

2018

WASHINGTON STATE ENERGY CODE Progress toward 2030

Progress toward Reducing Energy Consumption in Buildings
Required by RCW 19.27A.160 (ESSSB 5854, Chapter 423, Laws of 2009)

2018 Report to the Legislature
September 1, 2020

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5/15/2020

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Executive Summary:

On-Track Incremental improvement in the 2015 Washington State Energy Code

The Washington State Building Code Council (Council) submits this report to the Legislature as required by RCW 19.27A.160. The report addresses progress toward a 70 percent reduction in net annual energy consumption in newly constructed residential and nonresidential buildings by 2031, compared to the 2006 Washington State Energy Code (WSEC),

Building energy efficiency is the single largest factor in the region's future electric needs.

The 2018 WSECs are an incremental improvement over the 2015 codes. The 2018 WSECs are predicted to achieve between ** and ** percent cumulative energy savings for all new buildings compared to the 2006 WSEC and an estimated incremental savings between ** and ** percent for residential and between ** and ** percent for commercial from the 2015 codes.

Significant Measures

Significant measures adopted by the Council that save energy compared to the 2015 WSEC:

Section/Subject	Energy Saving/Year

Method

The SBCC conducted a national search for a consultant to evaluate building performance improvements as well as unregulated energy loads affecting buildings over the 2006 to 2018 code time. The SBCC consulted with Ecotope.

To model the energy consumption, Ecotope followed the framework developed by the Regional Technical Forum as well as processes used to develop the State's residential energy code. Ecotope also relied on historical studies including building stock assessments, metering studies, and surveys. The consultant used EnergyPlus and Simple Energy Enthalpy Model programs to produce annual energy use estimates from all regulated and unregulated loads. Batch modeling processes were used to complete over 200 residential and 90 commercial modeling runs to simulate each prototype under various combinations of location, HVAC system, and code year.

Estimated Energy Savings

The estimated energy savings reported here were derived from the *Modeling the Washington State Energy Code – 2006 & 2018 Baseline Energy Consumption* report. See Appendix A.

Outlook

The Council continues making steady progress to achieve the goal of 70 percent net annual reduction in building energy consumption by 2031. The Council is mindful that with each code cycle the cost to achieve the additional energy reduction is higher than it was for the previous code.

Background

The WSEC is based on a national model code that is less energy efficient than the WSEC, therefore, the State adoption process requires significant work prior to considering new energy saving amendment proposals. This preliminary process alone requires approximately *** staff and volunteer hours.

Completing the code adoption process involves multiple additional steps of code development including technical advisory group review and revision, the Council's Mechanical Ventilation and Energy Standing Committee review, Council approval of proposed rules, public comments and hearings, and final action.

Transparency throughout the process is crucial requiring extensive staff support.

The public process for code development represents a major time commitment for preparation, meetings and reporting.

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The energy code has historically drawn opposition due to differences in political and economic philosophies. Full consideration of these opposing perspectives has resulted in additional staff and volunteer time as well as the need, at times, for legal counsel.

The law mandates continuous improvement to energy efficiency in buildings. However, the law also states that if economic, technological, or process factors impede adoption, the Council may defer adoption, and that all measures must be cost effective to building owners and tenants. Various stakeholders disagree on whether or not the new rules increasing energy efficiency in buildings are cost effective, and those who believe they are not advocate for deferral stating the economic burden and technological unknowns do not justify new regulations.

The Council does not operate in isolation. State law also directs the Department of Commerce to develop and implement a strategic plan for enhancing energy efficiency, which must be used to help direct the future code increases in RCW [19.27A.020](#), with targets for new buildings consistent with RCW [19.27A.160](#). While this legislation anticipates that the plan will help inform the WSEC update process, funding that would enable the anticipated level of planning and guidance from Commerce is lacking.

The Council consists of 15 voting members appointed by the Governor, four ex-officio legislators appointed by the Legislature, and the chief electrical inspector. The Council provides independent analysis and objective advice to the Legislature and the Governor's Office on state building code issues.

The Council establishes the minimum building, mechanical, fire, plumbing and energy code requirements necessary to promote the health, safety and welfare of the people of the state of Washington by reviewing, developing and adopting the state building code.

The Council updates the state building codes every three years, on schedule with updated editions of the national model codes. There was a one time extension to four years for the 2018 codes to accommodate a revision in the SBCC review process. The Energy Related Building Standards law (RCW 19.27A) directs the Council to update the Washington State Energy Code every three years, synchronized with the code development cycle. In each cycle, the Council must make an incremental step toward the 70 percent reduction by 2030.

Energy Code Development Process

The Council relies on a large number of volunteers to develop energy code amendments, submit proposals, participate in the technical review, and submit testimony for SBCC consideration at final adoption.

- Of *** proposals received, ** were significant energy saving proposals; the remainder were either editorial clarifications or not approved. Of the ** significant proposals, * were not adopted.

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- The ** members of the Energy Code Technical Advisory Group each logged between 60 to 80 hours of meeting time and countless additional hours of review time over a **-month period.
- The Council used a form requiring more detailed information about energy savings and cost for each proposal. See Appendix *.

State and Federal Law on Building Energy Codes

The Washington State Legislature and the Governor's Office have directed the state Building Code Council to adopt energy codes. Federal Law also requires the state to meet minimum standards.

Targets set by the Climate Pollution Reduction--Energy Efficiency Act of 2009

The goal to reduce energy savings by 70 percent compared to 2006 by 2030 relates to an initiative of the American Institute of Architects (AIA). The AIA's Architecture 2030 Challenge was adopted in 2009 by the Washington State Legislature. As emphasized in testimony by Washington Environmental Council, Washington is one of nine states to adopt the Architecture 2030 initiative. According to the Architecture 2030 website, only California and Washington have adopted the 2030 challenge as mandatory for all buildings; other states have adopted Architecture 2030 for government buildings or directed that the challenge must be considered during administrative code adoption.

- Energy-Related Building Standards Law (RCW 19.27A)
- The Legislature directed the Council to reduce energy consumption in buildings, as codified in RCW 19.27A.160 **Residential and nonresidential construction — Energy consumption reduction — Council report:**

(1) Except as provided in subsection (2) of this section, residential and nonresidential construction permitted under the 2031 state energy code must achieve a 70 percent reduction in annual net energy consumption, using the adopted 2006 Washington State Energy Code as a baseline.

(2) The Council shall adopt state energy codes from 2013 through 2031 that incrementally move towards achieving the 70 percent reduction in annual net energy consumption as specified in subsection (1) of this section. The Council shall report its progress by December 31, 2012, and every three years thereafter. If the Council determines that economic, technological or process factors would significantly impede adoption of or compliance with this subsection, the Council may defer the implementation of the proposed energy code update and shall report its findings to the Legislature by December 31st of the year prior to the year in which those codes would otherwise be enacted.

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The International Energy Conservation Code (IECC) is the base model energy code adopted by the state of Washington. The IECC defines buildings in terms of “commercial” and “residential.”

- Residential buildings are defined as detached one and two family dwellings and multiple single family dwellings (townhouses) as well as apartment buildings three stories and less in height.
- Commercial buildings are defined as all buildings other than residential buildings, and include residential apartment buildings over three stories.

RCW 19.27A.150: Strategic plan—Development and implementation.

- (1) To the extent that funding is appropriated specifically for the purposes of this section, the department of commerce shall develop and implement a strategic plan for enhancing energy efficiency in and reducing greenhouse gas emissions from homes, buildings, districts, and neighborhoods. The strategic plan must be used to help direct the future code increases in RCW [19.27A.020](#), with targets for new buildings consistent with RCW [19.27A.160](#). The strategic plan will identify barriers to achieving net zero energy use in homes and buildings and identify how to overcome these barriers in future energy code updates and through complementary policies.
- (2) The department of commerce must complete and release the strategic plan to the legislature and the council by December 31, 2010, and update the plan every three years.

Federal law influencing state code development and adoption

Federal law requires states to periodically certify that the energy code adopted in their jurisdiction meets or exceeds specific national reference standards. ¹ This certification is to be submitted to the Secretary of the U.S. Department of Energy (DOE). The most recent rules require each state to report that their adopted commercial building energy code meets or exceeds American Society of Heating, Refrigerating and Air conditioning Engineers (ASHRAE) Standard 90.1-2013.

