STATE OF WASHINGTON

STATE BUILDING CODE COUNCIL

Washington State Energy Code Development

Standard Energy Code Proposal Form

Code being amended: ☐ Commercial Provisions ☒ Residential Provisions

Code Section # R403.5, R405.2, R503.1.3

Brief Description:

This code proposal would require new residential buildings to install heat pump water heaters for domestic hot water heating.

Proposed code change text: (Copy the existing text from the Integrated Draft, linked above, and then use underline for new text and ~~strikeout~~ for text to be deleted.)

Modify the section as follows:

R403.5 Service hot water systems. Energy conservation measures for service hot water systems shall be in accordance with ~~Sections R403.5.1 through R403.5.3~~ this section.

Add new section as follows:

R403.5.4 Heat pump water heating. Service hot water shall be provided by an electric heat pump system. The heat pump water heating system shall be sized to provide 100 percent of peak hot water demand. Where the heat pump is located in unconditioned space, the heat pump water heating system shall be sized to provide 100 percent of peak hot water demand at an entering source dry bulb (or wet bulb if rated for wet bulb temperatures) air temperature of 40°F (4°C).

Exceptions

1. Resistance heating elements integrated into heat pump equipment.
2. Electric water heaters with a rated water storage volume of no greater than 20 gallons.
3. Supplementary water heating systems in accordance with R403.5.4.1, provided the system capacity does not exceed the capacity of the heat pump water heating system.
4. Water heating systems that serve end-uses that require water temperature of 180°F (82°C) or hotter.
5. Solar water heating systems
6. Waste heat and energy recovery systemsHeat trace freeze protection systems.
7. Snow and ice melt systems.
8. Other water heating systems as *approved.*

R403.5.4.1 Supplementary heat for heat pump water heating systems. Heat pumps used for water heating and having supplementary heat shall have controls that limit supplemental heat operation to only those times when one of the following applies:

1. For heat pumps located in unconditioned space, the outside air temperature is below 40°F (4°C)
2. The heat pump is operating in defrost mode.

3. The vapor compression cycle malfunctions or loses power.

Exception: Heat trace temperature maintenance systems, provided the system capacity does not exceed the capacity of the heat pump water heating system.

Modify Table R405.2 as follows:

Systems	
R403.1	Controls
R403.1.2	Heat pump supplemental heat
R403.3.2	Sealing
R403.3.1	Equipment and system sizing
R403.3.3	Duct testing
R403.3.4	Duct leakage
R403.3.5	Building cavities
R403.4	Mechanical system piping insulation
R403.5.1	Heated water circulation and temperature maintenance system
R403.5.4	Heat Pump Water Heating
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt system controls
R403.10	Pool and permanent spa energy consumption
R403.11	Portable spas

Modify the section as follows:

R503.1.3 Service hot water systems. New service hot water systems that are part of the alteration shall comply with Section R403.5.

Exception: Replacements of water heating equipment shall not be required to comply with Section R403.5.4 where the rated capacity of the new equipment does not exceed the rated capacity of the existing equipment.

Purpose of code change:

Requiring water heating to be all-electric eliminates a significant source of fossil fuel combustion in buildings, and is generally 2-4x more energy efficient than either fossil fuel or electric resistance heating. This proposal aligns with State policy to increase energy efficiency by 70% by 2031. Additionally, this proposal will significantly reduce emissions and is aligned with State policy to achieve the broader goal of building zero fossil-fuel greenhouse gas emission homes and buildings by the year 2031. According to analysis done using data from the 2021 Washington State Energy Strategy, we need to reduce the commercial buildings sector emissions by 44% to keep on track to meet our 2050 climate goals. he State also needs to increase the proportion of annual sales of heat pumps from 0.4% of all residential water heating equipment in 2020 to 55% by 2030, a growth of 130x. To get to this increase in market penetration of heat pumps, the Washington State Energy Code should require all residential water heating to be all-electric in the 2021 code cycle. See Supplemental Attachment for further details on economics, emissions reduction and market penetration.

