

▾  
**Multifamily Mash-up  
2021 WSEC Commercial &  
Residential Comparison**



**WASHINGTON STATE  
UNIVERSITY**



Evergreen Technology Consulting  
**Energy Code Services**

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**Multifamily Mash-up  
2021 WSEC Commercial &  
Residential Comparison**

Jonathan Jones & Rick Blumenthal, WSU Energy Extension  
(360) 956-2042 | [energycode@energy.wsu.edu](mailto:energycode@energy.wsu.edu)

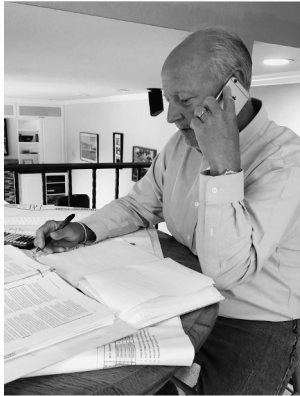
Lisa Rosenow, Evergreen Technology Consulting  
Duane Lewellen, Lewellen Associates  
(360) 539-5300 | [com.techsupport@waenergycodes.com](mailto:com.techsupport@waenergycodes.com)



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# WSEC Commercial Technical Support

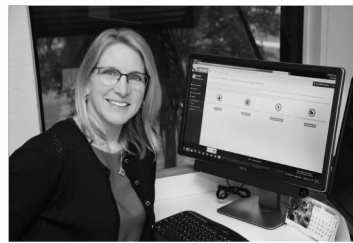


Duane Lewellen,  
Lewellen Associates

- On-call technical support thru 3 avenues
  - Telephone hot line – **360-539-5300**
  - Online form – <https://www.waenergycodes.com>
  - Email inquiries – [com.techsupport@waenergycodes.com](mailto:com.techsupport@waenergycodes.com)
- Classroom and webinar training
- We administer the technical support and compliance documentation webtool



Chris Haas, PE



Lisa Rosenow



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## Increasing progressive effectiveness of energy codes

The NEEA Codes and Standards program supports regional stakeholders in the development and adoption, training and implementation of energy codes. States engage in the code development process along different cycles and code versions, but all states now use the International Energy Conservation Code (IECC) as a baseline for their commercial energy codes. All states except Oregon now use the IECC as the basis of their residential code. The adoption of codes is the responsibility of state code boards or agencies. Official state-by-state energy code information can be found on state building code websites:

- Idaho - <http://dbs.idaho.gov/boards/index.html>
- Oregon - <http://www.cds.state.or.us/external/bcd/>
- Washington - <https://sbcc.wa.gov/>
- Montana - <http://svc.mt.gov/boards/>



Idaho

David Freelove, Idaho Circuit Rider  
[davidfreelove@yahoo.com](mailto:davidfreelove@yahoo.com)



Montana

Carl Little [carl@necat.org](mailto:carl@necat.org) or Paul  
[Tschida\\_pschida@mt.gov](mailto:Tschida_pschida@mt.gov)



Oregon

Residential: Roger Kainu  
[roger.kainu@state.or.us](mailto:roger.kainu@state.or.us) or  
Commercial: Blake Sheldie  
[blake.sheldie@state.or.us](mailto:blake.sheldie@state.or.us)



Washington

Residential:  
[energycode@energy.wa.edu](mailto:energycode@energy.wa.edu)  
Commercial:  
[com.techsupport@waenergycodes.com](mailto:com.techsupport@waenergycodes.com)

**WSEC technical support services are made possible thanks to the generous support of the Northwest Energy Efficiency Alliance**

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## Today's Presentation

- This presentation represents ETC's **unofficial** interpretation of WA State Energy Code intent.
- Our technical support team is not an affiliate, nor do we speak for the Washington State Building Code Council (SBCC).
- The WSEC commercial technical support we provide is advisory only and non-binding.



### **WSEC Commercial Technical Support Team:**

Duane Lewellen – Lewellen Associates, LLC

Lisa Rosenow - Evergreen Technology Consulting (ETC)

(360) 539-5300|com.techsupport@waenergycodes.com

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## Current Status of the 2021 WSEC-C

### **Effective date of all 2021 WA State Codes is March 15, 2024**

- The Washington State Building Code Council (SBCC) conducted the rulemaking process to modify the 2021 WSEC-C and 2021 WSEC-R to address legal uncertainty stemming from the decision in California Restaurant Association v. City of Berkeley, issued by the Ninth Circuit Court of Appeals.
- The updated 2021 WSEC-C 2<sup>nd</sup> Edition has been posted on the SBCC website under "State Codes, Regulations & Guidelines." January 2024
- Follow the Washington State Building Council <https://www.sbcc.wa.gov/> for the latest news or to participate in the code development process.



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## Topics we'll discuss today for Commercial Multifamily ~

1. Residential definition
2. Building thermal envelope performance
3. Building enclosure air leakage testing
4. Additional energy efficiency & load management measures
5. Prescriptive and Fossil Fuel Compliance Paths for space heating and service water heating (SWH)
6. Space heating & cooling equipment types and requirements in multifamily
7. Multifamily building ventilation
8. SWH equipment types and requirements in multifamily
9. Renewable energy and solar readiness



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## Residential Building Definition