1-42 U.S.C 6833(b)(2)(B)(i)

Commercial Buildings

On Sept. 26, 2014, DOE issued a determination that Standard 90.1-2013 would achieve greater energy efficiency in buildings subject to the code. DOE estimates national savings in commercial buildings of approximately:

- 8.7% energy cost savings
- 8.5% source energy savings
- 7.6% site energy savings

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State Certification

Upon publication of an affirmative determination, States are required to certify that they have reviewed the provisions of their commercial building code regarding energy efficiency, and, as necessary, updated their codes to meet or exceed the updated edition of Standard 90.1.

Additionally, DOE provides guidance to States on submitting certification statements and requests for deadline extensions. State certifications for Standard 90.1-2013 **must be submitted by September 26, 2016.**

Residential Buildings

On **June 11, 2015**, DOE issued a determination that the **2015** IECC would achieve greater energy efficiency in buildings subject to the code. DOE estimates national savings in residential buildings of approximately:

- 0.73% energy cost savings
- 0.87% source energy savings
- 0.98% site energy savings

State Certification

Upon publication of an affirmative determination, States are required to certify that they have reviewed the provisions of their residential building code regarding energy efficiency, and made a determination as to whether it is appropriate for them to revise their code to meet or exceed the updated edition of the IECC. Additionally, DOE provides guidance to States on submitting certification statements and requests for deadline extensions. State certifications for the **2015** IECC must be submitted by **June 12, 2017**

Equipment Efficiency

Federal efficiency standards for building heating and cooling equipment must be applied. For residential and small commercial equipment this is primarily regulated by restricting the manufacture and sale of the equipment. Any minimum efficiency that is referenced in the energy code must be consistent with the minimum federal standards. For commercial energy codes this largely means adopting the minimum equipment efficiency tables listed in the most recent edition of ASHRAE Standard 90.1.

Most Recent Washington Certification

The most recent state certifications were submitted to the Department of Energy **July 2013** by the Washington State Department of Commerce, State Energy Office. This certified that the state code in general provided greater energy efficiency than the commercial building reference standard ASHRAE 90.1 – 2010 and the residential standard, the 2012 International Energy conservation code. There were a few specific measures where Washington did not meet the federal standards.¹

¹ Washington State Department of Commerce, 2012 Washington State Energy Code compared to National Reference Standards, July 2013. <http://www.commerce.wa.gov/Documents/2012-energy-code-comparison.pdf>

Washington amendments to the 2018 IECC

2018 Energy Code Development

The Council relies on individuals and interest groups to submit proposals to improve the WSEC and meet the goals set by the Legislature. A complete list of proposals is posted on the Council website. [Full list of code change proposals link](#). The amendment proposals include information on proponents, specific code language and data on the cost and benefit where the amendment has an impact.

Number of proposals	Approved as submitted	Approved as modified	Disapproved	Withdrawn
154	44	72	18	20

Of 116 proposed amendments integrated into the proposed rule:

- 15 were substantive
- 9 of those had a significant cost and benefit
- The remaining 101 items were editorial clarifications.

Technical Advisory Group (TAG) activities

The Energy Code TAG held 12 meetings in 2018-2019, each work session was typically 5 hours long. The TAG was composed of 21 members, plus several alternates, with 14 – 18 members typically in attendance at any one meeting, depending on the discussion topic. Proponents were invited to make a short presentation of their proposal(s), after which any TAG members can make a motion and a second to approve it. Straightforward code improvements are often approved or modified within a few minutes, while more substantial or controversial proposals were debated for hours and often extensively modified in the process. Some proposals were tabled, and the proponents and opponents asked to return with more information or compromise proposals.

As part of proposing a code change, proponents were required to provide recommended changes to the code text and to complete an updated form (See Appendix D). This form asked the proponent to provide a statement justifying the code change and provide some general information of the cost and benefits associated with the proposal. Proposals were required to show economic information, data estimating costs and benefits. Many of the adopted proposals were extensively modified during the TAG and Council processes, which would have reduced the value of the original cost/benefit analyses.

Goals for Energy Code Development

Making buildings more energy efficient has been identified as a priority by the Legislature and the Washington State Building Code Council (Council). Improved energy efficiency:

- Saves money
- Creates good local jobs
- Enhances energy security
- Reduces pollution that causes global warming
- Speeds economic recovery
- Reduces need to invest in costly new generation

The Washington State Building Code Council (Council) finds that the following provides a guide to the Goals of the Washington State Energy Code (WSEC) per RCW 19.27A for both Residential & Nonresidential Buildings:

1. The WSEC must achieve a reduction in annual net energy consumption in buildings

- a. By 2030, the code must achieve a reduction of 70 percent compared to the 2006 Washington State Energy Code.
- b. Each code cycle, the Council must adopt a code requiring increasingly energy efficient homes and buildings
- c. The Council must determine and evaluate the costs and benefits of the WSEC

2. The Council must adopt more stringent energy codes

- a. The Legislature finds that energy efficiency is the cheapest, quickest, and cleanest way to meet rising energy needs, confront climate change, and boost our economy
- b. The Legislature promotes super-efficient, low-energy use building codes
- c. The law directs the council to review the Washington state energy code every three years.

Amendments adopted by the council must increase the energy efficiency of newly constructed buildings.

3. The Council must evaluate and determine the costs and the benefits

- a. The Legislature finds making homes, businesses, and public institutions more energy efficient will save money, create good local jobs, enhance energy security, reduce pollution that causes global warming, and speed economic recovery while reducing the need to invest in costly new generation

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- b. Any new measures, standards, or requirements adopted by the Council must be technically feasible, commercially available, and cost-effective to building owners and tenants.
- c. The Council has adopted a definition of cost-effectiveness based RCW 39.35 recommended by Department of Commerce
- d. Executive Order 14-04 from Washington Governor Jay Inslee directs the Council to “achieve early and widespread deployment of energy-neutral buildings prior to the 2031 statutory requirement in RCW 19.27A.160”
- e. A guide on how to evaluate cost-effectiveness is therefore defined by the Council as a code change that has a net present savings over a 50-year life-cycle of a building utilizing the Life Cycle Cost Tool (LCCT) as developed by the Washington State Office of Financial Management (OFM).

The method of the LCCT is based on the NIST Handbook 135 methodology and utilizes specific inputs as determined by the Council with guidance from the Washington State Department of Commerce.

- f. If the council determines that economic, technological, or process factors would significantly impede adoption of or compliance with incremental progress towards the 70 percent reduction in annual net energy consumption, the council may defer the implementation of the proposed energy code update and shall report its findings to the Legislature by December 31st of the year prior to the year in which those codes would otherwise be enacted.

4. The Council has established rules for amendment of the WSEC

- a. Residential energy code covers residential buildings including single family homes, townhouses, and multi-family buildings that are 3 stories and less.
- b. Commercial energy code covers all non-residential buildings and residential buildings that are 4 stories and more.
- c. The International Energy Conservation Code is the base document for the development of the WSEC. Washington state amendments are integrated into the base document.
- d. In considering amendments to the state energy code, the Council established and consulted with a technical advisory group including representatives of appropriate state agencies, local governments, general contractors, building owners and managers, design professionals, utilities, and other interested and affected parties

Life Cycle Cost Analysis of Energy Code Measures

Evaluating costs and benefits

In order to evaluate proposals to improve energy efficiency in buildings, the Council adopted the Life Cycle Cost Tool ([LCCT-Appendix B](#)) developed by the Washington State Office of Financial Management (OFM). All measures must be cost effective, and the Council determined that a net present savings over a 50 year period meets the cost effectiveness criteria.

The Council established an Economic Workgroup to review the proposed amendment and the economic criteria. The workgroup met twice to review the TAG recommendations. The workgroup is composed of Council members. Minutes and meeting documents for the Economic Workgroup are available on the Council website.

Some members of the workgroup expressed concern over the 50 year life cycle. For some of the measures, 50 years exceeds the expected life of the equipment. Future replacements costs and available technology are not known. The Workgroup did adopt the goals stated earlier in Section 3 of this report, with an explanation that the Life Cycle Cost Analysis would factor in equipment replacement costs and use an agreed upon set of parameters for inflation, discounts, and fuel escalation among other costs.

The methodology used to calculate the energy savings achieved through code for a large population of buildings is that used for development of the Northwest Power Plan. This method is most appropriate for documenting the costs and savings for broad application of the energy code. The NPPC model has accurately forecast energy use in the region for several decades.

