**From:** Murray, Chuck (COM) <chuck.murray@commerce.wa.gov>
**Sent:** Wednesday, June 12, 2019 3:55 PM
**To:** Vander Mey, Eric (SBCC Member) <eric.vandermey@des.wa.gov>
**Cc:** Brown, Richard (DES) <richard.brown@des.wa.gov>; Braaksma, Krista (DES) <krista.braaksma@des.wa.gov>
**Subject:** Public Comment for the June 13 MVE meeting

Mr. Vander Mey,

Since the work of the energy code technical advisory group work was completed, I have encouraged the development of some documentation that summarizes the work and makes a few recommendations for improvements. These are attached.

Thank you and the MVE committee for your consideration.

2018 SBCC – R406 code to code savings memo: This document provides a preliminary assessment of the energy code achievement recommended by the TAG. This is based on earlier work submitted with WSEC R23. https://fortress.wa.gov/es/apps/sbcc/File.ashx?cid=8353 It has been modified to reflect the number of credits recommended by the TAG.

R406 carbon emissions details: Further detail on the approach to the development of WSEC-R36 (R406 using carbon emissions). This is a summary of the approach used to assess the carbon impacts of R406 energy credits, and adjust them based on fuel choice.

Normalized Fuel Emissions Credits (revised): Several people have reviewed WSEC-R36 and recommend some modifications to table Table 2 Normalized Fuel Emissions Credits._ This provides more specific descriptions of the systems covered by each row of the credits. For the most part this is editorial. The last row "e" is not editorial. It recommends specific targets not previously considered for "all other" systems. We recommend this as a prudent addition for odd ball systems not covered by a-d. These are typically low efficiency systems that do not fit neatly into any of the other categories. With these changes we have clearly covered all heating system types.

Finally, I would like to make comment on a R406 credit that will not produce energy use reductions. This code change was approved by the TAG. But it will have negative impacts on the energy savings outcomes and will result in lower overall savings of the code package.

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**ATTN:** SBCC and MVE Members

**Subject**: 2018 Residential Energy Code: Modeled Code-to-code Energy Usage

**Date**: June 12, 2018

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The following memo outlines the modeled energy consumption for residential sector (single family detached, townhouses, and low-rise multifamily), using the proposed 2018 residential provisions to the Washington State Energy Code, as passed by the Energy Code TAG on 5/31/2019. This document is meant to highlight the input assumptions, analysis methodology, and sector-wide energy use summaries across multiple code cycles (2006, 2015, and 2018). Each code cycle's analysis is completed from the "ground up", meaning each code year is modeled independently – assumptions on baseline energy use are not carried over from previous analyses.


| | 2006 | 2009 | 2012 | 2015 | 2018 | 2021 | 2024 | 2027 | 2030 |
|---|---|---|---|---|---|---|---|---|---|
| *WA Target: 8.75% Savings/cycle over 2006* | 100% | 91% | 83% | 74% | 65% | 56% | 48% | 39% | 30% |
| *WA Target: 14% Savings over Previous Cycle* | 100% | 86% | 74% | 64% | 55% | 47% | 41% | 35% | 30% |
| ***Modeled Energy Use (Compared to 2006)*** | **100%** | **83%*** | **76%*** | **68%** | **55%** | | | | |

*Values sourced from the *2012 Washington State Energy Code Legislative Report*

## Residential Sector Energy Consumption (WA State Targets vs Modeled)

For each code cycle up through 2030, the SBCC and associated advisory groups are tasked with incrementally bringing Washington's new building sector down to 30% of the baseline energy consumption in 2006. The previous graph summarizes Washington State targets for energy use reduction in residential building sector as set forth in RCW 19.27A, as well as a snapshot of the modeled energy consumption related to each edition of the state energy code.

The trendlines lines (red and blue) show two methods to reaching the target in 2030. Red is a constant decrease in energy consumption while blue compares the savings of each code cycle to the one previous. As the energy consumption of new construction drops over each code cycle, the relative amount of available energy savings drops – meaning the 8.7% energy savings in 2027 will be much more difficult than it was in 2009.

As shown in the previous graph, the modeled energy use associated with the 2018 residential provisions to the Washington State Energy Code, as passed by the Energy Code TAG on 5/31/2019 are shown produce 45% energy savings (or 55% of the energy consumption in 2006). This is shown to be on the aggressive side of our code targets, but as savings become more elusive in the future, it is best to stay on the leading edge. This will help spur market transformation early, instead of playing catch up during later iterations of the code.