### 2021 WSEC-R DEFINITION

**RESIDENTIAL BUILDING.** For this code, the following building types are residential buildings:

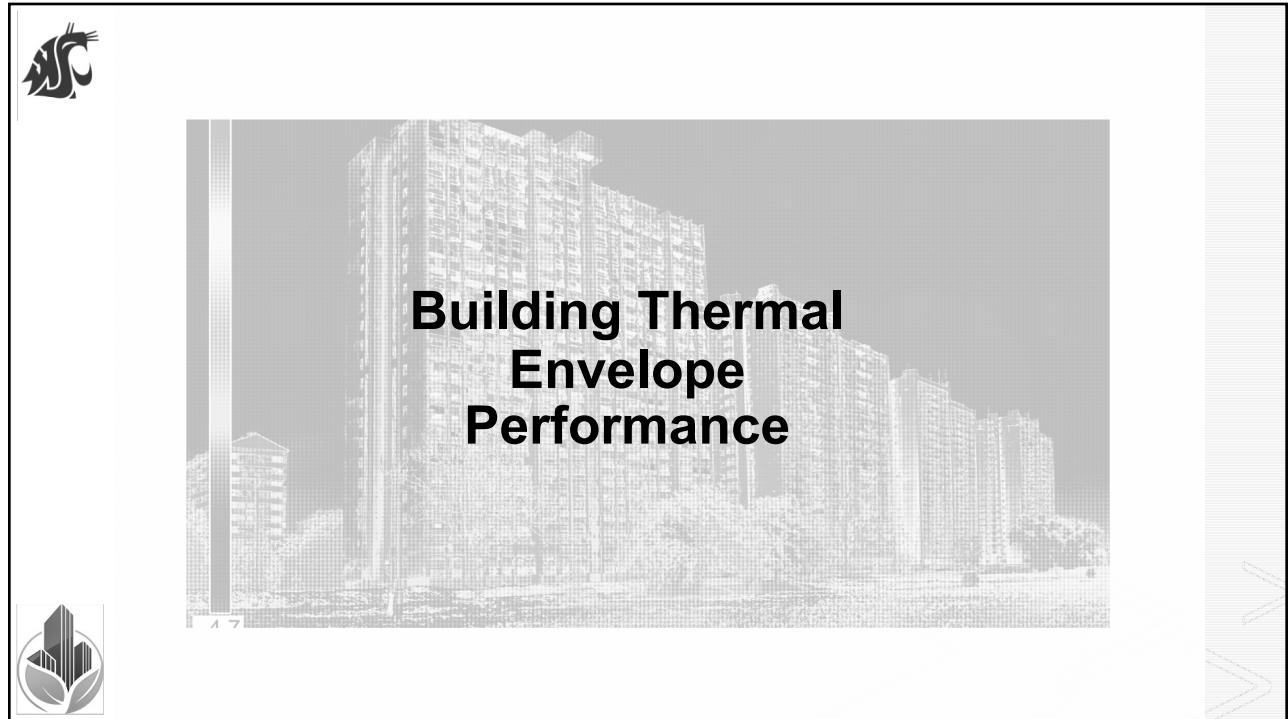
1. Detached one- and two-family dwellings.
2. Multiple single-family dwellings (townhouses).
3. Group R-2 and R-3 occupancy areas in buildings three stories or less in height above grade plane whose dwelling units are **accessed directly from the exterior**.
4. Accessory structures to residential buildings.

**BOTTOM LINE** - All Group R-2 multi-family buildings less than 4 stories **where dwelling units are accessed from interior corridors or other spaces** (i.e. interior lobby) are no longer within the scope of the WSEC-Residential. Shall now meet all applicable requirements of the **WSEC-Commercial**.



C202

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### 2021 WSEC-C - Roofs & Walls

**Table C402.1.3 - R-Value Method**

CLIMATE ZONE	5 AND MARINE 4	
	All Other	Group R
<b>Roofs</b>		
Insulation entirely above deck	R-38ci	R-38ci
Metal buildings	R-25 + <del>R-11</del> <b>R-22</b> LS	R-25 + <del>R-11</del> <b>R-22</b> LS
Attic and other	R-49	R-49
<b>Walls, Above Grade</b>		
Mass	R-9.5ci	R-13.3ci
Mass transfer deck slab	<b>R-5</b>	<b>R-5</b>
Metal buildings	<del>R-19ci or</del> <del>R-13 + R-13ci</del> <b>R-13 + R-14ci</b>	<del>R-19ci or</del> <del>R-13 + R-13ci</del> <b>R-13 + R-14ci</b>
Steel framed	R-13 + R-10ci	R-19 + R-8.5ci
Wood framed and other	<del>R-21 int or R-15</del> <del>+ R-5ci std</del> <b>R-13 + R-7.5ci</b> <b>std or R-20 +</b> <b>R-3.8ci std</b>	R-13 + R-7.5ci std or R-20 + R-3.8ci std or R-25 std

**Table C402.1.4 - U-Factor Method**

CLIMATE ZONE	5 AND MARINE 4	
	All Other	Group R
<b>Roofs</b>		
Insulation entirely above deck	U-0.027	U-0.027
Metal buildings	U-0.031	U-0.031
Attic and other	U-0.021	U-0.021
Joist or single rafter	U-0.027	U-0.027
<b>Walls, Above Grade</b>		
Mass	U-0.104	U-0.078
Mass transfer deck slab	U-0.20	U-0.20
Metal buildings	<del>U-0.052</del> <b>U-0.050</b>	<del>U-0.052</del> <b>U-0.050</b>
Steel framed	U-0.055	U-0.055
Wood framed and other	<del>U-0.054</del> <b>U-0.051</b>	U-0.051

Insulation requirements for below grade walls are the same as for above grade walls

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## Mechanical Equipment with Through-Wall Penetrations

**INTENT** – Reduce the impact of mechanical equipment through wall penetrations on overall building envelope thermal performance

If total area of penetrations **exceeds 1%** of the above-grade wall area ~

- Mechanical equipment penetrations area shall be assigned a default U-factor of U-0.5
- Penetration area U-factor shall be area-weighted with the opaque above-grade wall area
- Calculate the resulting overall effective wall U-factor for prescriptive or component performance compliance



Table C402.1.4, Footnote k  
C402.1.4.3



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## Mechanical Equipment with Through-Wall Penetrations