What the proposal does:

The proposal adds a new section that requires that water heating be provided by electric heat pump equipment. It includes key exceptions to foster flexibility, usability and enforceability:

- It exempts electric resistance water heaters with storage tanks smaller than 20 gallons since there are no heat pump models available for these small sizes. A typical 30 gallon electric resistance water heater would generally be replaced by a 40 gallon heat pump water heater (HPWH), so these are not exempted. This exemption would also exempt point-of-use electric water heaters. While it is conceivable that a project could choose a very large electric resistance point-of-use water heater instead of a HPWH, the electrical capacity and cost implications of this decision make it unlikely enough on practical terms that it does not need to be addressed.
- It is explicit that the resistance heating elements that are integrated into HPWHs, solar thermal systems, waste heat and energy recovery systems, freeze protection systems and snow and ice melt systems are not impacted by this new language. Some of these exceptions are not strictly necessary, but they have been included to improve the clarity and usability of the code.
- It allows supplementary heat in accordance with a new water heating supplementary heat section discussed below.

The proposal adds a new section for supplementary water heating that is modeled on the existing section for supplementary space heating for heat pumps in the model IECC and adapted for the specifics of HPs used for water heating.

The proposal then has language in section R503 to ensure that these requirements would not apply to simple equipment replacements. The exception is configured so that it is only available when new equipment is the same size as the equipment being replaced. This ensures that the new requirements will not trigger an electrification retrofit for equipment replacement unless it is a major system reconfiguration with a larger piece of equipment.

This proposal does not impact larger, more complex systems that serve multiple dwelling units since those systems are already referred to the commercial section of the code by R403.8.

Your amendment must meet one of the following criteria. Select at least one:

☐ Addresses a critical life/safety need.

☐ The amendment clarifies the intent or application of the code.

☒ Addresses a specific state policy or statute.
(Note that energy conservation is a state policy)

☐ Consistency with state or federal regulations.

☐ Addresses a unique character of the state.

☐ Corrects errors and omissions.

Check the building types that would be impacted by your code change:

☒ Single family/duplex/townhome	☐ Multi-family 4 + stories	☐ Institutional
☒ Multi-family 1 – 3 stories	☐ Commercial / Retail	☐ Industrial

Your name	Sean Denniston	Email address	sean@newbuildings.org
Your organization	NBI	Phone number	503-481-7253
Other contact name	Click here to enter text.		

Economic Impact Data Sheet

Is there an economic impact: ☒ Yes ☐ No

Briefly summarize your proposal's primary economic impacts and benefits to building owners, tenants, and businesses. If you answered "No" above, explain your reasoning.

Construction costs for heat pump water heaters are often, but not always, higher than for conventional natural gas or electric resistance water heaters. When eliminating the cost of gas infrastructure running to the building and the cost of a separate air conditioner for space cooling, all-electric homes are generally less expensive than mixed fuel homes. Annual energy costs for heat pump water heaters are much lower than for electric resistance heating, but comparable with gas heating, at current rates (World Bank long term forecasts indicate an increase of over 80% in gas prices over the coming decade.) When including the Washington State social cost of carbon, heat pump water heating is more cost effective than both gas water heating and electric resistance water heating over the life cycle analysis horizon.

Given the state's climate goals and policy, this Energy Code proposal will help ensure new assets permitted beginning July 1, 2023 will not need to be immediately retrofitted.

Provide your best estimate of the **construction cost** (or cost savings) of your code change proposal? (See OFM Life Cycle Cost **Analysis tool** and **Instructions:** use these **Inputs**. **Webinars on the tool can be found Here and Here**)

Upfront cost savings is -$0.27/ sq ft or -$646 per home. Note that negative savings means it has a cost.

The life cycle cost savings, not including the social cost of carbon, is -$0.28/ sq ft or -$674 per home.

The life cycle cost savings, including the social cost of carbon, is $0.42/ sq ft or $1,016 per home.

