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TO: Tim Nogler, Managing Director  
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SUBJECT: Recommendations for the Analysis of Cost and Benefits in support of the Development of Building Codes

The Washington State Department of Commerce (Commerce) has been asked by the Washington State Building Code Council (Council) to provide recommendations for economic analysis methods that document the impact of changes to the Washington State Energy Code. The following provides a methodology and recommends tools for evaluating cost and benefits related to changes in practice in the building industry. While the following analysis details are focused on energy code improvements, the same method and tools can be used to evaluate life cycle cost impacts for changes made to other codes as well.

The method below only evaluates the cost and benefit to the building owner and/or tenant. It does not include evaluation of cost or benefits to the local government enforcement community, the power industry, or other impacted parties.

It is anticipated that this document will be reviewed by the Council and adopted with modifications.

### **General Methodology**

Life cycle cost analysis methods for buildings are well established. Commerce is recommending standard methods documented by the National Institute of Standards and Technology. A primary reference document for Life Cycle Cost Analysis is Handbook 135, Life Cycle Costing Manual for the Federal Energy Management Program<sup>1</sup>.(Handbook 135) This manual describes implementation of the ASTM standards, "Practice for Measuring Life-Cycle Costs of Buildings and Building Systems," E917, "Practice for Measuring Net Benefits and Net Savings for Investments in Buildings and Building Systems," E1074 and others. These standards describe a fairly flexible set of rules for evaluation.

The resulting analysis will provide a comparative analysis between a base case and a proposed new standard. The proposed analysis method will provide a net present value for the proposed case expressed in three different forms:

- Total Life Cycle Cost
- Savings to Investment Ratio

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<sup>1</sup> [http://www.wbdg.org/ccb/NIST/hdbk\\_135.pdf](http://www.wbdg.org/ccb/NIST/hdbk_135.pdf)

- Adjusted Internal Rate of Return

The primary work for Commerce has not been the development of the analysis method, but the development of standard energy and economic inputs needed to complete the analysis in 2012. To provide these Commerce references a number of sources that will be detailed later. Commerce recommends that the inputs be reviewed by the energy code tag and the State Building Code Council's Economic Committee prior to finalizing the inputs.

At this time Commerce is recommending a limited set of inputs that document project cost and energy savings benefits over the project life. This should not limit the use of additional documented cost or benefits that may be relevant to the proposed change. We view this as a minimum input for evaluation.

To provide good uniformity in evaluation Commerce has identified a specific piece of software that can be used to implement the analysis. Energy Evaluator<sup>2</sup> is free software that implements the proposed analysis method. This software is recommended to provide anyone with an interest easy access to the analysis methods. Commerce does not recommend limiting the approach to this particular piece of software. There may be good reason to use alternate software or develop a model using a spread sheet in the future.

Commerce is not making recommendations of threshold outcomes. There are competing goals in statute that ask the State Building Code Council to achieve additional energy savings, while considering cost and benefits. The Council is responsible for developing the criteria for success.

Analysis Inputs:

There are two sets of data required to complete the analysis. First are cost and benefit inputs specific to a code change. Second are standard economic inputs for economic analysis.

Cost and benefits specific to code changes are submitted to the Council with the code change proposals. Additional input is provided throughout the code development process. This includes input received during technical advisory group process and data or analysis received as public testimony to the Council.

Handbook 135 provides a comprehensive list of recommended inputs specific to each energy efficiency measure evaluated. In summary they include:

1. Construction cost or savings
2. Annual estimated energy cost or savings
3. Operations and maintenance costs or savings

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<sup>2</sup> Energy Evaluator is available from Energy Design Resources at no charge, <http://www.energydesignresources.com/resources/software-tools/evaluator.aspx>

4. Other quantifiable cost or benefits such as worker productivity or environmental impacts

It is worth noting, most analysis of the code has been focused only on the first two items in this list, first cost related to construction and energy savings. A broader evaluation of quantifiable benefits has been beyond the scope of most analysis prepared for the Council.

To develop the life cycle cost of a specific energy efficiency measure or group of measures inputs are required to develop the long term view of cost and savings. To provide this type of analysis for the Washington State Commerce proposes the inputs from the following table. Some discussion on each input follows.