## Section R406 Requirements

Besides a few prescriptive requirements of the code, additional energy savings attained in each code cycle are attributed to Section R406. Various combinations of options are selected to meet the requirements listed under Section R406.2. The credit requirements for the 2018 residential energy code, as passed by the TAG are:

1. **Small Dwelling Unit: ............................................4.5 credits**
2. **Medium Dwelling Unit: ....................................... 6.0 credits**
3. **Large Dwelling Unit: ............................................ 7.0 credits**
4. **Dwelling units serving R-2 occupancies: ……………. 4.5 credits**
5. **Additions less than or equal to 500 square feet: …. 1.5 credits**

In addition to changes to the credit requirements, options were added and updated in Table R406.2 to allow more pathways to code compliance. This analysis does not attempt to define optimal pathways through code (i.e. least cost), but instead provides a high-level estimate of the expected energy savings attributed to the 2018 residential energy code. This analysis does not incorporate carbon accounting.

## Methodology and Prototype Development

Four distinct residential building prototypes are used in the SEEM simulations, the selection of building prototypes are standard analytical prototypes used by the Northwest Power Council to develop and evaluate energy forecasts and conservation plans for the region's utilities.

Prototypical representative characteristics include climate, occupancy, house size, ground contact type (slab, crawl, or basement), and heating system type. Distributions of foundation type, heating system, building size, and climate zones are be drawn from regional housing characteristics surveys.[1,2,3] The four different space conditioning systems are modeled in climate zone (Seattle and Spokane) and include:

- Gas Furnace (GFNC)
- Central Heat Pump (HP)
- Gas Furnace with central AC (GFAC)
- Zonal Electric (ZONAL)

| Type | Prototype | Weighting |
|---|---|---|
| **Single-family** | 2688sf with Basement | 11% |
| **Single-family** | 5000sf with Basement | 2% |
| **Single-family** | 1344sf over crawlspace | 13% |
| **Single-family** | 2200sf over crawlspace | 61% |
| **Single-family** | 1344sf on slab | 2% |
| **Single-family** | 2200sf on slab | 11% |
| **Multifamily** | 3x units (820sf each) stacked over crawlspace | 100% |

| Type | Heat/Cool Equip | Weighting |
|---|---|---|
| **Multifamily** | GFAC | 2% |
| **Multifamily** | GFNC | 7% |
| **Multifamily** | HP | 4% |
| **Multifamily** | ZONAL | 87% |
| **Single-family** | GFAC | 30% |
| **Single-family** | GFNC | 53% |
| **Single-family** | HP | 12% |
| **Single-family** | ZONAL | 5% |

## Model Variables: Energy Inputs

The energy end-uses considered in the modeling exercise are all regulated loads, including: space heating, space cooling, ventilation, domestic water heating, and lighting. Plug use and other miscellaneous electric loads are unregulated loads, as there are no explicit conservation measures or targets set for these end-uses. All unregulated load energy usage has been sourced from building stock assessments and have remained constant among different code analysis years.

### Comparison of 2006, 2015 and 2018 Model Inputs

While energy code is the primary driver in managing the energy consumption across the residential sector, other factors such as the minimum federal equipment standards and Washington State law, impact energy savings as well. All these inputs are considered when modeling the residential sector under any given code cycle. The tables below summarize these inputs.

**Table 1**: WSEC Envelope Parameters

| Year | Climate Zone | Window U-Value | Door U-Value | Ceiling Ins | Wall Ins | Floor Ins | Bsmt Wall Ins | Slab Ins |
|---|---|---|---|---|---|---|---|---|
| **2006** | 4C | 0.35 | 0.2 | R-38 std | R-21 std | R-30 | R-19 | R-10 for 2' |
| | 5B | 0.32 | 0.2 | R-38 std | R-19 + 5ci | R-30 | R-19 | R-10 for 2' |
| **2015** | 4C/5B | 0.3 | 0.3 | R-49 std | R-21 int | R-30 | R-21 | R-10 for 2' |
| **2018** | 4C/5B | 0.3 | 0.3 | R-49 std | R-21 int | R-30 | R-21 | R-10 for 2' |

