004, and constructed by the end of 2006. 146 randomly selected commercial buildings from throughout the state of Washington were audited in this study. The audits looked at all areas of the code as well as operating and occupancy patterns present in this sample.

MULTI-FAMILY BUILDINGS

There were several major initiatives associated with the non-residential codes established by the SBCC. In this code initiative the multi-family buildings (more than two units) or townhouses are included as a separate category in the non-residential code. For the first time the Washington State Energy Code (WSEC) will regulate these as using the non-residential building chapters of the WSEC rather than as a variation on residential code. The effect of this change is to reduce many of the confusing aspects of large-scale central systems associated with these types of buildings thereby making regulating the mechanical system less confusing and less difficult. In this analysis the savings impact for multi-family buildings was not included in the non-residential savings analysis summarized below.

The multi-family building envelope requirements were transferred into Tables 13-1 and 13-2 to make these tables roughly equivalent to Tables 5-1, 5-2, 6-1, and 6-2, which currently regulate the multi-family buildings. The principal changes from the previous 2006 code include a somewhat more lenient window standard relative to the unlimited glazing path, but no comparable unlimited glazing path would be allowed under this code change. This change would result in a 6%-10% improvement in the building shell of the multi-family buildings under this code proposal. But unlike the other single family

residential, no additional adjustments beyond the envelope requirements in Chapter 13 addressed separate standards for multi-family buildings.

NON-RESIDENTIAL CODE CHANGES

Beyond the multi-family buildings there are several significant changes to the non-residential chapters proposed by the SBCC. For this analysis these changes have been evaluated for non-residential building types: office, retail, grocery, school, restaurant, warehouse, hospital, and other. Each of these buildings were evaluated with up to three separate prototypes to account for variations in building size and type within these broad categories.

We have divided these changes into the three major categories in the code:

- 1. Building Envelope, Chapter 13:** There are two major changes in Chapter 13:
 - a. The first is a reformatting of Table 13.1 to be more specific with respect to building components and to be consistent with the format used by the ASHRAE 90.1 tables. These tables now are developed for specific requirements for different construction types and window component types. The values proposed represent a 10 percent improvement in most individual components. Only the masonry walls were not upgraded from the 2006 WSEC by the SBCC. The impact of these improvements represents about a 4% improvement in overall building energy use. An effort was made not to preserve the existing technologies and construction techniques for the non-residential buildings while improving incrementally the components of the envelope building.
 - b. The second major change is the requirement for a tested air barrier in buildings over four stories. This has been a part of the ASHRAE Standard 90.1; the language proposed here is roughly equivalent to the proposed 2010 ASHRAE language, which requires a level of sealing in all commercial envelopes demonstrated by a pressure test from either an outside source or from the HVAC system itself.
- 2. Chapter 14, Mechanical Systems.** There are several major improvements in the mechanical systems developed by the committee.
 - a. The ASHRAE equipment efficiency tables are the basis of our code tables (14-1 through 14-7). The new ASHRAE 2010 table is to be effective before the end of 2010. The committee has passed amendments that upgrade our efficiency to be consistent with the new ASHRAE tables.
 - b. Economizer and OA requirements have been clarified for packaged systems. This includes the opportunity to “gang” systems to improve overall efficiency and effectiveness in economizer operation. The control language has been upgraded to include a two stage cooling thermostat in all applications which require economizer capability.
 - c. Variable refrigerant flow (VRF) compressors systems are regulated based on their manufacturers testing. The use of heat recovery in the rating and evaluation of this equipment is defined.
 - d. Sensible heat recovery from refrigeration systems is mandated for all grocery stores and related operations where such heat recovery can be taken from refrigerated grocery cases.

- e. Several improvements have been made in regulation of ventilation system controls and ventilation air heat recovery, especially for schools and retail buildings.
- f. Commissioning language improved to make commissioning more enforceable and to make clear to the Building Officials the specific requirements for commissioning.

While all of these measures have not been evaluated together, the overall impact of the mechanical section as we described it has been estimated at 5.5% improvement in equipment efficiency as applied to the commercial sector as a whole. When the most significant changes to the equipment design and installation requirements are taken into account the savings estimate goes to 11.0%. Because of the complexity of Chapter 14 and its different applications to different building types this represents a conservative estimate since most of the specialized provisions were not included in this calculation.