- **Sample Area-Weighted Wall Assembly Calculation**
    - Percent area of mechanical equipment penetrations = **2%**
    - Mechanical equipment penetrations default U-factor = **U-0.5**
    - Wood-framed wall prescriptive U-factor = **U-0.051**
- Area-weighted U-factor =  $(0.5 * 0.02) + (0.051 * 0.98) = U-0.060$**

Other elements of the building envelope will require better than code performance to make up the delta



Table C402.1.4, Footnote k  
C402.1.4.3

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## 2021 WSEC-C - Floors & Opaque Doors

**Table C402.1.3 - R-Value Method**

CLIMATE ZONE	5 AND MARINE 4	
	All Other	Group R
<b>Floors</b>		
Mass	R-30ci	R-30ci
Joist/Framing	R-30	R-30
Steel floor joist system	R-38 + R-10ci	R-38 + R-10ci
<b>Slab-on-Grade Floors</b>		
Unheated slabs	R-10 for 24" below	R-10 for 24" below
Heated slabs	R-10 perimeter & under entire slab	R-10 perimeter & under entire slab
<b>Opaque Doors</b>		
Non swinging	R-4.75	R-4.75

**Table C402.1.4 - U-Factor Method**

CLIMATE ZONE	5 AND MARINE 4	
	All Other	Group R
<b>Floors</b>		
Mass	U-0.031	U-0.031
Joist/Framing	U-0.029	U-0.029
<b>Slab-on-Grade Floors</b>		
Unheated slabs	F-0.54	F-0.54
Heated slabs	F-0.55	F-0.55
<b>Opaque Doors</b>		
Non-swinging door	U-0.34 <u>U-0.31</u>	U-0.34 <u>U-0.31</u>
Swinging door	U-0.37	U-0.37
Garage door < 14% glazing	U-0.31	U-0.31
<u>Garage door ≥ 14% &amp; ≥ 25% single row glazing</u>	<u>U-0.44</u>	<u>U-0.44</u>
<u>Garage door ≥ 14% &amp; ≤ 50% glazing</u>	<u>U-0.34</u>	<u>U-0.34</u>

All doors with > 50% glazed area are defined as Fenestration



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## 2021 WSEC-C – Vertical Fenestration

- Class AW Rated fenestration values have been lowered (more stringent)
- New category for operable or mulled windows with fixed and operable sections
- SHGCs no longer based on orientation, now divided by fixed versus operable fenestration

**Table C402.4 - U-Factor & SHGC**

CLIMATE ZONE	5 AND MARINE 4	
<b>U-Factor for Class AW rated in accordance with AAMA/CSA101/1.S.2/A440, vertical curtain walls and site-built fenestration products</b>		
Fixed U-factor	U-0.38 <u>U-0.34</u>	
Operable U-factor	U-0.40 <u>U-0.36</u>	
<b>Entrance doors</b>		
U-factor	U-0.60	
<b>U-factor for all other vertical fenestration</b>		
Fixed U-factor	U-0.30 <u>U-0.26</u>	
<u>Operable or mulled windows with fixed and operable sections U-factor</u>	<u>U-0.28</u>	
<b>SHGC for all vertical fenestration</b>		
<b>Orientation</b>	<b>SEW</b>	<b>N</b>
	<b>Fixed</b>	<b>Operable</b>
PF < 0.2	0.38	<del>0.51</del> <u>0.33</u>
0.2 ≤ PF < 0.5	0.46	<del>0.56</del> <u>0.40</u>
PF ≥ 0.5	0.61	<del>0.61</del> <u>0.53</u>
<b>Skylights</b>		
U-factor	U-0.50	
SHGC	0.35	

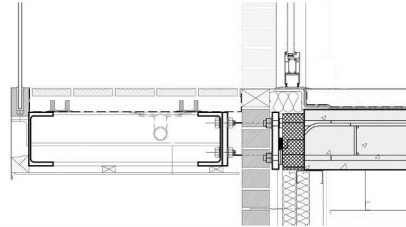


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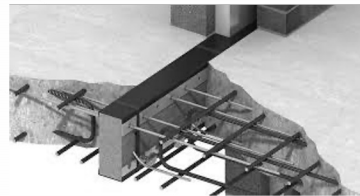


## Decks & Balconies

The thermal bridge at each balcony or deck can cause substantial heat loss, unless a thermal break is provided



### SOLUTIONS



C402.2.8

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## Decks & Balconies

### C402.2.8 Above grade exterior concrete slabs

- Decks, balconies and other above-grade slabs shall have a minimum **R-10 thermal break** aligned with the primary insulating layer in the adjoining wall assemblies
- Stainless steel reinforcing bars are permitted to penetrate the thermal break without penalty
- Where the thermal break does not comply with these requirements:
  - Above-grade exterior concrete slab shall be assigned an exposed concrete default U-factor from **Table A103.3.7.2 Peripheral Edges of Intermediate Concrete Floors**
  - R-value of exterior concrete slabs shall be area-weighted with the adjacent wall assemblies for code compliance

C402.2.8

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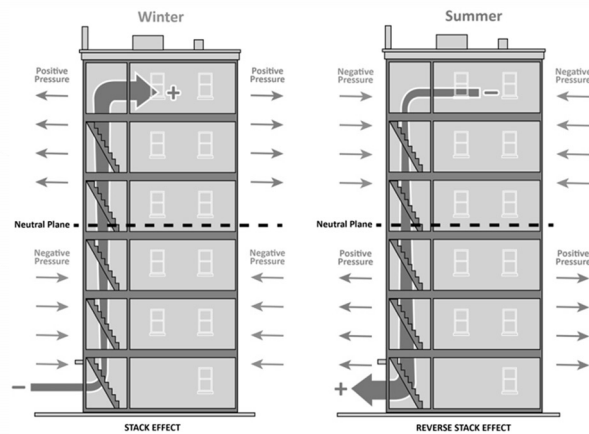
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## Air Barrier Durability

