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To: Kjell Anderson, Energy TAG Chair

ATTN: Energy Code TAG Members

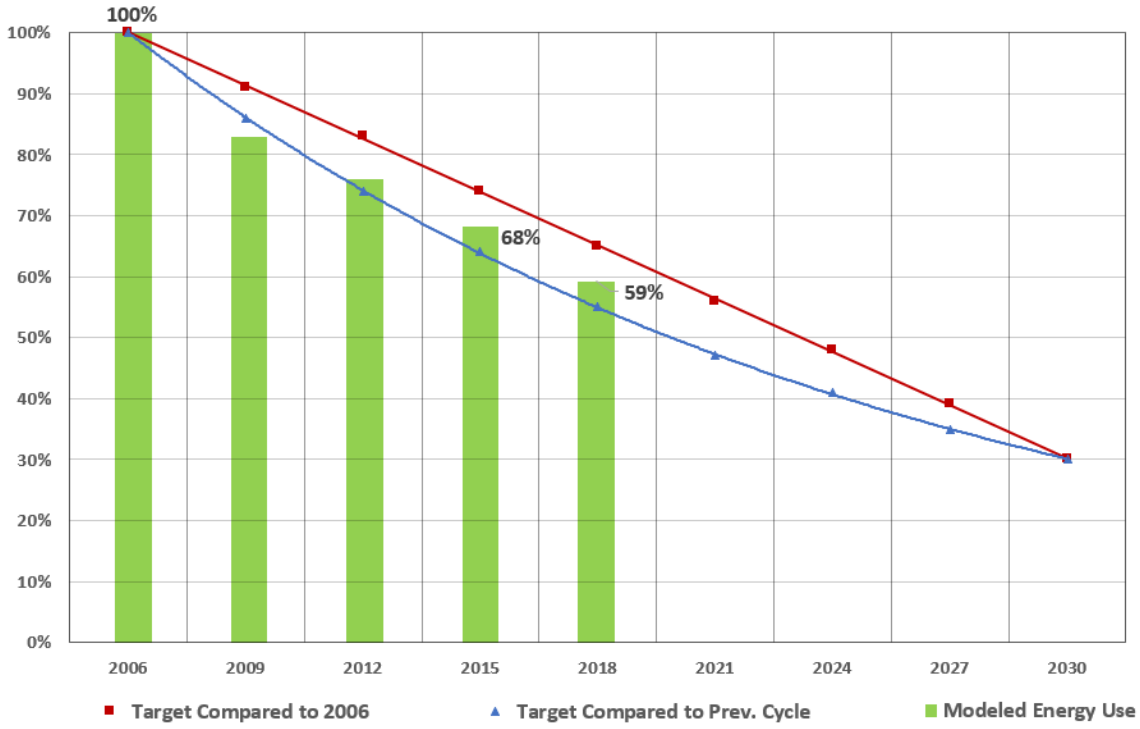
From: Henry Odum, Ecotope

Subject: Residential Energy Code: Baseline Usage of 2006, 2015, and 2018 Code Cycles

Date: May 9, 2018

The following memo outlines Ecotope's analysis for residential provisions to the Washington State Energy Code (WSEC), specifically regarding Proposal 19-WSEC-R23. 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, 2015, 2018 Residential Energy Consumption: RCW 19.27A Targets vs. Modeled



	2006	2009	2012	2015	2018	2021	2024	2027	2030
Target: 8.75% Savings Compared to 2006	100%	91%	83%	74%	65%	56%	48%	39%	30%
Target: 14% Compared to Previous Cycle	100%	86%	74%	64%	55%	47%	41%	35%	30%
Modeled Energy Use (Compared to 2006)	**100%**	**83%***	**76%***	**68%**	**59%****				

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

***Estimated 59% energy savings derived from Proposal 19-WSEC-R23, as submitted on April 15, 2019*

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

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%	YES - WA State Law**

*Not specified in 2006. This value sourced from RBSA

**Included in HB 1444 and therefore removed as an energy code measure. But included in analysis

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%

Section R406

The most substantial difference between the 2006 and 2015/2018 codes is the advent of the option table in 2009. This adds a lot of uncertainty to code analysis studies, such as this. Our methodology to model the average energy consumption of a typical home used a lowest first cost analysis to predict the most utilized options.

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%

These prototypes and associated distributions (weighting) remain constant across each code analysis.

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]

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