Show calculations here, and list sources for costs/savings, or attach backup data pages

See attached supplemental.

Provide your best estimate of the **annual energy savings** (or additional energy use) for your code change proposal?

Annual energy savings of 3.2 kBTU/ sq ft

Annual energy savings of 7,680 kBTU per home

(For residential projects, also provide Click here to enter text.KWH/KBTU / dwelling unit)

Show calculations here, and list sources for energy savings estimates, or attach backup data pages

List any **code enforcement** time for additional plan review or inspections that your proposal will require, in hours per permit application:

Instructions: Send this form as an email attachment, along with any other documentation available, to: sbcc@des.wa.gov. For further information, call the State Building Code Council at 360-407-9255.

All questions must be answered to be considered complete. Incomplete proposals will not be accepted.

- No increase in plan review or inspection time.

Small Business Impact. Describe economic impacts to small businesses:

No impact on small businesses, since this is the residential code.

Housing Affordability. Describe economic impacts on housing affordability:

Small impact on housing affordability if the builder decides to not build all-electric which would save them money.

Other. Describe other qualitative cost and benefits to owners, to occupants, to the public, to the environment, and to other stakeholders that have not yet been discussed:

Improve air quality and reduce greenhouse gas emissions.

Instructions: Send this form as an email attachment, along with any other documentation available, to: sbcc@des.wa.gov. For further information, call the State Building Code Council at 360-407-9255.

All questions must be answered to be considered complete. Incomplete proposals will not be accepted.

Office of Financial Management
Olympia, Washington - Version: 2020-A
Life Cycle Cost Analysis Tool

Executive Report

Project Information	
Project:	
Address:	N/A, N/A, N/A
Company:	RMI
Contact:	Jonny Kocher
Contact Phone:	
Contact Email:	jkocher@rmi.org

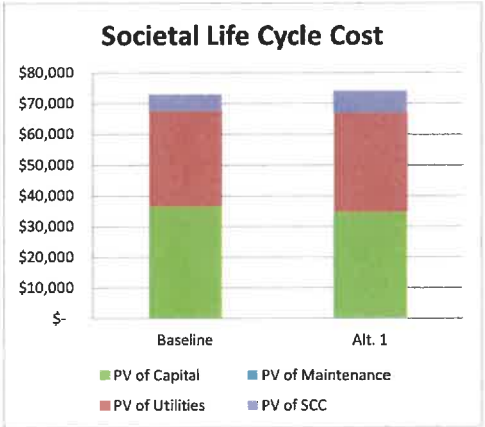
Key Analysis Variables		Building Characteristics
Study Period (years)	50	Gross (Sq.Ft)
Nominal Discount Rate	5.00%	Useable (Sq.Ft)
Maintenance Escalation	1.00%	Space Efficiency
Zero Year (Current Year)	2022	Project Phase
Construction Years	0	Building Type

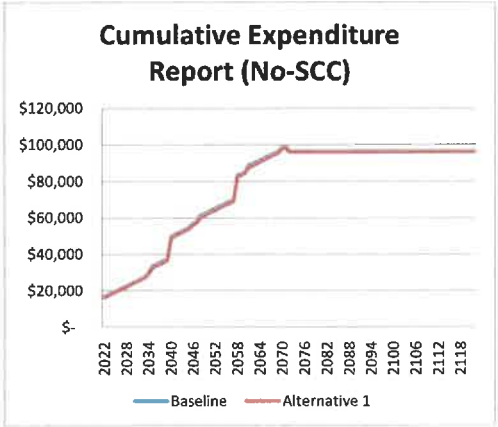
Life Cycle Cost Analysis		BEST
Alternative	Baseline	Alt. 1
Energy Use Intenstity (kBtu/sq.ft)	21.2	24.4
1st Construction Costs	$ 17,057	$ 16,411
PV of Capital Costs	$ 36,563	$ 34,752
PV of Maintenance Costs	$ -	$ -
PV of Utility Costs	$ 31,182	$ 32,319
Total Life Cycle Cost (LCC)	**$ 67,745**	**$ 67,071**
Net Present Savings (NPS)	**N/A**	**$ 674**