### Air barrier construction

- Sealing at joints, seams, penetrations and between different air barrier materials
- Allow for expansion and contraction from wind, stack affect, building pressurization and from mechanical vibration



C402.5.1.1

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## Building Enclosure Air Leakage Test Criteria

- Testing criteria per one of the following standards:
  - ASTM E779
  - ANSI/RESNET/ICC 380
  - ASTM E3158
  - ASTM E1827
  - Alternative method approved by the code official



Image courtesy of Neudorfer Engineers

Report that demonstrates a **passing result of the air leakage test** shall be provided to the Code Official and building owner

C402.5.2  
C402.5.3



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## Building Enclosure Air Leakage Test Procedures

### Test procedures defined in the 2021 WSEC-C

- **Standard whole building test** – Measured air leakage shall not exceed **0.25 cfm/SF** of the building envelope thermal area at a test pressure differential of 0.3 inch wg (75 Pa)
- **Weighted average test** – Portions of the building are tested and the measured air leakage results are area-weighted. Resulting area-weighted value shall not exceed 0.25 cfm/SF at 0.3 inch wg (75 Pa).
- **Building test for mixed-use buildings with central corridor dwelling unit access** – Comply in the same manner as all other commercial occupancies, regardless of building height



C402.5.3

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## Building Enclosure Air Leakage Test Procedures

### 2021 WSEC-C test procedures for buildings where dwelling/sleeping units are accessed directly from the outdoors

- **Weighted average test of dwelling/sleeping units** – Each unit shall be tested separately with an un-guarded blower door test. Test results of all units shall be area-weighted. Resulting area-weighted value **shall not exceed 0.25 cfm/SF at 0.2 inch wg (50 Pa)**.
- **Two options for mixed use buildings** – For buildings 3 stories or less above grade, the Group R-2 / R-3 areas are permitted to be tested separately from the commercial areas using the residential test procedure per the **2021 WSEC-R Section R402.4.1.2**, or test the whole building per a 2021 WSEC-C test procedure.



C402.5.2  
C402.5.4

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## What if the building initially fails the building enclosure test?



If measured or weighted-average air leakage rate **exceeds 0.25 cfm/SF....**

- Conduct inspection of all air barrier elements
- Corrective action shall be taken to seal leaks in the air barrier
- **Must RE-TEST and continue corrective actions until the building passes the 0.25 cfm/SF maximum allowed leakage rate**
- A resulting failed test after corrective actions is no longer permitted under the 2021 WSEC-C



C402.5.2  
C402.5.3

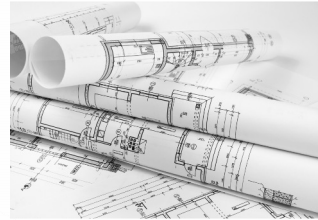
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## Plan Review & Field Inspection

### What to look for during plan review?

- Verify a **continuous air barrier boundary** is included in the project documents
- Confirm Architect of Record has calculated the total SF area of the air barrier boundary, which is used for testing calculations
- Confirm building enclosure air leakage testing and the requirement to pass the test is **included in the general project scope of work**



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## Plan Review & Field Inspection

### What to look for during field inspection?

- Verify presence of air barrier materials in envelope assembly - **too often not installed at all**
- Inspect for continuity
  - Air barrier material **transitions** are sealed
  - **Penetrations** by trades in the air barrier are sealed
- **Request building enclosure air leakage test results** that includes tested surface area and floor area, and resulting measured air leakage rate and test pressure



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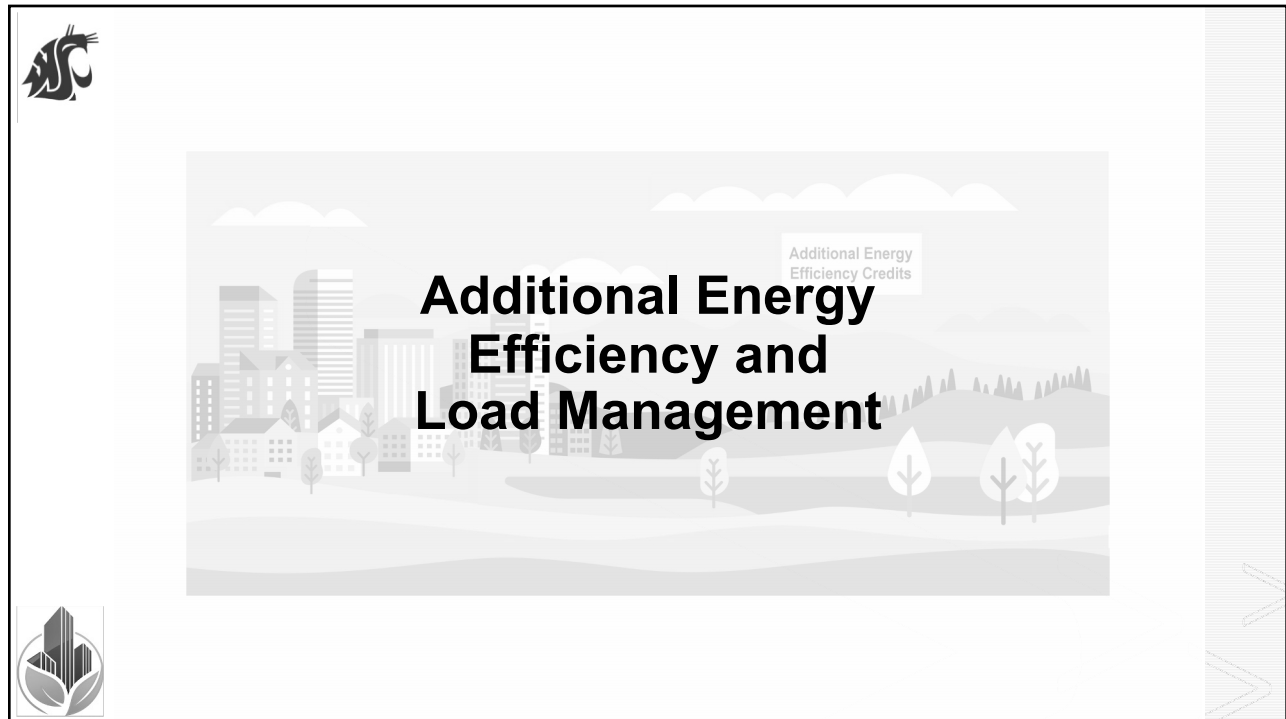
## Required Envelope Performance Documentation