In some cases, costs for measures based on estimates provided by code amendment proponents varied widely. In those cases, the Council considered a range of costs and values such as years to positive cash flow as well as net present value. Information on the Life cycle cost analysis presented during the 2018 code adoption is available on the Council website.

New Measures Bring Incremental Improvements

An initial estimate of savings under the 2018 WSEC provides some round figures based on initial proposals, TAG review and input, and public testimony.

A comparison between the 2006 code and the 2018 code was performed to provide an accurate representation of savings, and then the actual energy use of new construction should be monitored to validate the estimates. See Appendix *

For residential buildings, defined as one and two family and town houses regulated by the International Residential Code, and apartment buildings three stories and under, the incremental improvements have followed the more aggressive progress and appear to exceed the steady incremental savings target.

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For commercial buildings, which include all buildings not covered by residential, the progress has followed the steady track and appears to fall just outside the target. The state law directs the Council to “incrementally move toward” the 70 percent reduction in energy use. The improvement targets are based on equivalent savings in each three year cycle through 2030.

Moving toward 2021 targets for building energy savings

The code development process involves several stages over the three year cycle, all of which must engage stakeholders and be transparent:

- Preliminary process to examine national model code and align proposed updates with state mandates
- Technical advisory group review and revision
- Council approval of proposed rules
- Public process, including taking public comments and holding hearings
- Final revision and action

APPENDIX A: Modeling the Washington State Energy Code – 2006 & 2018 Baseline Energy Consumption report

Provide link to report {Note: Report has not yet been written}

Office of Financial Management Life Cycle Cost Tool (LCCT) Instructions

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Introduction to the Life Cycle Cost Tool

Life Cycle Cost Analysis (LCCA) is a complex but important analytical technique capable of comparing the present value of upfront capital cost to future operational costs. LCCA helps decision makers determine which project designs are likely to deliver the lowest total Life Cycle Cost (LCC).

The Office of Financial Management (OFM) capital project [Pre-Design Manual](#), [RCW 39.35](#), [EO 12-06](#) and [EO 13-03](#) strongly encourage LCCA analysis and require that a LCCA examining a baseline and three alternative scenarios is completed for State building projects over \$5,000,000 or 5,000 sq.ft.

While Washington State has required LCCA for public projects, in particular public schools, the methodology and standards have not been well defined. Without a standard methodology and set of assumptions LCCA completed by different parties generally yield incomparable results and there exists significant opportunity for gaming. To improve the application of LCCA, The Department of Commerce revisited the standardized approach to LCCA developed for federal building projects and laid out in [NIST Handbook-135](#).

In August 2013 [EO 13-03](#) directed OFM, who has the authority to standardize LCCA assumption and methodology within the capital budget, to develop a tool to assist with Washington State LCCA. OFM collaborated with The Department of Commerce, Department of Enterprise Services and other stake holders to develop a set of Washington State standards for LCCA which generally follows [NIST Handbook-135](#) and its associated annual publication of [Energy Price Indices and Discount Factors](#).

The two primary differences from the NIST standards are:

1. A Longer Study Life to better align with [EO 12-06](#) and [EO 13-03](#) which states LCCA should consider the life of the building.
2. The use of a Washington specific Real Discount Rate which is routinely estimated by the Washington State Treasurer. The discount rate for state projects was defined by [RCW39.35.03-9](#) as “the current rate for borrowing public funds”

Standardization and correct application of LCCA methodology are critical to achieving comparable results but LCCA can be very difficult and time consuming for those unfamiliar with the NIST methodology. For this reason OFM contracted the Department of Commerce to develop an excel based Washington State Life Cycle Cost Tool (WA LCCT) which aims to simplify the process for users.

The WA LCCT takes basic inputs like the installed cost and the useful life of a component and automatically applies the NIST methodology calculating how often it needs to be replaced, and what residual value remains at the end of the study life. Additionally, the WA LCCT standardizes the key LCCA assumptions including: Building Life, Discount Rate, and Fuel Escalation Rates to increase the comparability between results. The WA LCCT both simplifies the process for users, and produces an easy to read executive report allowing reviewers to quickly identify the modeled design with the lowest total Life Cycle Cost (LCC) or greatest Net Present Savings (NPS) compared to a baseline scenario.

While the OFM standardized key variables are required for final submission the WA LCCT is also a very flexible tool allowing the user to customize assumptions as well as produce completely custom year by year LCCA. Custom scenarios make the tool applicable to unexpected or unique scenarios, and make it a powerful tool for sensitivity analysis. While this functionality is important any customization performed by the user results in a prominent flag being presented on the Executive Report so the reviewer knows he or she may be no longer reviewing LCCA which conforms to consistent key variable and methodology assumptions.

The most useful output from the WA LCCT is the Executive Report which summarizes which analyzed option is likely to deliver lowest total LCC and the greatest NPS compared to the baseline. In addition to the Executive Report, the WA LCCT allows produces detailed reports for each different scenario as well as side by side cash flow reports.

To increase consistency in building component descriptions and encourage complete building LCCA the WA LCCT uses the most current version of [Uniformat II Elemental Classification for Buildings](#) as the basis for the building component list.

The WA LCCT is an excel based workbook made up of a number of different input and report pages each located on separate worksheet tabs within the workbook. These separate worksheets can be access by clicking the labeled tabs located at the bottom of the excel work screen.

The WA LCCT PRO is a large excel file that performs calculations on over a million individual cells. The Standard WA LCCT is a much smaller and faster file but has less lines for custom components and only examines 2 instead of three alternative scenarios. If the program is operating slower than you would like you can turn off Auto Calculations in Excel 2010 by:

1. Clicking File Menu
2. Selecting Options
3. Clicking the Formulas Tab
4. Selecting “Manual” under workbook calculations section

Now entries will be very quick, but you will need to tap F9 any time you want the WA LCCT to calculate the results of your entries. Additionally you will need to tap F9 after using any of the special selection tools prior to re-filtering the page. Saving and Auto-Saving can still be time consuming. To increase the speed associated with auto-saving and filtering the WA LCCT is saved as a binary file .xlsb. Binary files are lighter and faster. However binary files will only work with Microsoft excel. If you are trying to use another database program you will need to obtain an .xlsx version of the WA LCCT.

Definitions, Abbreviations & Color Labels

Definitions

Component – An existing or proposed building part. Examples: Furnace, Flooring, Toilet, Insulation, Windows, Daylighting Control, Foundation, etc.

Study Period – The scope of the study in years

Building Life – The assumed remaining life for the building being analyzed

Useful Life – The estimated life of a component before it needs replacement

Residual Value – Dollar value assigned to a component which still has a Useful Life at the end of the Study Period. (Based on the NIST standard of straight-line depreciation)

Present Value – The dollar value of a future Cashflow today. This is calculated by discounting constant future dollars, using the real discount rate.

Baseline –

For existing buildings, this is the current condition of the building, including current energy, operating, maintenance, and replacement costs.

For new construction, this is a minimum cost building designed to meet the current building codes of the State of Washington.

Alternative – A different building design which is compared to the baseline scenario.

Abbreviations

LCCA -Life Cycle Cost Analysis: A standardized methodology for cumulating construction, financing, and operational costs over a specified period of time while taking into consideration the time value of money.

LCC – Life Cycle Cost: The present value of all construction, design, operational and replacement costs.

NPS – Net Present Savings: The present value of the construction and operational savings created by choosing a specific alternative instead of the baseline scenario.

WA LCCT – Washington State Life Cycle Cost Tool: Excel based tool developed to streamline and standardized the LCCA process for Washington state building projects.

OFM – Washington State Office of Financial Management

COM – Washington State Department of Commerce

DES – Washington State Department of Enterprise Services

NIST – Refers to the National Institute of Standards and Technology [Handbook 135 - Life-Cycle Costing Manual](#) for the Federal Energy Management Program. This Handbook establishes the core methodology powering the WA LCCT.

CCF – 100 Cubic Feet

KWH – 1000 Watt Hours (Kilowatt Hour)

KBTU – 1000 British Thermal Units

Color Labels

Primary User Inputs	Secondary User Inputs	Labels/Formulas (Locked)	OFM Inputs (Locked)	Locked Cells
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General Info Page

Upon opening the WA LCCT.xlsx file the first page you will see is the quick start guide. After reading through the quick start guide click on the General Info tab. The General Info Page is where you enter all the general information about the project, building, and user. It is important that all information cells on this page are completed so the reviewer has all the required project and contact information available to them during the review process.