3. Chapter 15, Lighting. There are two major initiatives in Lighting.

- a. The first is the development of a reduction in some lighting power density requirements in Table 15.1. The general structure of the lighting power density code remains consistent with WSEC 2006. The new lighting power allowances were derived from consultations among the lighting designers and suppliers in the state. In addition several improvements were made in the regulations for the outdoor and site lighting. These changes represented a comparable improvement in this category of lighting. The overall impact of the lighting power density and exterior lighting changes are almost 13% less lighting power across all building types. The major impacts are on the important building types of retail and office construction.
- b. The second area that is significant is the use of lighting controls. The lighting control sections of the code have been upgraded to be more generally applicable and to insist on both daylighting and control of egress lighting in virtually all building types. These are significant changes for certain building types where existing sky-lighting and/or day lighting are available, but not currently controlled by the lighting control system. The overall impact of lighting control impact is about a 5% improvement in all lighting energy use in the sector.

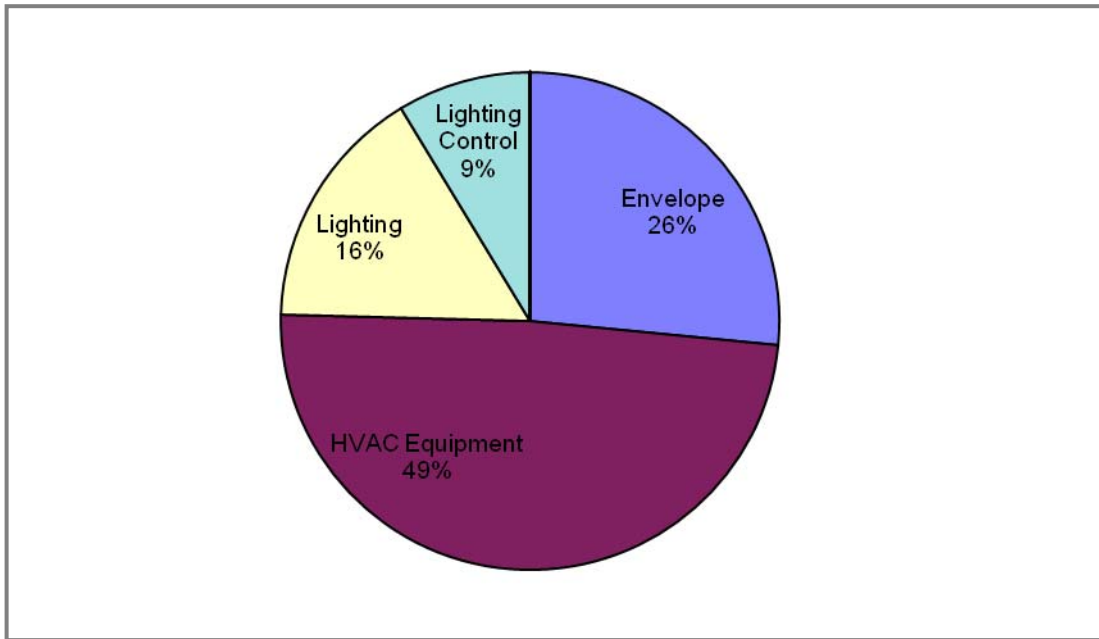
SAVINGS ESTIMATES

Energy savings estimates for the suite of energy code proposals approved by the SBCC were evaluated using the DOE-2.2 simulation. Several individual regional building prototypes were used (modified based on the audits of new buildings in the State of Washington conducted in 2006-2007). Approximately 5,000 simulation runs were done on these building types comparing the various proposed code changes and establishing the savings over baseline energy use in each of the prototype buildings.

The overall impact of these changes (not including the impact of a few of the specific mechanical system changes or overall improvement in the enforceability of the commissioning standards) is about 13.2% of total building energy use. This includes several categories of plug loads and internal building equipment that are not currently (and are not proposed to be) regulated by the energy code. When those items are removed, the overall impact of this package is about 17.2% of regulated energy use which is space conditioning, lighting, ventilation, and certain refrigeration categories (grocery, refrigerated warehouse, etc.).