**Table 2**: Ventilation and Lighting

[1] NEEA. (2007). *Single-Family Residential New Construction Characteristics and Practice Study.* RLW Analytics
[2] NEEA. (2007). *Multifamily Residential New Construction Characteristics and Practice Study.* RLW Analytics
[3] NEEA. (2012). *2011 Residential Building Stock Assessment: Single Family Characteristics and Energy use.* Ecotope

| Year | Duct Insulation | Duct leakage (cfm/ft² floor area) | Fan Eff (cfm/W) | Envelope leakage (ACH) | High Efficacy Lighting | Low flow Fixtures? |
|---|---|---|---|---|---|---|
| **2006** | R-8 | 0.12 | 0.86 | 7 | 30%* | NO |
| **2015** | R-8 | 0.04 | 1.4 | 5 | 75% | R406 |
| **2018** | R-8 | 0.04 | 1.4 | 5 | 90% | WA State Law |

**Table 3**: Federal Mechanical System Efficiencies

| Year | Air Conditioner (SEER) | Central Heat Pump (SEER, HSPF) | Gas Furnace | Electric Water Heater | Gas Water Heater |
|---|---|---|---|---|---|
| **2006** | 13 | 13, 7.7 | 78% | 90% | 57% |
| **2015** | 13 | 14, 8.2 | 80% | 94% | 59% |
| **2018** | 13 | 14, 8.2 | 80% | 94% | 59% |

For a comprehensive description of the analytic approach used for modeling the energy consumption of the residential sector, refer to: NEEA. (2019). *2015 Washington State Energy Code: Residential Impact Assessment.*[4]

[4] As retrieved from: https://neea.org/resources/2015-washington-state-energy-code-residential-impact-assessment

# CARBON ACCOUNTING FOR THE RESIDENTIAL OPTION TABLE

WSEC-R36

David Baylon and Chuck Murray

## INTRODUCTION

The Energy TAG reviewed and approved a code change proposal, WSEC-R36, which changed the calculations and structure of the "Option Table" in section R406. This change uses carbon emissions rather than energy use as the basis for setting the values of the savings. In addition, the proposal adds a new table that normalizes the fuel use so that the emissions rates of individual homes can be compared regardless of fuel type. The emission accounting is based on the carbon table passed by the SBCC as part of the revisions to the commercial energy code (C407.3). The purpose of this code change is to introduce the concept of carbon emissions into the WSEC and provide guidance for builders and designers to use this accounting in the selection of component options that would comply.

The Carbon emissions table passed by the SBCC in the Commercial round was a compromise between the anticipated carbon emission rate of electric energy used in the state of Washington using current resources and the potential for increased carbon emissions from load increases that require the use of gas combustion turbines to meet expanded consumption across the entire western region. The values agreed to in this process are shown in Table 1.

**Table 1: Carbon Emissions Factors (C407.3(1))**

| Type | CO2e (#/unit) | Unit | CO2e(#/kwh) |
|---|---|---|---|
| Electricity | 0.7 | kWh | 0.70 |
| Natural Gas | 11.7 | Therm | 0.39 |
| Oil | 19.2 | Gallon | 0.55 |
| Propane | 10.5 | Gallon | 0.47 |
| Other* | 195 | mmBtu | 0.55 |
| On-site renewable energy | 0 | | 0 |

*district heating with distribution losses (site specific)

As can be seen in this table the electric system emissions are taken to be about 70% higher than direct use gas emission rates. This is meant to reflect the possibility that the zero emissions (Clean Energy) plans of both Washington and California will be only partly successful, especially by 2026.

## FUEL EMISSIONS NORMALIZATION:

In the commercial energy code, the emissions table is used as to normalize the fuel used in a particular design option to be compared against emissions in a standard practice (performance path). In developing the residential (R406) proposal, the calculations were changed to CO2 emissions *savings*. The first step is to normalize the fuel selection. This is necessary since the emissions produced by the various base heating systems differ. These differences are not currently addressed in the 2015 option table. However, to regulate emissions the comparison between fuels must reflect the relative emissions of energy delivered by these fuels. Table 2 shows the proposed fuel normalization table from the WSEC-R36 proposal (as revised). This table is designed to normalize the emissions regardless of the initial heating fuel selection. The table uses gas heating as the base. The emissions are calculated using the prototype gas heated home with a standard efficiency gas furnace and DHW and all the mandatory electric loads.  Emissions from other heating system types are then calculated (using the same energy loads). Credits or penalties are then assigned based are based on the relative increase or decrease in emissions from each system type within that prototype compared to the gas heating system. For example, a standard efficiency gas furnace has much less emissions than an electric resistance heating system. When this difference is taken into account the total amount of emissions for the whole house is about 6% higher in the electric case. To normalize this effect the electric home in penalized one credit. In effect, this increases the required credits from the option table by one credit. Conversely if the initial system is a standard efficiency heat pump installed in accordance with the WSEC, the emissions from that system are much lower than a standard gas furnace system. In that event the base system is given one credit which is used to offset the requirements from the option table by a credit.