Key Variables

LCCA results are sensitive to these key variables. In an effort to achieve more consistent and comparable results OFM, in coordination with the Washington State Treasurer, has established standard values for these key variables which are updated regularly. The version year displayed in the upper left hand corner of each page corresponds to the last OFM update of key assumptions.

OFM standard values for Key Variables must be used when submitting a final version of your WA LCCT to the reviewing agency. OFM values will be used so long as the option button next to “OFM” is selected. The user option is for custom or sensitivity analysis described in more detail within the Custom Analysis section of these instructions.



Key Variables	<input checked="" type="radio"/> OFM	<input type="radio"/> User	Value
Building Life	50	50	50
Real Discount Rate	1.71%	1.71%	1.71%
Standard Maintenance Escalation	1.00%	1.00%	1.00%
General Inflation	2.79%	2.79%	2.79%
Study Period (years)	53	53	53
Fuel Escalation Assumptions Located on Fuel Escalation Page			

Timing Variables

The user inputted timing variables are important for establishing the base year for constant dollar calculations and fuel escalation calculations as well as establishing when the building first goes into operation.

Timing Variables	Year(s)
Base Year (Generally Current Year)	2014
Construction Years (Partial Year = 0)	3

1st Operation Year = 2018

The Base Year - should be set to the year for which the LCCA study is being initiated. This is generally the current calendar year.

Note: The base year cannot be set to a value more than one year before the version year unless using a custom user defined fuel escalation table with an earlier starting year.

Construction Years - should be set to Zero if the project is expected to be operational at the beginning of the following year. If construction will take one complete year in addition to the time remaining in the base year this value should be set to one, and so on. Partial years of construction should not be counted.

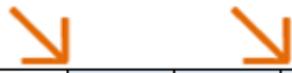
The WA LCCT is performing full not partial year LCCA for buildings. If the construction year is set to zero the Construction costs will be applied at the end of the base year. Operation in regard to consumption of useful life and operational costs will begin at the beginning of the following year. All year end totals will be discounted to present value. If a construction period is entered the capital costs will be applied to the end of the middle year of the construction period, rounded up for odd construction periods.

The WA LCCT assumes that the building study will last the specified Building Life for all scenarios. Scenarios which have longer construction periods than others have a correspondingly longer study period.

Financing Variables

Generic financing assumptions can be applied to the construction costs associated with any of the scenarios being analyzed by checking and unchecking the boxes next to the scenario title. If the financing check box is marked the user adjustable financing options below it will be applied to the associated scenario. The financing calculations assume that two annual payments are made towards the loan every six months. Unlike the real discount rate the interest rate is entered on a nominal basis. Bank rates are normally posted on a nominal basis.

$$Real\ Interest\ \% = \frac{1 + Nominal\ \%}{1 + General\ Inflation} - 1$$



Finance 1st Purchases for ->	<input checked="" type="checkbox"/> Baseline	<input type="checkbox"/> Alt. 1	<input checked="" type="checkbox"/> Alt. 2
Down Payment (%)	20%	20%	20%
Term (Years)	15	15	15
Nominal Interest Rate	4.54%	4.54%	4.54%
Real Interest Rate	1.71%	1.71%	1.71%

When analyzing design options financing options should always be set to equivalent values. Once a design scenario has been selected it can be analyzed under various financing scenarios to determine the final plan for acquisition. The WA LCCT applies financing to the first construction costs only and does not apply it to any component replacements.

Define the Scope and Level of Detail

When you begin the analysis, the first task is defining the project scope and level of detail for the analysis. When using the WA LCCT, the scope and level of detail are defined by creating a list of building

components to be analyzed. This section describes the WA LCCT features which assist with the creation of a user specified component list.

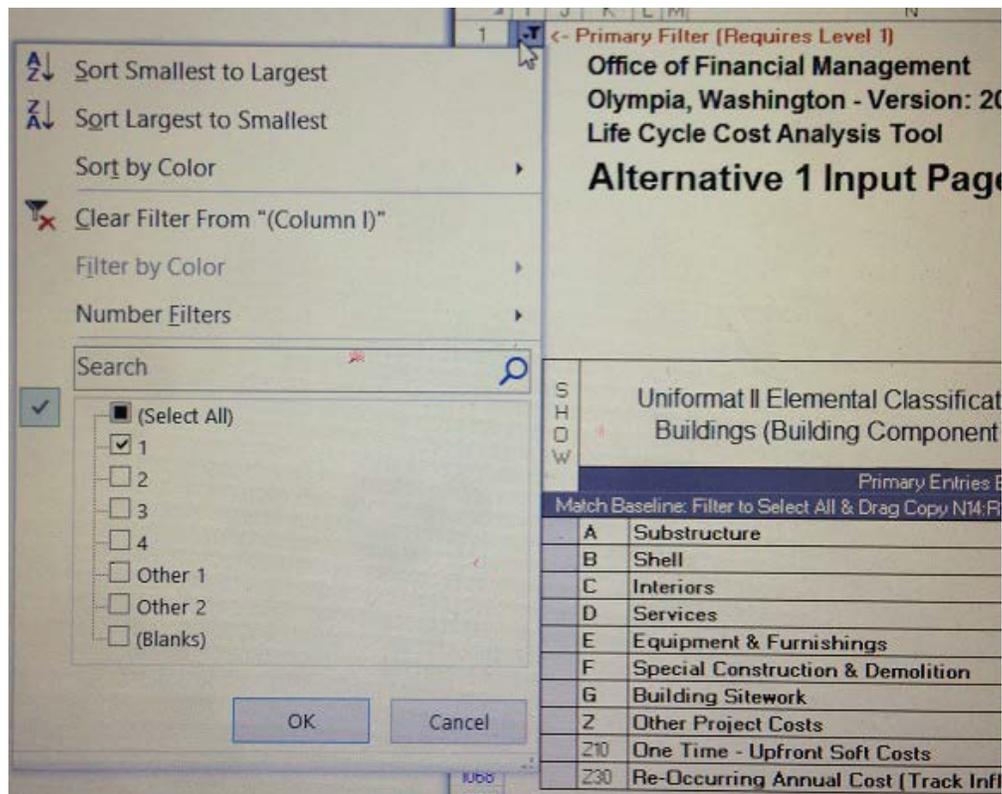
The Primary Filter

In the upper left hand corner of all scenario input and report pages is a small Primary Filter button. 

The Primary Filter is probably the most helpful tool for you to understand.

The combination of the extensive Uniformat II Elemental list and the customizable “Other” categories combine to create over 1,600 lines available for building component entries within the WA LCCT PRO. This level of detail may be needed for some projects, but many other projects will only require one or two lines. The filter and some of the special selections tools will help you easily navigate and display just the rows you are interested in.

Clicking on the Primary filter button will open a control box that allows you to turn on and off different levels of detail. For the WA LCCT to display and filter properly the **level 1 box must always be checked**. Turning off level 1 will hide all labels on the screen except the label for the Primary filter. Additional levels of detail can be added or subtracted with the other checkboxes in the control box followed by clicking OK.



The best place to start is by defining the level of Uniformat II detail for your LCCA. The Uniformat II list has 4 levels of detail each more specific than the level of lower numerical value. These levels of detail can be turned on or off by selecting the corresponding checkboxes: 2, 3, & 4 in addition to Level 1.

When searching for a specific building component it is recommended that you move the parent category to the top of the screen using the scroll wheel on your mouse prior to turning on the next higher level of detail on.

To add building elements not defined by Unifomat II you need to set the filter to include “other” rows. In addition to the 4 levels of prescribed Unifomat II component descriptions the WA LCCT also has two levels of “other” building component categories which can be customized by the user. By selecting Other 1 the WA LCCT will add one “other” line at the bottom of every Unifomat II level 3 parent category. Selecting Other 2 will add a 2nd “other” line. If more customizable fields are needed than two, the WA LCCT PRO version can be obtained from OFM. The WA LCCT PRO file allows 9 custom fields for every level 3 Unifomat II category.