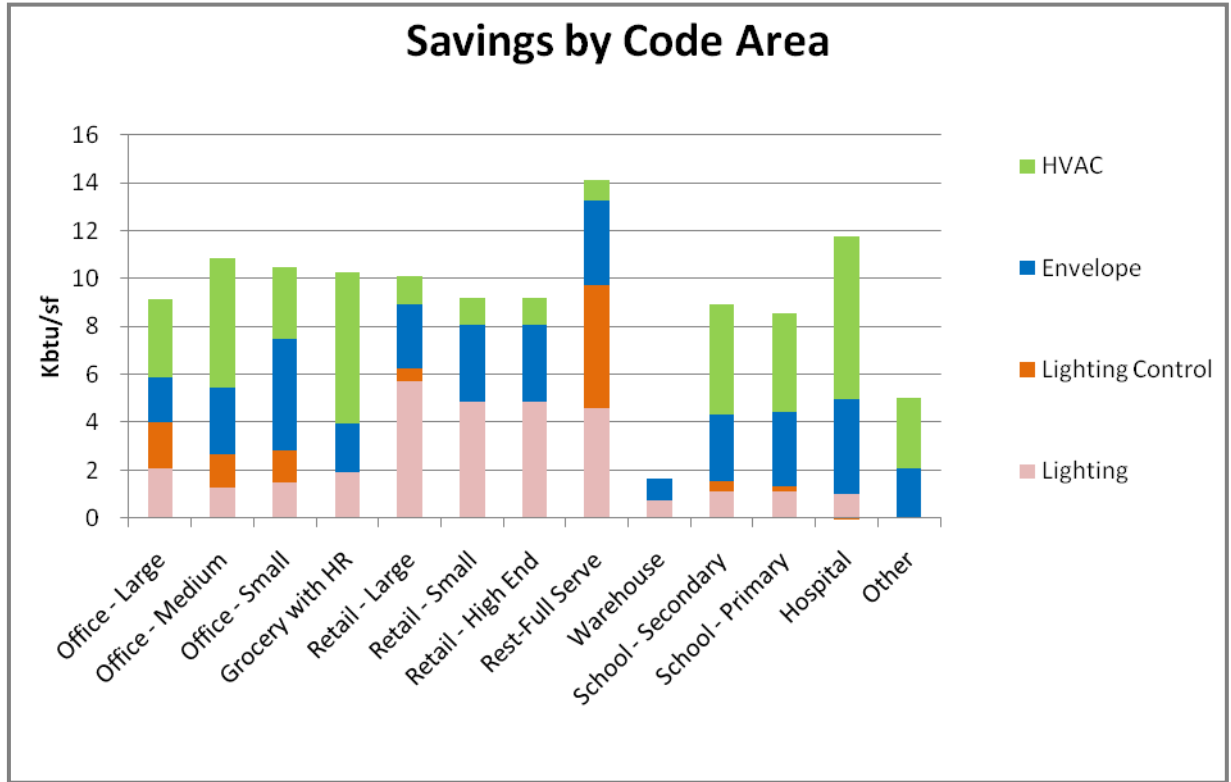
The overall savings are divided between lighting efficiency measures, lighting control measures, equipment and mechanical system measures, and envelope measures. Figure 1 shows the distribution of savings for these non-residential code proposals. The overall savings from this proposal, 25% are from lighting power and lighting control, 26% are from building envelope and air barrier design, and the final 49% are from improved equipment efficiency and other HVAC provisions.