Societal LCC takes into consideration the social cost of carbon dioxide emissions caused by operational energy consumption

(GHG) Social Life Cycle Cost	BEST	
GHG Impact from Utility Consumption	Baseline	Alt. 1
Tons of CO2e over Study Period	81	108
% CO2e Reduction vs. Baseline	N/A	-32%
Present Social Cost of Carbon (SCC)	$ 5,502	$ 7,191
Total LCC with SCC	**$ 73,247**	**$ 74,263**
NPS with SCC	**N/A**	**$ (1,016)**

Warning: OFM Assigned Variables Not Used





Baseline Short Description
Heat Pump Water Heating Home
Alternative 1 Short Description
Mixed-Fuel Home

Life Cycle Cost Analysis				
Alternative	**Mixed-fuel Building (Baseline)**	**All-Electric Building Proposal**	**Heat Pump Water Heating Proposal**	**Heat Pump Space Heating Proposal**
Energy Use Intenstity (kBtu/sq.ft)	24.4	15.0	21.2	18.9
% Energy Reduction	N/A	39%	13%	22%
1st Construction Costs	$ 16,411	$ 13,402	$ 17,057	$ 13,686
PV of Capital Costs	$ 34,752	$ 32,318	$ 36,563	$ 28,959
PV of Utility Costs	$ 32,319	$ 28,890	$ 31,182	$ 29,920
Total Life Cycle Cost (LCC)	**$ 67,071**	**$ 61,208**	**$ 67,745**	**$ 58,879**
Net Present Savings (NPS)	**N/A**	**$ 5,864**	**$ (674)**	**$ 8,192**
Tons of CO2e over Study Period	108	30	81	64
% CO2e Reduction vs. Baseline	N/A	72%	25%	40%
Present Social Cost of Carbon (SCC)	$ 7,191	$ 2,242	$ 5,502	$ 4,410
Total LCC with SCC	**$ 74,263**	**$ 63,450**	**$ 73,247**	**$ 63,288**
NPS with SCC	**N/A**	**$ 10,813**	**$ 1,016**	**$ 10,974**

Energy Analysis:

	Site Energy Use (MMBtu/yr)			
End Use	**Mixed-fuel Building**	**All-Electric Building**	**Heat Pump Water Heating***	**Heat Pump Space Heating***
Misc. (E)	9.1	9.1	9.1	9.1
Vent Fan (E)	2	2	2	2
Lg. Appl. (E)	6.5	8.06	6.5	6.5
Lights (E)	6.77	6.77	6.77	6.77
Cooling Fan/Pump (E)	0.39	0.08	0.39	0.08
Heating Fan/Pump (E)	0.53	0.15	0.53	0.15
Cooling (E)	0.98	0.73	0.98	0.73
Heating (E)	0	5.58	0	5.58
Heating (G)	17.78	0	17.78	0
Hot Water (E)	0.15	2.88	2.88	0.15
Hot Water, Suppl. (E)	0	0.56	0.56	0
Hot Water (G)	10.97	0	0	10.97
Lg. Appl. (G)	3.33	0	3.33	3.33
Total	58.5	35.9	50.82	45.36

* All-Electric Space and Water Heating Scenario's end uses were estiamted from All-Electric Results. Future modeled results will be provided during the TAG process

	Site Energy Use (MMBtu/yr)			
Fuel	**Mixed-fuel Building**	**All-Electric Building**	**Heat Pump Water Heating**	**Heat Pump Space Heating**
Electricity	26.4	35.9	29.7	31.1
Natural gas	32.1	0.0	21.1	14.3
Total	58.5	35.9	50.8	45.4