The description field for these “other” components can be re-titled on the baseline input page to allow analysis of any components not included in the Unifomat II list. It is requested that the prescribed Unifomat II titles are used whenever possible for increased comparability. However, a completely customizable list of components can easily be created by turning on Level 1 and Other 1

Show all rows: The Select All box at the top of the filter control box can be clicked once to select all levels of detail, or clicked again to remove all levels of detail. This can be useful for viewing all component rows, or for returning the filter to viewing only level 1. When only level 1 is turned on the WA LCCT will display the labels at the top of the screen, Unifomat II Level 1 categories, and any specially selected rows. There are two ways to specially select a specific building component row for display even when only Level 1 detail is selected by the Primary Filter.

Special Selection Methods

To lock the display of any row, put an X in the “SHOW” box. Any line within the Unifomat II list can be manually added to level 1+ filtered lists by adding an X or any other character in “SHOW” box located on the far left side of the component line.

S H O W	Unifomat II Elemental Classification for Buildings (Building Component List)	
	Primary Entries Below: # of Units m...	
	A	Substructure
	B	Shell
x	B10	Superstructure
x	B1020	Roof Construction
x	B102011	Structural Frame
x	B102002	Structural Interior Walls
	C	Interiors
	D	Services
x	D30	HVAC
x	D3050	Terminal & Package Units
x	D305098	Other
	E	Equipment & Furnishings

After an X has been added the page must be re-filtered by clicking on the primary filter control box, selecting a minimum of Level 1 detail, and clicking OK.

Manually including specific components can be a very useful tool for Project Managers or other users that want to build a customized list of components to be considered during the LCCA. Deleting the character from the “*SHOW*” Box will remove the manual special selection. This feature is available on all input and report pages but primarily used on the Baseline Input page and transferred to other pages using the automatic special selection methods described below.

Baseline Input and Report Page Options

When you first open the Baseline Input page in the non Pro version of the WA LCCT the page will be set up to display two comment boxes. Reading through these comments and following the filter instruction will display additional comment boxes. Reading each of these comment boxes is a good way to get introduced to the different elements of the Input Pages.

The Comment boxes can be turned On and Off by clicking on the Review tab at the top of the excel page and clicking on “Show All Comments” option. Once the Comments are turned off and the filter has been set to a minimum of level 1 the page will display normally. The comments can still be read one at a time by rolling the cursor over the red arrows in the tagged cells.

Display Active Rows Only: After you have entered the required data for different building components, you may now filter by active rows only. At the top and center of the Baseline Input Page there is a checkbox titled “*Show All Entered Units*”.



By selecting this checkbox and re-filtering, the page will now display any components which have one or more number of units assigned to it. This special selection can be completed with following these steps:

Step 1. Check the box “*Show All Entered Units*”

Step 2. If you have turned OFF Automatic Calculations to increase input speed you must now tap F9 to update all calculations within the workbook.

Step 3. Select the filter button

Step 4. Select only level 1 from the hierarchy
(unless rows from other detail levels are desired to be displayed)

Step 5. OK.

Alternative Input Page Options

At the top and center of each alternate analysis worksheet there are three special selection options.

The use of any of these options requires a re-filter, as described above, prior to affecting the display.

Special Selection Tools are generally used while the filter is set to display only level 1 detail.

Open Primary Filter and Click OK to Re-filter

<input type="radio"/>	Manual Special Selection Only (Requires Refilter)
<input checked="" type="radio"/>	Show Baseline Fields and Entered Units (Requires Refilter)
<input type="radio"/>	Show Differences Between Alternative and Baseline (Req. Refilter)

Manual Special Selection Only: This option makes the filter display only the selected levels of detail and any rows that have been manually selected using the “SHOW” box

Show Baseline Fields and Entered Units: This option displays all rows which have been manually selected on either the Baseline Input Page or the Alternative Input Page as well as any rows which have been assigned 1 Unit, or more on the Alternative Input Page. Components which have been assigned 1 unit or more on the Baseline Input Page will also be displayed if the “Show All Entered Units” box is checked on the Baseline Input Page. This is the recommended selection option for most users.

Show Differences Between Alternative and Baseline: This selection option combined with only a level 1 filter sets the display to only include alternative input rows which contain different values than the corresponding row on the Baseline Input Page. This option will not include any manually selected rows unless the values inputted on that row are different from the baseline.

Report Page Options

Alternate Report Filters: At the top and center of each Alternative Report page there are also three option buttons. The top and bottom options have the same title and functionality as the Alternative Input Page. The 2nd option “*Show Values and Parent Categories*” makes the page display all components that have an entered number of units greater than one as well as any of its associated the parent categories. A component entered at level 3 will also display the level 2 and level 1 parent categories when this option is selected. Because categories are totaled on the report page this option should generally be selected to produce a read-able and print-able report.

Click Primary Filter and Click OK to Ref-ilter

<input type="radio"/>	Manual Special Selection Only (Requires Refilter)
<input checked="" type="radio"/>	Show Values and Parent Categories (Requires Refilter)
<input type="radio"/>	Show Differences Between Alternative and Baseline (Req. Refilter)

For normal use it is advised that the “*Show All Entered Units*” checkbox is selected on the Baseline pages, “*Show Baseline Fields and Entered Units*” option is selected on all the alternative input pages, and “*Show Values and Parent Categories*” option is selected on all report pages. This will transfer the manually selected custom report built on the baseline input page to all input pages and produce read-able report pages. You will however need to re-filter each Input Page after building the custom component list on the Baseline Page. You will also need to re-filter each Report Page after entering all the data on the Input Pages.

Baseline and Alternative Input Pages

Baseline Input Page

The most important part of any LCCA is the baseline scenario. This is the base-case to which all alternative designs will be compared to. When analyzing the construction of a new building the baseline scenario should represent the lowest capital cost building that can be constructed to meet all the current Washington State code requirements.

If immediate replacement of an existing but no longer functioning component is being analyzed the base-case should represent the lowest capital cost replacement option that meets the current code requirements. However, if the LCCA is considering replacing an existing component that has not yet reached the end of its useful-life the base-case should represent using the existing component until the end of its useful-life and then replacing it with an identical component as many times as needed to reach the end of the study period. This can be done by entering all the component information normally on the Input Page but then entering the number of remaining years the existing component has before it reaches the end of its useful-life in column AB on the Baseline Input Page and column AE on the Alternative Input Pages

The Baseline Input Page is where you will define the characteristics of each individual component examined by the baseline scenario. It is preferable to make the baseline as detailed as possible and input data regarding every group or individual building component within the building as well as the total utility costs. A perfectly complete baseline report will show reviewers the total Life Cycle Cost (LCC) of constructing and operating the baseline building.

However, if the purpose of the LCCA is not to determine the total Life Cycle Cost (LCC) of the various scenarios but only to determine which alternative will create the greatest Net Present Savings (NPS) over the baseline a much simpler approach can be employed. If total LCC is not desired only a determination of which design will yield the lowest total LCC the baseline only needs to include every group or individual building components that will be removed, replaced, or altered by any of the alternative scenarios being considered. Components that are identical for all scenarios can be ignored.

Using Input Pages

On each scenario's Input Page entries can be made on every row associated with the building component list. It does not matter what level of Uniformat II detail it is associated with. This means entries affecting a Standard Foundation can be entered on the Level 3 "*Standard Foundation*" row or made on the Level 1 "*Substructure*" row and the same result will be achieved. There is no summing to a lower level of detail on the Input Page, that characteristic is performed on the detailed report pages. **Do not make the same entry on multiple rows in an attempt to make a component appear at each different level of detail on the Input Page.**

It is recommended that you start by creating a customized list of building components on the baseline input page by placing an X in all of the "*SHOW*" boxes associated with the components that will be examined in any of the alternatives considered. Once the Building Component List has been customized

to display just the components being analyzed it is time to start entering the required information for each building component.

SHOW	Uniformat II Elemental Classification for Buildings (Building Component List)		REF	# of Units	Useful Life (Yrs.)	Installed Cost (\$/Unit)	1st Year Maint. Cost (\$/Unit)
	Primary Entries Below: # of Units must be > 0 to be counted; Useful Life must be >= 2						
	A	Substructure					
	A10	Foundations					
	A1010	Standard Foundations					
x	A101098	Custom Description Entered Here		1	75	\$ 75,000.00	\$ 500

Building Component List – “Other” fields in the baseline Component List are unlocked and can be overwritten to any user defined description. “Other” building components can only be re-titled on the baseline input page. The description entered on the Baseline Input page is automatically transferred to all alternative scenario input and report pages.