Figure 1: Distribution of Energy Savings by Code Section



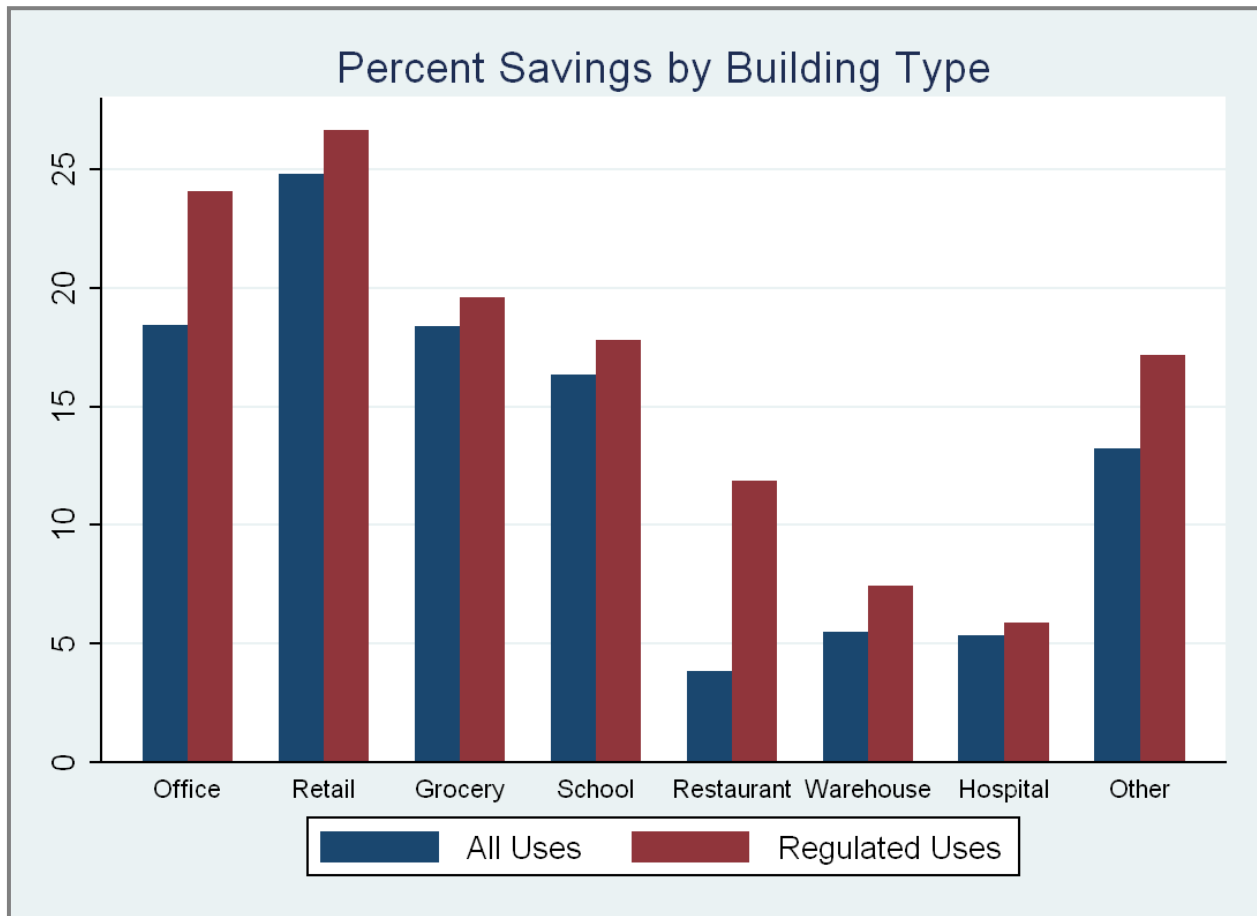
The simulation results were summarized for each building type evaluated. Figure 2 presents the distribution of savings in each prototype across the entire set of simulations. The “Other” category represents the average of all the simulations overall square footage for each building type. Figure 2 shows the distribution of the four major categories of code changes in this proposal distributed by the actual buildings used in the prototype analysis. As can be seen, the major impacts are expected in grocery and restaurants largely due to HVAC improvements from heat recovery and ventilation system control. In hospitals and schools, major impacts from HVAC largely come from the improved equipment efficiency adopted to be consistent with the new ASHRAE standards. Lighting and lighting control dominate savings in the retail and restaurant sectors. Envelope measures impact most buildings across all sectors and are largely driven by the upgrades in building ceiling and roof insulation. Only warehouses show a more modest savings because the major code proposals in lighting and HVAC are not typically a part of warehouse design and operation.

Figure 2: Savings by Building Type and Code Section



Overall savings are shown by building type in Figure 3. In this case, each building prototype has been combined into its major category based on square footage weightings within the categories. As can be seen, the total savings are approximately 13% across the board, all uses in the commercial sector and when regulated uses only are considered approximately 17%. Some building types have significantly more impact as a percent of savings than others based on the impact of lighting and HVAC on those particular prototypes.

Figure 3: Overall Saving by Building Type



The annual savings impact for the SBCC proposed 2010 WSEC changes is about 3.6 aMW (31,800 MWh) and about 1.1 million therms. Over the course of five years of construction, the buildings built under this code proposal would accumulate energy savings of 45.0 aMW or about 394 million kWh; the accumulated saving in natural gas would be about 14.9 million therms. This savings would contribute significantly to meeting utility goals and regional conservation targets. Finally the savings in energy costs to the non-residential consumers would amount to almost \$3.6 million per year with and total savings to the state’s businesses accumulated over 5 years would be about \$46 million (at current utility rates).