**NEW for Commercial – Thermal envelope certificate**

- Certificate shall be posted where space conditioning equipment is located, within a utility room or other approved location
- A copy shall be included in the project construction documents
- Certificate details shall include:
  - Insulation R-values – Ceilings, roofs, walls, foundations & slabs, crawlspace walls & floors, ducts outside conditioned space
  - Fenestration U-factors and SHGCs
  - Area-weighted envelope assembly values, where applicable
  - Results from building enclosure air leakage testing

**C401.4**

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## Additional Energy Efficiency and Load Management Measures

- **C406.2 Additional Energy Efficiency** – Measures that enhance building systems and equipment energy performance
- **C406.3 Load Management Measures** – Measures that require automatic control of building systems based on load demand, and energy storage
- In addition to complying with all applicable mandatory and prescriptive provisions, a project is required to comply with a minimum number of additional energy efficiency and load management credits
- Number of required credits varies by occupancy group
- Credit value of each measure is based on modeled energy efficiency potential by occupancy group

**C406.2**  
**C406.3**

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## Additional Energy Efficiency and Load Management Measures

### Project types required to comply with Additional Energy Efficiency Measures

- New buildings, including shell & core
- First occupancy build-out of a tenant space (initial TI)
- Building additions
- Existing building retrofits that require full compliance with 2021 WSEC-C are treated the same as a new building
- All levels of space conditioning

### Project types required to comply with Load Management Measures

- New buildings greater than 5,000 SF
- Does NOT apply to:
  - Unconditioned & low energy spaces
  - Open and enclosed parking garages
  - Warehouses
  - Equipment buildings

C406.2  
C406.3



## Baseline Required Energy Measure Credits

TABLE C406.1  
ENERGY MEASURE CREDIT REQUIREMENTS

Required Credits for Projects	Section	Occupancy Group					
		Group R-1	Group R-2	Group B	Group E	Group M	All Other
New building energy efficiency credit requirement	C406.2	54	41	42	48	74	49
Building additions energy efficiency credit requirement	C406.2	27	20	21	23	36	21
New building load management credit requirement	C406.3	12	15	27	15	13	26





## Additional Energy Efficiency – Prescriptive vs. Fossil Fuel Compliance Path

### Table C406.2(1) Efficiency Measure Credits

- There are 32 available measures providing energy saving options for all disciplines
- Credit value of each measure is based on occupancy type

### Table C406.2(2) Efficiency Measure Credits For Use With Fossil Fuel Compliance Path

- Credit values for various measures are adjusted to account for the space heating baseline not being heat pumps, and SWH baseline not being heat pump water heaters (HPWH)
- Only applies to Additional Energy Efficiency measures. Fossil Fuel Compliance Path does not impact Load Management measures.



C406.2

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## Additional Energy Efficiency Measures

### Efficiency measures specific to and most applicable to Group R-2 buildings

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>▪ High performance dedicated outside air systems (DOAS)</li> <li>▪ Dwelling unit HVAC control</li> <li>▪ Residential lighting lamp efficacy</li> <li>▪ Residential lighting controls</li> <li>▪ Service water heat recovery</li> <li>▪ Shower drain heat recovery</li> <li>▪ Low flow residential shower heads</li> <li>▪ Heat pump water heating</li> <li>▪ Service hot water distribution right sizing</li> <li>▪ High performance service hot water temperature maintenance</li> </ul> | <ul style="list-style-type: none"> <li>▪ Enhanced residential kitchen equipment</li> <li>▪ Enhanced residential laundry equipment</li> <li>▪ Heat pump clothes dryers</li> <li>▪ Enhanced commercial kitchen equipment</li> <li>▪ Enhanced envelope performance</li> <li>▪ Reduced air leakage</li> <li>▪ Efficiency elevator equipment</li> <li>▪ Renewable energy</li> <li>▪ High efficiency SWH, gas-fired (Fossil Fuel Path only)</li> </ul> |
|--|--|



Table C406.2(1)  
Table C406.2(2)

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## Load Management Measures

**TABLE C406.3  
LOAD MANAGEMENT MEASURE CREDITS**

Measure Title	Applicable Section	Occupancy Group					
		Group R-1	Group R-2	Group B	Group E	Group M	All Other
1. Lighting load management	C406.3.1	12	15	27	15	NA	NA
2. HVAC load management	C406.3.2	29	24	42	23	13	26
3. Automated shading	C406.3.3	NA	7	12	16	NA	NA
4. Electric energy storage	C406.3.4	41	50	126	72	37	65
5. Cooling energy storage	C406.3.5	13	10	14	19	NA	14
6. Service hot water energy storage	C406.3.6	31	248	59	8	5	70
7. Building thermal mass	C406.3.7	NA	NA	50	95	96	80



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## Space Heating & Cooling



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## 2021 WSEC-C Prescriptive Space Heating Compliance Path