	Site Energy Use			
Fuel	**Mixed-fuel Building**	**All-Electric Building**	**Heat Pump Water Heating**	**Heat Pump Space Heating**
Electricity (kWh)	7,743	10,524	8,707	9,103
Natural gas (therms)	321	-	211	143

	Utility Costs (Electricity Rate = $0.0856/kWh & Gas Rate = $0.818/therm)			
Fuel	**Mixed-fuel Building**	**All-Electric Building**	**Heat Pump Water Heating**	**Heat Pump Space Heating**
Electricity (kWh)	$ 662.80	$ 900.87	$ 745.33	$ 779.20
Natural gas (therms)	$ 262.48	$ -	$ 172.72	$ 117.00

Energy analysis completed by RMI

Cost Data:

City	Building	Retrofit/NewCon	Appliance Family	Appliance	G/E	Total Costs	Source
Seattle	Single family	New Construction	Gas Connection	new gas connection	Gas Baseline	$2,164	RMI EEB v2
Seattle	Single family	New Construction	Air Conditioner	air conditioner - 2ton	Gas Baseline	$6,536	RMI EEB v2
Seattle	Single family	New Construction	ASHP	multi-zone heat pump HVAC - low capacity	Electric	$8,477	RMI EEB v2
Seattle	Single family	New Construction	Gas Furnace	new gas furnace - 80k BTU	Gas Baseline	$4,666	RMI EEB v2
Seattle	Single family	New Construction	Gas Stove	gas stove 2	Gas Baseline	$1,151	RMI EEB v2
Seattle	Single family	New Construction	Gas Water Heater	gas water heater 1	Gas Baseline	$1,894	RMI Heat Pumps for Hot Water
Seattle	Single family	New Construction	HP Water Heater	heat pump water heater 1	Electric	$3,028	RMI Heat Pumps for Hot Water
Seattle	Single family	New Construction	Induction Stove	induction stove 1	Electric	$2,385	RMI EEB v2

Equipment Lifetimes:

Equipment	Equipment Lifetime*
Heat Pump	18
Gas Fired Furnace	18
Cental AC	18
Gas Water Heater	13
Heat Pump Water Heater	13
Cookstove	12

* https://www.eia.gov/analysis/studies/buildings/equipcosts/pdf/appendix-a.pdf

Total Gross Emissions: Reference vs Electrification Scenarios

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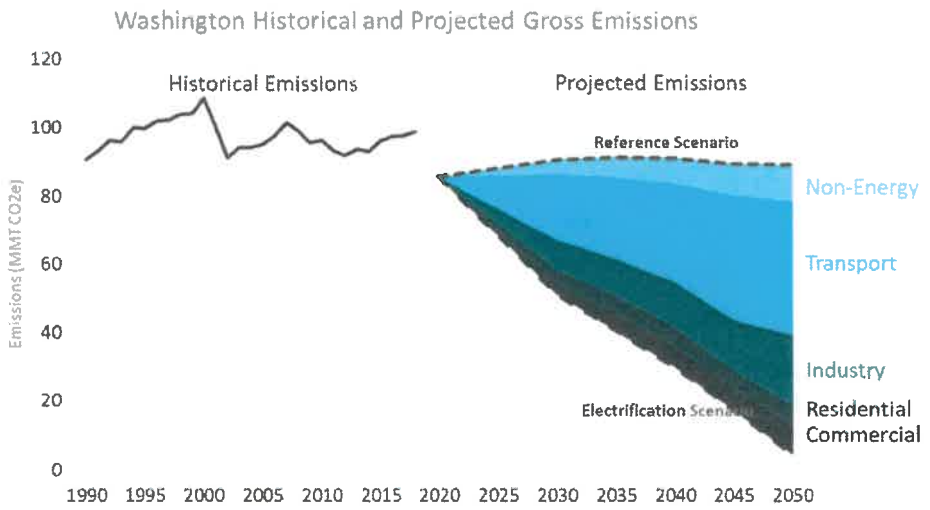
		Emissions (MMT CO2e)
Year	Scenario	Residential
2020	Reference	11.4
2030	Reference	9.0
2035	Reference	9.0
2040	Reference	8.1
2045	Reference	6.9
2050	Reference	6.5
2020	Electrification	10.2
2030	Electrification	5.0
2035	Electrification	3.7
2040	Electrification	2.6
2045	Electrification	1.8
2050	Electrification	0.5