REF – This is an optional field which can be used to assign a reference number to a specific component row which can later be referenced in the narrative report turned in with the completed WA LCCT.

of Units – This is a very important entry. This value must be set to a value of 1 or greater or all other entries on that row will be ignored. The number of units could be set to represent 10,000 sq.ft of roofing, or 1 roofing package.

Useful Life - The number of years until the building component needs to be replaced. This entry impacts when replacement cost are assigned to the LCCA and the residual value at the end of the study period.

Components expected to last the Life of the building should be assigned a useful life equal to the Building Life value displayed on the General Info Page.

Useful life values should be supported by reliable references. For example, the Department of Enterprise Services has included equipment life tables from ASHRAE Systems Handbook as a reference for equipment life. References should be included in the narrative turned in with the final WA LCCT describing what sources you used to develop all of your Useful-Life values.

Installed Cost – This is the cost of purchasing and installing one unit of the specified building component. It is important to match all component specific dollar entries to the number of units specified. A 10,000 sq.ft roof could be entered as 1 roof costing \$50,000, or as 10,000 units of roofing costing \$5 per installed unit.

1st Year Maint. Cost – This is the 1st year annual cost of maintaining one unit of the specified building component. This value escalates above and beyond inflation based on the OFM assigned escalation rate and the age of the component. When a component is replaced it resets the annual maintenance cost to the 1st year value.

Utility Consumption and Cost - The easiest way to enter Water and Energy consumption data into the WA LCCT is on a total building basis. For existing buildings, the baseline utility consumption and cost will likely be based on historical billing data. For large new building projects energy use and costs will likely come from engineering estimates created with energy models. Retrofit projects frequently use energy use per unit estimates provided by utilities. There are a variety of methods to be considered. The one selected should be in common use in the building and utility industry and described in the Narrative turned in with the final WA LCCT. A report of the key modeling assumptions and the energy modeling report for each scenario should be turned in with the final WA LCCT if applicable.

Total Building Annual Utility Analysis	\$	5,000	Water (CCF)	Electricity (KWH)	Natural Gas (Therms)	Diesel#2 (Gallons)	#5/#6 Oil (Gallons)	Gas (Gall)
Annual Utility Bill [\$]				\$ 5,000				
Annual Utility Consumption Not Entered Below				50,000				
Sum of Annual Utility Consumption Below			-	-	-	-	-	-
Total Annual Utility Consumption			-	50,000	-	-	-	-
Annual Utility Bill = Total Utility Consumption	\$		\$	0.10	\$		\$	

Annual Utility Bill – This is the cost for one year of utility service. It includes all customer charges, demand charges, block rate charges and taxes. Some building designs may reduce demand or block rate charges while still consuming the same quantity of energy. For this reason it is important to take into consideration the local utility’s rate structure when a estimating the “*Annual Utility Bill.*” A copy of the local Utility Rate structure used for analysis should be turned in with the completed WA LCCT.

Annual Utility Consumption Not Entered Below – This field can be used to enter the whole building utility consumption or just the quantity of utility consumption that is not part of the entries made on a component by component basis. If overlapping energy consumption has been allocated to individual components a negative number may need to be entered here to get the Total Annual Utility Consumption value to match the integrated energy model. Make sure to use the units for water and energy that are specified in the column heading when entering utility consumption data. For assistance converting common energy units the [Energy Star Thermal Conversion](#) sheet may be helpful.

Sum of Annual Utility Consumption Below – Is the sum of all units of water or energy that are entered below on component by component basis.

Total Annual Utility Consumption - Total Annual Utility Consumption is the sum of “*Annual Utility Consumption Not Entered Below*” + “*Sum of Utility Consumption Below.*”

Detailed Utility Use Inputs: For more detailed analysis utility consumption can be entered into the WA LCCT on a component by component basis as shown in the table below. The grey area is used to enter utility consumption data specific to an individual building component. This is most useful for attributing changes in energy consumption directly to a specific building component that will be replaced or modified. This value is multiplied by the # of units specified for the building component.

Total Building Annual Utility Analysis		\$ 5,000	Water (CCF)	Electricity (KWH)	Natural Gas (Therms)	Diesel#2 (Gallons)	#5/#6 Oil (Gallons)	Gas (Gall)
Annual Utility Bill (\$)				\$ 5,000				
Annual Utility Consumption Not Entered Below								
Sum of Annual Utility Consumption Below			-	50,000	-	-	-	-
Total Annual Utility Consumption			-	50,000	-	-	-	-
Annual Utility Bill ÷ Total Utility Consumption		\$	-	\$ 0.10	\$	-	\$	-

# of Units	Useful Life (Yrs.)	Installed Cost (\$/Unit)	1st Year Maintenance Cost (\$/Unit)	1st Year Energy Cost (\$/Unit)	Annual Water (CCF/Unit)	Annual Electricity (KWH/Unit)	Annual Natural Gas (Therm/Unit)	Annual Diesel#2 (Gall/Unit)	Annual #5/#6 Oil (Gall/Unit)	Ann Gas (Gall)
be > 0 to be counted; Useful Life must be >= 2										
Entries Below for Component Specific Utility Analysis (Consumption)										
2	15	\$ 400.00	\$ 500	\$ 2,500		25,000				

Component specific utility consumption inputs may be positive or negative numbers. Entering a negative number within the component energy consumption fields is one way you can assign an energy savings to a specific component. This can be done by entering the same total building energy consumption value in the “Annual Utility Consumption Not Entered Below” field on both the Baseline and the Alternative Input Page. Now an individual component on the Alternative Input Page which is assigned a negative energy consumption value will reduce the “Total Annual Utility Consumption” accordingly while assigning the economic savings to the specific component.

This same effect can be achieved by entering the actual component utility consumption on both the Baseline Input Page and the Alternative Input Page and the WA LCCT. If the Alternative component consumes less utilities the WA LCCT will recognize the savings and assign them to that component.

Additional Inputs: On the far right of the input page there are three other fields that may be useful.

1st Year Maintenance (\$)	LPG (Gallons)	District Heat (KBTU)	Coal (KBTU)	Biomass (KBTU)	1st Year Maintenance	User Notes
					(\$) Escalates Over Entire Study Life	
-	-	-	-	-		
- \$	- \$	- \$	- \$	- \$		
Annual LPG (Gallons/Unit)	Annual Dist. Heat (KBTU/Unit)	Annual Coal (KBTU/Unit)	Annual Biomass (KBTU/Unit)	Remaining Life of Existing Component		
Analysis - Total Building Utility Analysis Above						

1st Year Maintenance – This applies a maintenance cost to the entire building that will escalate every year based on the standard maintenance escalation rate. This is in contrast to the individual component maintenance costs which escalates annually but resets every time a component is replaced.

Remaining Life of Existing Component – This field is used to model a scenario that considers maintaining an existing component vs. replacing it with an alternative component prior to the end of its useful life. For example, if a 20 year component has been installed in a building for 15 years and is being considered for replacement, on the Baseline Input page 5 years should be entered for the remaining life of the existing component.

User Notes – This is series of unlocked fields where the user can enter notes or make calculations. This can be helpful for describing different types of the same building component or describing the changes which were made to an alternative component or page.

Z categories: At the bottom of the Building Component List you will find the Z category for which many input boxes have been blacked out. The Z category is separate from the component list and allows two different types of entries for non-component related costs.

One Time, Upfront Soft Costs – These rows are for one-time non-reoccurring costs that are assigned to the project at the point of construction. The WA LCCT automatically assumes that these costs are a life of building investment. Many of these Z category rows have customizable descriptions on the baseline input page which can be viewed by setting the filter to display Unifomat II Level 3, Other 1 and Other 2 levels of detail.

Re-Occurring Annual Cost – These rows are for re-occurring annual costs which are only expected to keep pace with inflation. This is where maintenance or other costs which are not expected to escalate based on the building or component age, above and beyond inflation, should be entered. Window washing for example may be a non-escalating annual cost. Entries for these rows can only be made in the 1st Year Maintenance Cost column and the WA LCCT automatically assumes that this cost will occur every year during the study period.