**PROPOSED INPUTS**

**Residential**

**Analysis Period (years)**

**Electric Cost (kWh)**

**Natural Gas Cost (Therm)**

Energy cost including state and local taxes

**Discount Rate (% Real)**

**Loan Rate (%)**

(after tax)

**Loan Term (years)**

**Loan to Value (%)**

**Inflation Rates (%)**

General	2.0%
Electricity	1.7%
Gas	3.2%
O&M	2.0%
Capital Purchases	2.0%

**Commercial**

**Analysis Period (years)**

**Electric Cost (kWh)**

**Natural Gas Cost (Therm)**

Energy cost including state and local taxes

**Discount Rate (% Real)**

**Loan Rate (%)**

**Loan Term (years)**

**Loan to Value (%)**

**Inflation Rates (%)**

General	2.0%
Electricity	1.7%
Gas	3.2%
O&M	2.0%
Capital Purchases	2.0%

**Analysis Period**

Life cycle cost analysis requires establishing boundaries on the term analyzed. Buildings have a long service life. National standards for analysis of building codes have typically been evaluated on a 30

year basis. This includes the analysis completed for ASHRAE 90.1 and DOE analysis of the residential sections of the International Energy Conservation Code.

### **Energy Unit Cost**

To support financial analysis Commerce has developed median state energy cost per unit of energy. In addition to the median values, a discussion of the range of electric energy cost has been included. It is important to note these are unit cost, not actual utility rates.

Commerce energy unit costs are based on data from the U.S. Energy Information Administration (EIA). EIA collects data each utilities total sales and revenue by sector (residential, commercial etc). The source data used by Commerce includes the Natural Gas Annual (2010)<sup>3</sup> and the Electric Power Annual (2010)<sup>4</sup>

For natural gas EIA reports a single figure for each sector that summarizes the sales (units of energy) and revenue for all four Washington gas utilities. Commerce has made several adjustments to calculate energy cost to the customer for energy. To account for base fees not related to units of energy, Commerce has subtracted 11 percent from residential revenue and 7 percent from commercial revenue<sup>5</sup>. Then to account for state and local taxes Commerce has added 9.78 percent. Commerce has also adjusted the gas cost from 2010 to 2013 values using documented changes in gas charges. This has been updated using the EIA June 2012 Natural GAS Monthly update<sup>6</sup>. With this adjustment Commerce recommends using \$1.10 per therm for residential customers and \$1.01 for commercial customers.

For electricity EIA reports sales and revenue for each utility by sector<sup>7</sup>. Commerce has made several adjustments to calculate energy cost to the customer. To account for base fees not related to units of energy sold, Commerce has subtracted 7 percent from residential revenue and 3 percent from commercial revenue. Then to account for state and local taxes Commerce has added 9.78 percent. Commerce has also adjusted the electric cost from 2010 to 2013 values using a documented inflation using the EIA short term inflation adjustment factors included in the electric power annual. Resulting Washington median cost for residential electricity is \$0.081 per kWh for residential and \$0.077 for commercial customers.

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<sup>3</sup> <http://www.eia.gov/naturalgas/annual/>

<sup>4</sup> <http://www.eia.gov/electricity/annual/>

<sup>5</sup> The estimate of the cost of base fees is based on Commerce communications with several large utilities in WA.

<sup>6</sup> IEA, Natural Gas Monthly, [http://www.eia.gov/naturalgas/monthly/archive/2012/2012\\_06/ngm\\_2012\\_06.cfm](http://www.eia.gov/naturalgas/monthly/archive/2012/2012_06/ngm_2012_06.cfm)

<sup>7</sup> Electric Power Annual, 2011, Tables 6 and 7 [http://www.eia.gov/electricity/sales\\_revenue\\_price/](http://www.eia.gov/electricity/sales_revenue_price/)

Electric rates are complex and include many factors that are captured in this single figure presented above. EIA revenue reports include base fees, energy rates (kWh) which may include several block rates, demand rates (KW), conservation charges and other adjustments. With the exception of the base fees which Commerce has estimated and subtracted, the charges are for energy use and appropriate to this study.