### C403.1.4 – Use of electric resistance and fossil fuel-fired HVAC heating equipment

- **Prescriptive Space Heating Baseline = Heat Pumps**
- *“HVAC heating energy shall not be provided by electric resistance or fossil fuel combustion appliances.”*
- Although heat pumps are the basis of prescriptive compliance, there are a variety of **EXCEPTIONS** that allow electric resistance (ER) and/or fossil fuel (FF) space heating equipment



C403.1.4

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## 2021 WSEC-C Prescriptive Space Heating Compliance Path

### **EXCEPTIONS that allow electric resistance and/or fossil fuel heating**

- **Dwelling & sleeping units** – ER heating is permitted within ALL rooms; wattage limitations based on Climate Zone apply
- **Small systems** – ER and/or FF heating is permitted if the total combined capacity of all small ER and FF equipment is < 5% of total building heating capacity, or serves < 5% of the total conditioned floor area (includes decorative appliances)
- **Small conditioned buildings < 2,500 SF** – ER heating is permitted
- **Temporary systems** – Future tenant spaces that are unfinished and unoccupied may be temporarily semi-heated with ER equipment



C403.1.4

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## 2021 WSEC-C Prescriptive Space Heating Compliance Path

### EXCEPTIONS that allow electric resistance and/or fossil fuel heating

- **Low heating capacity** – ER heating is permitted in buildings or discrete areas with total installed HVAC heating capacity less than **2.5 watt/SF** (Low energy building = 1 watt/SF; Semi-heated = 2.34 watts/SF)
- **Freeze protection** – Spaces with  $\leq 45^{\circ}\text{F}$  ( $7^{\circ}\text{C}$ ) indoor design temperature are permitted to have ER heating for the purpose of freeze protection
- **Heat tape (trace)** – Water-filled equipment and piping located outside the building thermal envelope can be protected with ER heat tape



C403.1.4

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## 2021 WSEC-C Prescriptive Space Heating Compliance Path

### EXCEPTIONS that allow electric resistance and/or fossil fuel heating

- **Essential facilities** – Groups I-2 and I-3 occupancies that by regulation are required to have redundant emergency backup systems are permitted to have ER and/or FF space heating equipment
- **Specific condition areas** – ER and/or FF space heating equipment are permitted to serve discrete areas used specifically for research, health care, process applications or other specific conditions, if heat pumps cannot practicably serve the space heating needs (requires AHJ pre-approval)
- **Tempered kitchen make-up air** – Kitchen exhaust systems are permitted to use ER heating equipment in Climate Zones 4/5 and FF heating equipment in Climate Zone 5



C403.1.4

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## 2021 WSEC-C Prescriptive Space Heating Compliance Path

### EXCEPTIONS that allow electric resistance and/or fossil fuel heating

- **DOAS ERV auxiliary/supplemental heating**
  - **ER** auxiliary/supplemental in Climate Zones 4/5 and **FF** in Climate Zone 5 are permitted
  - DOAS auxiliary heating to preheat OSA for defrost
  - DOAS supplemental heating to temper supply air to 55°F
  - Only allowed in buildings without hydronic heating systems



C403.1.4

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## 2021 WSEC-C Prescriptive Space Heating Compliance Path

### EXCEPTIONS that allow electric resistance and/or fossil fuel heating

- **Heat pump supplemental heating** – Heat pump compressor shall be configured as the first stage of heating; various other eligibility conditions apply
  - Air-to-air heat pumps – **ER** supplemental heating is permitted
  - Air-to-water heat pumps – **ER** in Climate Zones 4/5 and **FF** in Climate Zone 5 are permitted
  - Ground source heat pumps – **ER** supplemental heating is permitted
- **Heat pump defrost cycle** – **ER** heating is permitted



C403.1.4

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## 2021 WSEC-C Prescriptive Space Heating Compliance Path

### Other allowed ALTERNATIVE sources of space heating energy

- **Pre-existing district energy** – Steam or hot water district energy systems that serve multiple buildings, that utilize **FF** equipment as the primary source of heat energy. Must be pre-existing to the effective date of the 2021 WSEC-C.
- **Low carbon district energy** – Complies with the 2021 WSEC-C definition for *low-carbon district energy exchange system*, OR, *low-carbon district cooling and heating or heating only systems*
- **On-site & off-site renewable energy** – Heat energy derived from renewable energy sources



C403.1.4

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## 2021 WSEC-C Fossil Fuel Space Heating Compliance Path

### C401.3 Allows fossil fuel equipment to be used as the primary source of space heating

- **C403.1.4 Modification** – “HVAC heating energy shall not be provided by electric resistance ~~or fossil fuel combustion~~ appliances.”
- **C401.3.3 Additional efficiency credits** – The number of additional energy efficiency credits required per Section C406 shall be increased by the number of Additional Credits Required in Table C401.3.3.
- **C401.3.3.1 HVAC Credit Modification** – For mixed fuel buildings, the number of Additional Credits Required is adjusted based on the total fossil fuel space heating output capacity, relative to the overall output capacity of all space heating systems in the project.



C403.1.4  
C401.3.3  
C401.3.3.1

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## 2021 WSEC-C Fossil Fuel Space Heating Compliance Path

TABLE C401.3.3  
ADDITIONAL CREDITS REQUIRED

Measure Title	Applicable Section	Occupancy Group					
		Group R-1	Group R-2	Group B	Group E	Group M	All Other
New building - Additional efficiency credits required for space heating systems using the fossil fuel pathway	C401.3.3.1	7	24	101	38	111	56
New building - Additional efficiency credits required for service water heating systems using the fossil fuel pathway	C401.3.3.2	198	212	27	17	79	107
Building additions - Additional efficiency credits required for space heating systems using the fossil fuel pathway	C401.3.3.1	4	12	51	19	56	28
Building additions - Additional efficiency credits required for service water heating systems using the fossil fuel pathway	C402.3.3.2	99	106	14	9	40	54