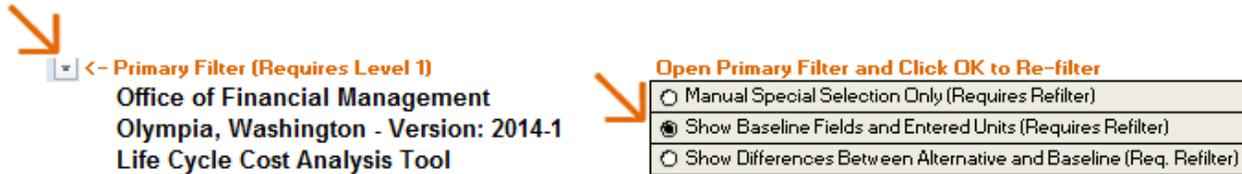
SHOW	Unifomat II Elemental Classification for Buildings (Building Component List)		REF	# of Units	Useful Life (Yrs.)	Installed Cost (\$/Unit)	1st Year Maintenance Cost (\$/Unit)	1st Year Energy Cost (\$/Unit)
	Primary Entries Below: # of Units must be > 0 to be counted; Useful Life must be >= 2							
Z	Other Project Costs							
Z10	One Time - Upfront Soft Costs			1	50			
Z1010	Agency Project Management			1	50			
Z1010	Consultant Services			1	50			
Z1030	Project Contingency			1	50			
Z1030	GC/CM or D/B Management Costs			1	50			
Z1030	DES Management Fees			1	50			
Z1040	Other Soft Costs			1	50			
Z1050	Other One Time - Upfront Cost			1	50			
Z1060	Other One Time - Upfront Cost			1	50			
Z1070	Other One Time - Upfront Cost			1	50			
Z1080	Other One Time - Upfront Cost			1	50			
Z1090	Other One Time - Upfront Cost			1	50			
Z30	Re-Occurring Annual Cost (Track Inflation)			1	1			
Z3010	Non Escalating Maintenance			1	1			
Z3020	Other Re-Occurring Annual Cost			1	1			

Alternative Input Pages

The WA LCCT is set up to be able to compare two different alternative design scenarios to the baseline scenario. The WA LCCT PRO is set up to compare three different design scenarios to the baseline scenario. The individual design characteristics of each of these alternatives can be set using the three different Alternative Input Pages.

Begin by Replicating the Baseline Input Display. When you first open an Alternative Input Page it is advised that you select the special selection option “*Show Baseline Fields and Entered Units*” and re-

filter the page to display only Level 1. This action will cause the page to display all components manually selected on the Baseline Input Page. In addition, if the “*Show All Entered Units*” box is currently checked on the Baseline all components which are assigned one unit or more on the Baseline Input Page will also be displayed on the Alternative Input Page, regardless of manual selection.



If the Alternative Input Page has not been modified it will automatically be populated to match all of the individual component entries made on the Baseline Input Page. This eliminates the need to duplicate inputs for each alternative. Users should now overwrite any of the automatically populated data in the Alternative Input page that needs to change to accurately model the alternative scenario. **Don't forget to update the Total Building Annual Utility Analysis box with the new annual utility bills and consumption data that correspond with the alternative scenario.**

Complete the same procedure on each Alternative Input Page to develop two alternatives to the baseline scenario. Each alternative should be unique with respect to the life cycle cost of constructing and operating the building.

After over-writing component data on the Alternative Input Pages the WA LCCT will no longer auto-populate that field. If you plan to use this workbook again for another LCCA or just want to restart the analysis using the baseline assumptions you can re-populate the input page using the following steps.

1. Set Primary Filter to Select All
2. Select Cells O14:S14 and drag copy to the start of the Z Group (Black Line)
3. Copy and paste an “*Installed Cost*” cell into R1592 and drag copy to the black line
4. Copy and paste a “*1st Year Maintenance Cost*” cell into S1631 and drag copy to S1633
5. Select Cells U14:AE14 and Drag copy to the start of the Z Group (Black Line)
6. Manually match cells within the “*Total Building Annual Utility Analysis*” box if desired

Reports

Executive Report

The Executive Report is the primary output from the WA LCCT. It provides reviewers with a quick summary of which modeled scenario produced the lowest Total Life Cycle Cost and/or Net Present Savings compared to the baseline scenario. Additionally this page summarizes the present value of each scenario's Capital Costs, Maintenance Cost and Utility Costs as well as the general project information. Again, cash flows associated with financing are grouped with Capital Costs.

Using consistent assumptions is of paramount importance for creating comparable LCCA results and for this reason the Executive Report creates flags to warn the reviewer if any non-standard assumptions or

custom entries have been made. These flags which appear below the Net Present Savings Calculations can also be useful for a user as they will tell you if, and where, any major data errors exist. If an error or custom entry is flagged on the executive report more details regarding that flag can be found underneath the page title on the specified Input Page.

Net Present Savings (NPS)	N/A	#VALUE!	#VALUE!	#VALUE!
----------------------------------	------------	----------------	----------------	----------------

Warning: OFM Assigned Variables Not Used

MAJOR ERROR ON: Base Alt. 1 Alt. 2 Alt. 3
Note: Custom Entry On: Base Alt. 1 Alt. 2 Alt. 3
Note: Inconsistent Financing Applied

The executive report also displays two charts. The first is a graphical representation of the Total Life Cycle Cost, and the second is a line chart showing the cumulative expenditures spent on each scenario. The point in time when two scenario’s cumulative cash flow lines cross is when they reach an economic break-even point.

At the bottom of the Executive report there are three open fields which can be used to provide a brief description to the reviewer of each different scenario being examined by the WA LCCT. A more detailed narrative describing the baseline and alternative scenarios must be turned in with the final WA LCCT.

Expenditure Reports

The two left most tables show side by side comparisons of the Annual Expenditure Flows and the Cumulative Expenditure Flows for each scenario. To the right of these summary tables are separate tables showing detailed expenditure reports for each different alternative. Loans taken, and payments made, appear within the Capital column of these reports. These expenditure reports are presented on a constant dollar basis so all values match the value of the dollar in the base year.

For each alternative expenditure report there are two additional columns of data showing both the annual and cumulative savings compared to the Baseline. At the far right of the Expenditure Report Page are two graphs which graphically show each scenario’s Cumulative and Annual Expenditures. The point in time where the cumulative cash flows lines of two scenarios cross is when they reach a break-even point.

Detailed Reports

Each different scenario has a detailed report page associated with it. The Report Pages utilizes the same Primary filter as the input pages. In most instances it is advisable to use the special selection “*Show Values and Parent Categories*” option and re-filter the page to only level 1. This will display all components rows for which one or more units have been assigned as well as the parent Uniformat II category.



At the top of the detailed Report Page there are two charts. The Chart on the left shows a graphical representation of expenditures over time in constant dollars. It is important to recognize expenditures are being represented as positive numbers and revenue represented as negative numbers. To the right of this chart is a similar time-line but on this chart all future value are being displayed based on their present value in the base year. This chart gives a visual representation of the impact the real discount rate, and time, has on the LCCA.

Unlike the Input page, on the detailed report page values Sum up to their associated parent level of detail. All level 4 entries sum up to the level 3 parent category plus any entry that may have been made directly to the level 3 component line. This sum up procedure continues all the way up to level 1.

You will see that the Detailed Report Pages have a new Level 1 category which displays the Whole Building Entries. This row cumulates the Present Value of the whole building utility analysis, any whole building maintenance costs as well as the Present Value of the financing which is displayed in the “*Present Value of Capital Costs*” field. A new level 1 category for Custom entries is also displayed which cumulates any custom line by line entries made for this scenario.

The Detailed Report Pages can be useful for examining the present value of: capital, maintenance, and utility costs for an individual or group of components. It also displays the Savings to Investment Ratio (SIR) for each individual and group of components. The SIR is powerful design tool that can help engineers pick and choose how to best allocate limited funds to the most cost effective components.

$$SIR = \frac{PV\ Operation\ Costs_{Baseline} - PV\ Operation\ Costs_{Alternative}}{(PV\ Capital\ Costs_{Alternative} - PV\ Capital\ Cost_{baseline})}$$

Because the SIR can often lead to negative values, and divided by zero errors, the WA LCCT is programmed to only display the SIR if the group, or individual, alternative component costs more in terms of capital expenditures, and saves money on annual basis compared to the baseline.