**Table 2 Normalized Fuel Emissions Credits. (as passed by the TAG)**

| Option | Description | Credits (Single Family) | **Credits (Group R-2, R-3, R-4)** |
|---|---|---|---|
| a | For heating system using Gas furnace with minimum efficiency in accords with federal standards (AFUE 80) | 0 | **N/A** |
| b | For heating system using a heat pump that meets federal standards | 1.0 | **1.0** |
| c | For heating system based on electric resistance only (either forced air or Zonal) | -1.0 | **-1.0** |
| d | For heating system based on electric resistance with a DHP per section R403.7.1 including the exception (either forced air or Zonal) | 0 | **N/A** |

OPTION TABLE:
The option table continues with the whole building energy savings approach used in the past code cycles. In this case, however, the energy use is translated into carbon emissions using Table 1 (above). Each single credit is approximately 6% reduction in whole house emissions. In the case of envelope and ventilation and distribution options (Options 1, 2, and 4) the credits are unchanged. In the case of the heating and DHW options (Options 3 and 5), the credits are recalculated to take the relative emission savings into account. This has the effect of increasing most of the credits associated with high efficiency electric options and reducing credits for the lower efficiency gas DHW options.  Overall these changes result in equivalent energy savings when the overall option credits are included using the carbon emissions.

CARBON EMISSIONS IMPACTS:
The effect of this proposal is to make carbon emissions the primary accounting for achieving the RCW 1927a energy savings goals. It has the effect of incenting the use of high efficiency electric heat pumps over high efficiency gas technologies and penalizing low efficiency electric options against comparable gas technologies. The second effect is to provide a mechanism so that all fuel sources can be compared on an equal footing. This is the goal of the normalization table and it provides a template for future code cycles as electric emissions rates decrease due to an increase in renewable sources. Given the “clean electricity bill” (SB 5116) passed in the 2019 legislative session, this table would be updated as the goals for decarbonization of the electric grid are realized.

**Table 2 Normalized Fuel Emissions Credits**

| Option | ~~Description~~ Base Heating System | Credits (Single Family) | **Credits (Group R-2, R-3, R-4)** |
|---|---|---|---|
| a | Combustion heating equipment meeting minimum federal efficiency standards listed in tables C403.2.3(4) or C403.2.3(5)~~For initial heating system using Gas furnace with minimum efficiency in accords with federal standards (AFUE 80)~~ | 0 | **~~N/A~~ 0** |
| b | For an initial heating system using a heat pump that meets federal standards as listed in table C403.2.3(2). | 1.0 | **1.0** |
| c | For an initial heating system based on electric resistance only. (either forced air or Zonal) | -1.0 | **-0.5** |
| d | For an initial heating system based on electric resistance with a ductless mini-split system ~~DHP~~ per section R403.7.1, including the exception. ~~(either forced air or Zonal)~~ | 0 | **N/A** |
| e | All other heating systems | -1.0 | **-0.5** |

**Discussion, New Credit 4.1 Buried ducts**

As adopted, this provision requires all ducts be located in the attic. This is bad practice and will certainly increase energy use. I recommend that this section not be adopted.

If the M&V committee is compelled to move forward with this proposal, I recommend the modifications below. To gain this credit only the ducts located in the attic will be required to comply with R403.3.7. This will limit but not mitigate my concerns.

I assume this measure will be popular. Adoption of either the will result in lower energy savings achieved by the code improvements. This impact is not reflected in the code achievement assessments presented to date but will have a negative impact on total energy savings in future analysis.

As recommended by the TAG:

All supply and return ducts deeply buried in ceiling insulation in accordance with Section R403.3.7. For mechanical equipment located outside the conditioned space, a maximum of 10 linear feet of return duct and 5 linear feet of supply duct connections to the equipment may be outside the deeply buried insulation. All metallic ducts located outside the conditioned space must have both transverse and longitudinal joints sealed with mastic. If flex ducts are used, they cannot contain splices.

Recommended Modification

All ~~supply and return~~ ducts located in the attic shall be deeply buried in ceiling insulation in accordance with Section R403.3.7. For mechanical equipment located outside the conditioned space, a maximum of 10 linear feet of return duct and 5 linear feet of supply duct connections to the equipment may be outside the deeply buried insulation. All metallic ducts located outside the conditioned space must have both transverse and longitudinal joints sealed with mastic. If flex ducts are used, they cannot contain splices.