EIA reports the sales of 62 Washington electric utilities. The energy costs vary from a bit more than 2 cents to almost 11 cents per kWh. Additional analysis may be desirable to document impacts from the higher and lower rate utilities. To support this Commerce has provided the following additional information on Electric rates. Commerce suggests that the lower bound for analysis is 6 cents per kWh, for both residential and commercial case studies. The upper bound of 10 cents for residential and 9 cents for commercial seems appropriate. The following describes the population of customers covered by these energy cost.

- 93% of residential customers electric energy cost are greater than 6 cents kWh
- 34% of the residential customers electric energy cost are greater than 10 cents kWh
  
- 87% of commercial customers electric energy cost are greater than 6 cents kWh
- 41% of the commercial customers electric energy cost are greater than 9 cents kWh

State and local energy taxes included in the above calculation are included in the following table. State tax rates are from the Washington State Department of Revenue. Local taxes are based on the Association of Washington Cities, Annual Tax and Fee survey, 2008 edition<sup>8</sup>. Local taxes vary to some degree, but are widespread. Because of this, Commerce chose to include them universally in the analysis.

**State and Local Energy Taxes**

	Electric	Gas
State	3.87%	3.85%
Local	5.87%	5.93%
Total	9.74%	9.78%

**Discount Rates**

The discount is applied to reflect the present value of future benefits from energy efficiency measures. The discount rate is used to discount future cash flows to present value, based on the building owner’s time-value of money. This value often reflects what the building owner thinks they

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<sup>8</sup> <http://www.awcnet.org/documents/TUFS08web.pdf>

could earn from alternative investments over the same time period or the investor's minimum acceptable rate of return. For a home owner the expectations are thought to be much less than for a business person.

For this analysis Commerce recommends adoption of the discount rates developed for the Sixth Northwest Conservation and Electric Power Plan, detailed in appendix N. For home owners, the resulting discount rate is 3.2 percent. For business, it is 7.6 percent<sup>9</sup>.

### **Lending Rates**

It is assumed in this analysis that the building project will require outside capital.

Lending rates for residential building are based on anticipated mortgage rates. A 5.5 percent interest rate was anticipated, but with an assumed 15% income tax rate the results are 4.7 percent. This is discounted to reflect federal mortgage interest tax deductions.

For commercial construction capital from a wide range of sources is used. Some reflects the interest from typical mortgage lending institutions while others find private capital at rates below the federal prime rate.

Estimates of the cost of capital were drawn from the U.S. Department of Energy analysis prepared in support of the ASHRAE 90.1-2010 Equipment Standards rulemaking and the 6th NW Power Plan. The equipment standards use a weighted cost of capital model that provided a cost of capital of 4.98 percent for commercial office, with lower rates for healthcare (4.2%) and private education (4.6%). The 6th NW Power Plan discusses private capital rates and selected a weighted average cost of capital of 5.5 percent for their analysis. To provide a conservative analysis the 5.5 percent rate has been selected.

### **General and Energy Inflation Rates**

Commerce has selected 2 percent as the general inflation rate for this study. All other rates are relative to this figure. Operations and maintenance inflation were set to the general inflation rate. Energy inflation rates have been taken from the National Institute of Standards and Technology document, Energy Price Indices and Discount Factors for Life-cycle Cost Analysis. Annual Supplement to NIST Handbook 135 and NBS Special Publication 70910. This document is specifically published to support life cycle cost assessments by the federal government. The figures used by

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<sup>9</sup> [http://www.nwcouncil.org/energy/powerplan/6/final/SixthPowerPlan\\_Appendix\\_N.pdf](http://www.nwcouncil.org/energy/powerplan/6/final/SixthPowerPlan_Appendix_N.pdf)

<sup>10</sup> [http://www.wbdg.org/ccb/browse\\_cat.php?c=131](http://www.wbdg.org/ccb/browse_cat.php?c=131)

Commerce are specific to the western census region. Inflation rates are levelized over a 30 year analysis period 2012-2041.

**Inflation Rates (Nominal %)**

	Residential	Commercial
General	2.0%	2.0%
Electricity	1.9%	1.7%
Gas	3.2%	3.2%
O&M	2.0%	2.0%