For mixed fuel buildings –  
**CR = A x (C-B)/D**

CR = Additional Credits Required

A = Baseline additional credits required

(C-B) = Total fossil fuel space heating capacity minus the total capacity of all equipment eligible for a C403.1.4 exception

D = Total capacity of all space heating equipment

C401.3.3



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## Dwelling Units - Electric Resistance Heating Appliances

Electric resistance space heating is permitted under the Prescriptive Compliance Path as long as the installed heating capacity *in any separate space* does not exceed the following:

- Spaces with fenestration:** Not more than 750 watts in Climate Zone 4 and 1,000 watts in Climate Zone 5
- Spaces with fenestration facing two cardinal orientations:** 1,000 watts in Climate Zone 4, and 1,300 watts in Climate Zone 5
- Spaces with exterior walls and no fenestration: 250 watts

Buildings in locations with lower than 4°F winter outdoor design temperature for heating are permitted to add an additional 250 watts above the base wattage allowed for Climate Zone 5

Reference Appendix C for outdoor design temperatures for locations in WA State

C403.1.4



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## Dwelling Units - Electric Resistance Heating Appliances

Electric resistance wall heater



Electric resistance baseboard



Electric resistance cove heater



Images courtesy of King Electric



## Dwelling Units – Ductless Heat Pumps

Single-zone ductless heat pump



Multiple-zone ductless heat pump



**NOTE** – For Group R-2, cooling equipment shall comply with an economizer exception; options include high efficiency or HVAC equipment paired with DOAS

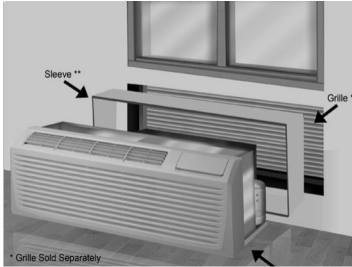
Images courtesy of LG





## Dwelling Units – Packaged Terminal Heat Pumps (PTHP)

Packaged terminal heat pump



High efficiency packaged terminal heat pump



Image courtesy of Epocha

**NOTE** – For Group R-2, cooling equipment shall comply with an economizer exception; options include high efficiency or HVAC equipment paired with DOAS



## VPTHP & Split System Heat Pump Air Handlers

Ducted split system heat pump



Image courtesy of Trane

Vertical packaged terminal heat pump



Image courtesy of AMANA

**NOTE** – For Group R-2, cooling equipment with indoor supply fans and < 54,000 Btu/h capacity are exempt from economizer controls provided cooling efficiency exceeds code minimum by 15%







## Water Source & Ground Source Heat Pump Systems

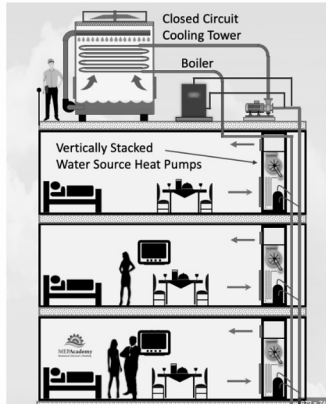
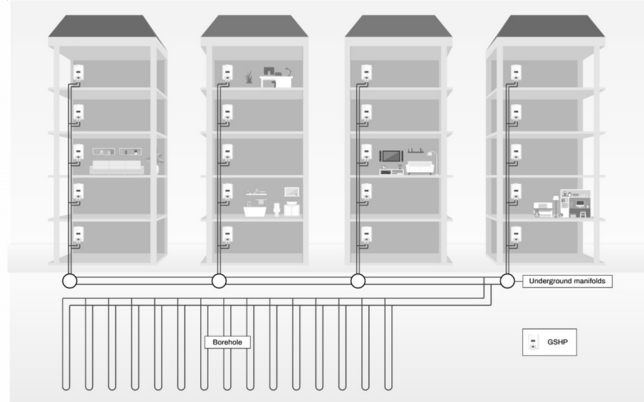


Diagram courtesy of MEP Academy



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## Ventilation in Multifamily Buildings

- **Dwelling units** – Requires balanced flow ventilation system with energy recovery
- **Corridors & common areas** – Requires ventilation capacity per Chapter 4 of the IMC and energy recovery depending on design outdoor air CFM
- **Accessory occupancies** – If accessory space SF area is  $\geq 10\%$  of the total building floor area, DOAS may be required if occupancy is a type that is required to comply with the DOAS provisions
- **Stand alone buildings** – Club house, leasing center or residential services building on a multifamily building complex shall comply with the WSEC-C provisions



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## Dwelling Units – Balanced Flow Ventilation

Whole house (or dwelling unit) energy recovery ventilators (ERV)



Image courtesy of Greenheck

Ceiling mounted, low CFM spot ERVs



Image courtesy of Panasonic

Rated efficiency per HVI 920 based on adjusted sensible recovery effectiveness (ASRE) is permitted



## Dwelling Units – Balanced Flow Ventilation

- Outdoor air shall be provided directly to each habitable space via a balanced ventilation system with heat recovery
- Delivered outdoor air CFM shall comply with the 2021 IMC
- HRV/ERV sensible energy recovery effectiveness shall be  $\geq 60\%$
- System shall be configured so the ventilation airflow rate in each habitable space can be commissioned (Cx)