Fuel Escalation Page

The Fuel Escalation Page displays the assumptions that are used to escalate fuel prices, above and beyond inflation, during the study period. The escalation assumptions, Version Year, and Version # are updated annually by OFM on this page. The first 30 years of the study period is currently set to match the annually released NIST federal [Energy Price Indices and Discount Factors](#).

Beyond the first 30 years OFM has the option of assigning either a linear or exponential extrapolation based on the last 5 years of the NIST Energy Price Indices and Discount Factors.

Escalation rates are factors which are multiplied by the price of energy in the base year to calculate the price of energy in the future. For internal, or sensitivity analysis, users can create their own escalation rates in the “*User Input*” box as described in the Custom Analysis section.

Custom Analysis

While the primary goal of the WA LCCT is to standardize the assumptions and methodology for LCCA for State projects the WA LCCT is also a very flexible tool capable of handling unique situations as well as allowing users to produce sensitivity analysis. This flexibility can be unlocked with many custom analysis features hidden within the WA LCCT. All custom analysis performed should be referenced, and described, within the narrative turned in with the completed WA LCCT. Users should be aware that performing custom analysis will create a flag on the Executive summary.

Key Variables

To allow flexibility for sensitivity, and other internal analysis, the user can customize the key variables found on the User Input Page by selecting the “User” option button and manually changing the key variables below it.



Key Variables	<input type="radio"/> OFM	<input checked="" type="radio"/> User	Value
Building Life	50	50	50
Real Discount Rate	1.71%	1.71%	1.71%
Standard Maintenance Escalation	1.00%	1.00%	1.00%
General Inflation	2.79%	2.79%	2.79%
Study Period (years)	53	53	53
Fuel Escalation Assumptions Located on Fuel Escalation Page			

User Inputs are for sensitivity analysis only, final submissions must be made using OFM inputs

Building Life – Establishes the life of the building being studied. The Building Life plus the Construction Years establishes the Study Period.

Real Discount Rate – Set the rate at which future cash flows will be discounted into present dollars. A real discount rate includes general inflation and is applied to constant dollars amounts matched to the value of a dollar in the base year.

General Inflation – This value is not actually used by the WA LCCT but is an important variable for users to know when they are creating constant dollar cash flows for custom year by year analysis or calculating the Real interest rates to attach to a financing option.

Standard Maintenance Escalation – This is the rate that the 1st year maintenance costs escalate, above and beyond inflation, per year. Individual component maintenance rates are reset to the 1st year value every time they are replaced.

Fuel Escalation

The WA LCCT fuel escalation rates are currently based on the annually released NIST [Energy Price Indices and Discount Factors](#); a supplement to [NIST Handbook-135](#). Users can choose to model their own energy escalation rates by selecting the User option located at the top of the Fuel Escalation Page.

**Office of Financial Management
Olympia, Washington - Updated: 2014
Life Cycle Cost Analysis Tool
Fuel Escalation Page**

Input Method OFM User

After selecting the User options the WA LCCT will use all the escalation rates located in the User Input box for fuel price calculations. The fuel escalation page is establishes the multiplication factor for each year in the future which is applied to the original Utility cost in the base year. These utility price factors can be manually adjusted on a year by year basis. The average utility price per unit includes: taxes, block, customer and demand charges and is calculated based on the Utility values entered on each scenarios input page.

User Input							
\$ Escalation	2014	2015	2016	2017	2018	2019	2020
Electricity	1.00	1.00	1.00	1.01	1.02	1.01	1
Distillate Oil	1.00	0.88	0.85	0.86	0.88	0.90	0
Residual Oil	1.00	0.74	0.67	0.68	0.69	0.71	0
Natural Gas	1.00	1.01	1.01	1.06	1.11	1.17	1

The User can also change the base year that fuel prices escalation begins by changing the date in the upper left field of the User Input box. To perform a study of an existing building including a historical point of construction both this field and the base year located on the General Info Page need to be adjusted to the beginning of historical study. Additionally, all dollar values must be entered in inflation adjusted dollars that match the historical base year of the LCCA.

Hidden Custom Input Entries

On each scenario input page located just to the left of the User Notes column there are two hidden columns. By selecting the “User Notes” and “Remaining Life of Existing Component” column and right clicking you will open a control box. At the bottom of the control box select Unhide. Now two hidden columns will appear.

Cooling Heat (BTU)	Coal (KBTU)	Biomass (KBTU)	1st Year Maintenance	Custom Construction	User Notes	
-	-	-	(\$ Escalates Over Entire Study Life	(Years)		
-	-	-	-	-		
-	\$	\$	-	-		
Annual Coal (KBTU/Unit)	Annual Biomass (KBTU/Unit)	Remaining Life of Existing Component	Custom Annual Maint. Escalation Rate	Eliminate Residual \$ by Entering 1 Below		
Analysis Above						

Custom Construction – This field can be used to make this scenario have a different construction period in years than all other scenarios which are defined by the value inputted on the User Input Page. This can be used for designs which are expected to have significantly shorter or longer construction periods than the on the scenarios.

Custom Annual Maintenance Escalation Rate – This column applies a custom escalation rate to a specific building component that is different than the value inputted on the General Info Page. This can be useful for analyzing building components whose maintenance costs are expected to change over time at a significantly different rate than the Standard Maintenance Escalation rate.

Eliminate Residual \$ By Entering 1 Below – Entering the number 1 in this column will automatically set the residual value of the specified component to zero. This can be useful for analyzing projects scheduled for future demolition where no residual value is expected for specific components regardless of their remaining useful life.

Custom Year by Year Entries

To allow complete flexibility the WA LCCT is also capable of accepting year by year expenditure and revenue entries. Users using this feature should be familiar with the NIST methodology for LCCA and follow the general methodology rules. Namely, replace components at the end of their useful life, and calculate a residual value at the end of the study period for all components based on a linear depreciation of the asset.

Note: Custom Line by Line Entries		Annual Utility Bill + Total Utility Consumption					\$	-	\$	-	\$	-	\$	-	\$
S H O W	Uniformat II Elemental Classification for Buildings (Building Component List)	REF	# of Units	Useful Life (Yrs.)	Installed Cost (\$/Unit)	1st Year Maint. Cost (\$/Unit)	1st Year Energy Cost (\$/Unit)	Annual Water (CCF/Unit)	Annual Electricity (KWH/Unit)	Annual Natural Gas (Therm/Unit)	Annual Diesel#2 (Gallons/Unit)	Ann #5#E (Gallon			
	Primary Entries Below: # of Units must be > 0 to be counted; Useful Life must be >= 2							Entries Below Only for Component Specific							
x	Custom Year By Year Entries in Constant 2014 Dollars (Enter Manually Show Row and Reference in Narrative)				2014	2015	2016	2017	2018	2019	2020				
x	Example of Custom Netry	14			Custom Capital Cost #1	0	\$ 1,400	\$ 1,530	\$ 700	\$ 57	\$ 250	\$			
					Custom Capital Cost #2	0									
					Custom Capital Cost #3	0									
					Custom Capital Cost #4	0									
					Custom Capital Cost #5	0									
					Custom Maintenance #1	0									
					Custom Maintenance #2	0									
					Custom Maintenance #3	0									

On each different scenario’s input page the custom year by year entries can be viewed by clicking the primary filter and turning on the “Other 2” level of detail and clicking OK. After doing so five rows of Custom Capital, Custom Maintenance and Custom Utility lines plus one line of Custom financing will appear at the very bottom of the building component list.

All custom entries rows with entries should be manually selected for display by placing a character in the “SHOW” box on the Input Page. All Custom entries should be assigned a reference number using the “REF” box and described in the narrative turned in with the completed WA LCCT. Using year by year entries allows for total flexibility but requires much more external calculations by the user to make the LCCA properly match the prescribed NIST methodology.

When entering cash flow figures on a year by year basis all expenditures should be entered as positive numbers and all revenues should be entered as negative numbers. It is also important that all values are entered in constant dollar values. This means that inflation is factored into the time value of money

calculations completed by the LCCT and should not be included in your entries. All dollar values should be entered in dollar values equal to the value of a dollar in the specified base year. If you are analyzing a current dollar stream, typical of bank loans, care must be taken to use the OFM specified inflation rate to convert all current dollars into constant dollars.

APPENDIX C: Washington State Building Code Council Application for Review of a Proposed Statewide Amendment to the Washington State Building Code

Insert Proposal Template