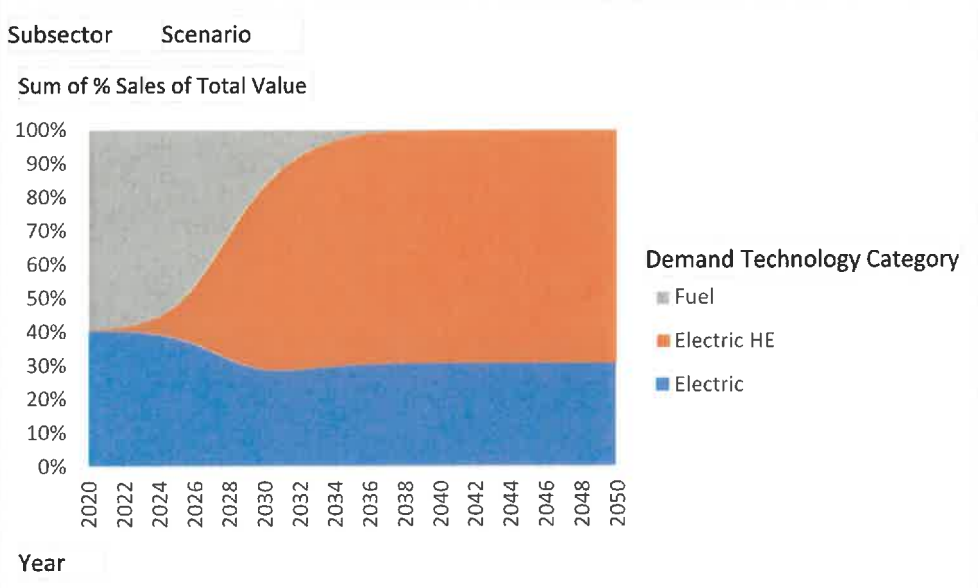
	% reduction in Residential Building emissions required by target year in Electrification Scenario
2030	51%
2035	64%
2040	75%
2045	83%
2050	95%

Required % Sales of Residental Heat Pump Water Heaters to be Aligned with the Electrification Scenario

Subsector	residential water heating
Scenario	Electrification

Sum of % Sales of Total Value	Column Labels		
Row Labels	**Electric**	**Electric HE**	**Fuel**
2020	40.5%	0.4%	59.1%
2021	40.4%	0.8%	58.8%
2022	40.2%	1.6%	58.3%
2023	39.8%	3.0%	57.2%
2024	39.2%	5.6%	55.2%
2025	38.1%	10.1%	51.8%
2026	36.4%	17.2%	46.4%
2027	34.2%	26.7%	39.1%
2028	31.8%	37.4%	30.8%
2029	29.9%	47.2%	23.0%
2030	28.7%	54.8%	16.5%

Growth from 2020 to 2030 = 130.2 x



Required % Sales of Residental Heat Pump Space Heaters to be Aligned with the Electrificatic

Subsector	residential space heating
Scenario	Electrification

Sum of % Sales of Total Value	Column Labels		
Row Labels	Electric	Electric HE	Fuel
2020	42.7%	20.6%	36.8%
2021	42.6%	20.7%	36.7%
2022	42.7%	20.9%	36.5%
2023	42.6%	21.3%	36.1%
2024	42.5%	22.1%	35.4%
2025	42.5%	23.3%	34.2%
2026	42.4%	25.3%	32.3%
2027	42.2%	28.1%	29.7%
2028	41.7%	31.5%	26.8%
2029	40.8%	35.2%	24.0%
2030	39.4%	38.9%	21.6%