COST ESTIMATES

The evaluation of these code proposals included an assessment of the costs that would be anticipated as applied to the individual code areas (lighting, envelope, and HVAC) and by individual building types. The measures were determined by reviewing the information gathered in the survey of 146 new buildings in Washington conducted in 2006. This survey collected the characteristics of each building surveyed. The impact of the code proposals was calculated as the changes that would have been required to bring these buildings into compliance with the new code. The measure costs themselves were derived from several sources. The lighting costs were developed by the regional planning process conducted by the Northwest Power and Conservation Council (NPCC) for their region-wide resource plan. The HVAC and envelope measures were generally derived from R.S.Means using specifications derived from the code proposals themselves. In a few cases, costs were generated from construction experience in applying these measures to utility supported conservation programs in the commercial sector.

Figure 4 shows the distribution of costs by main code category. As can be seen the majority of the costs are derived from the increased insulation and envelope sealing resulting from changes to chapter 13. These measures include increased ceiling and roof insulation (about 70% of all the costs), increased mass wall insulation and improved window performance requirements. The lighting and lighting control represent less than 20% of all the costs but are the most cost-effective package of measures. HVAC systems are specified to impact particular mechanical system types. These are often minor changes and were not included in the analysis. The analysis here focused on several areas, including more efficient equipment (in accordance with revisions to federal standards) and heat recovery from both refrigeration systems in groceries and from ventilation systems. In addition, the analysis included the increased requirements for demand control ventilation.

Figure 4: Cost Distributions by Code Section

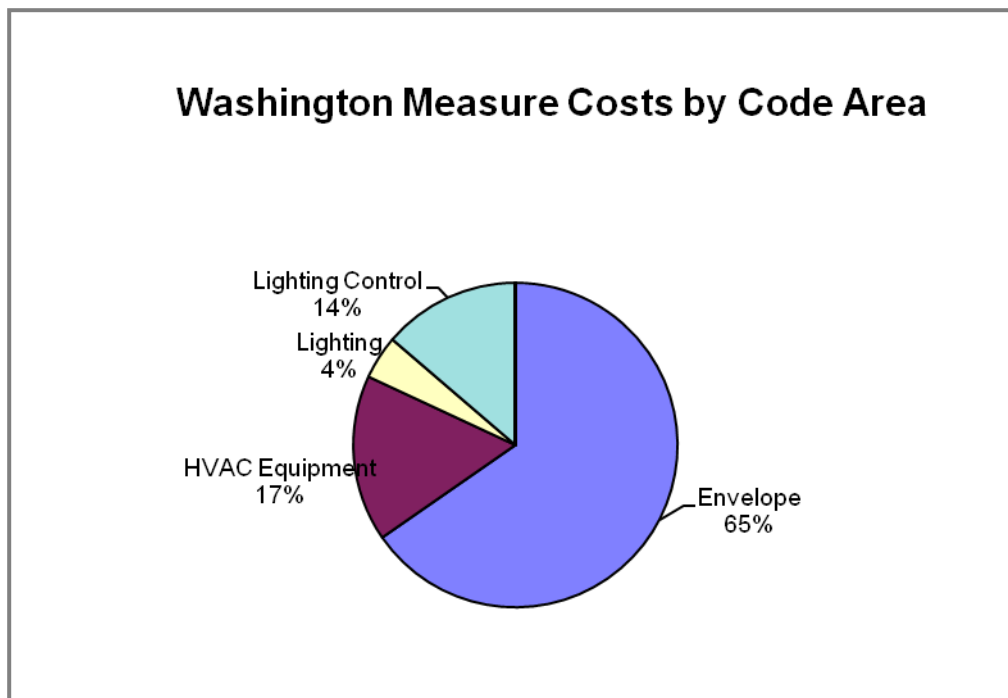


Figure 5 shows the distribution of these costs by building type. These costs average about \$0.97 per square foot across all buildings types. The average has been weighted by the projected amount of square feet of each building developed by the NPCC in its planning process. The weights were derived from the anticipated mix of buildings over the five years from 2010 to 2015. There are significant differences among buildings with the range of cost impacts on various buildings varying from about \$1.80 to under \$0.70 per square foot of building area. These costs represent considerably less than 1% of the building construction costs in all cases.

Figure 5: Cost per Square Foot of Building Area by Building Type