**Balanced Flow – Supply CFM and Exhaust CFM are within 10%**

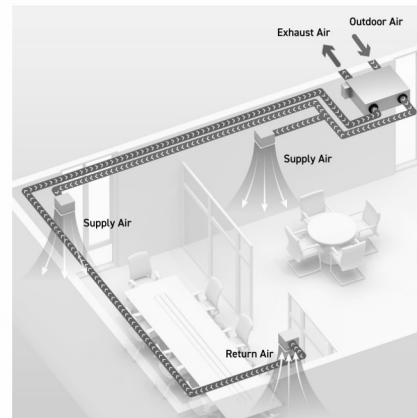


Image courtesy of Panasonic

**C403.7.6.1**





## Corridors & Common Areas – Ventilation

- Ventilation system shall be sized to provide **not more than 150%** of the minimum outdoor air required by Chapter 4 of the IMC or other applicable code or standard (whichever is greater)
- For ventilation air systems serving spaces other than dwelling units, energy recovery **may be** required depending on the total required outdoor air CFM (refer to Tables C403.7.6 (1) & (2))
- Ventilation air systems that are required to have energy recovery shall provide  $\geq$  **68%** sensible recovery effectiveness or **60%** enthalpy recovery ratio



C403.2.2.1  
C403.3.5  
C403.7.6.2

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## Corridors & Common Areas – Space Heating & Cooling

### Equipment Types

- Electric resistance space heating is allowed in small areas such as vestibules, stairwells and storage rooms provided the capacity does not exceed 5% of total space heating capacity of the project
- Heat pumps (single-zone, multiple-zone, multiple-zone VRF, packaged rooftop, package terminals)
- Fuel-fired furnaces and fuel-fired package rooftop units (must comply with Fossil Fuel Compliance Path)
- Central hydronic heating & cooling systems (applicable space heating Compliance Path depends on equipment type)

**NOTE** – Where mechanical cooling is provided, system shall comply with economizer or qualify for an exception (i.e. DOAS or high efficiency system)



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## Corridors & Common Areas – DX-DOAS Heat Pump

Rooftop DX-DOAS heat pump with energy recovery

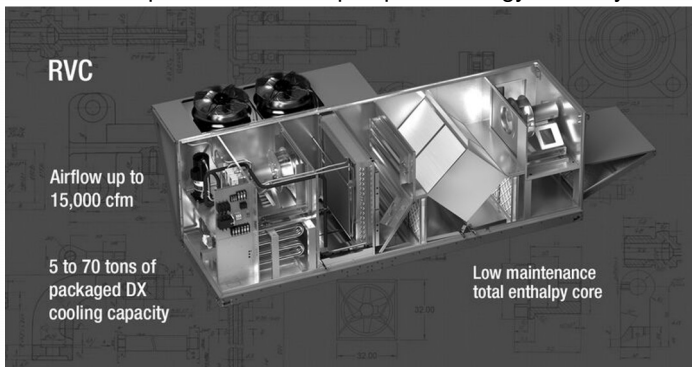


Image courtesy of Greenheck

If provided to comply with the DOAS provisions, DX-DOAS heating & cooling capacity shall not exceed what is required for outside air tempering and dehumidification

Economizer is required for all rooftop mechanical cooling equipment



## Corridors & Common Areas – DX-DOAS Heat Pump

Rooftop DOAS with ERV and Gas Heating/DX Cooling

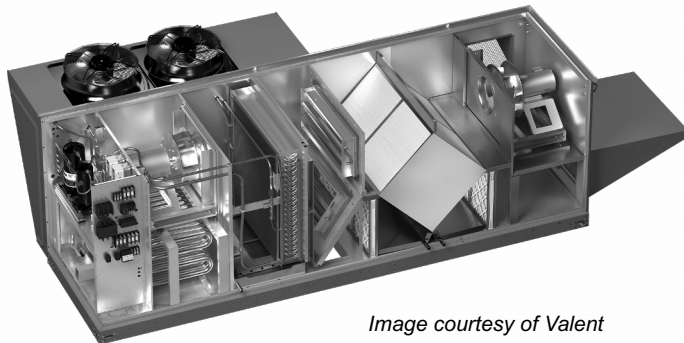


Image courtesy of Valent

Areas served by fuel-fired air handling equipment shall comply with the Fossil Fuel Compliance Path

Economizer is required for all rooftop mechanical cooling equipment



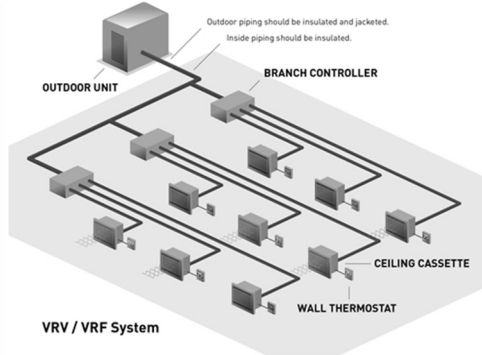


## Corridors & Common Areas – High Efficiency DOAS with VRF

High efficiency DOAS with energy recovery (ERV)



Multiple zone VRF heat pump system with ductless ceiling cassettes



Images courtesy of Ventacity



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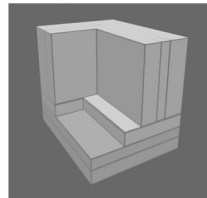
## What is Total System Performance Ratio?

$$TSPR\ Score = \frac{Annual\ HVAC\ Loads}{Annual\ HVAC\ Carbon\ Emissions}$$



Whole building seasonal HVAC efficiency rating

- TSPR energy analysis tool
- Compares score of the proposed building to a reference building as defined in 2021 WSEC-C Appendix D
- Uses default loads and schedules



Runs a simplified energy model



C403.1.1

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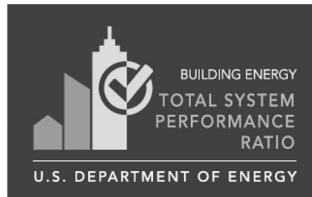
# TSPR Score Verification

## Whole Building Total System Performance Ratio

Proposed Building TSPR: **16.9**  
 Baseline Building TSPR: 12 ← **Larger number = Better score**

The Total System Performance Ratio complies with the 2018 Washington State Energy Code.

Total System Performance Ratio (TSPR) is the ratio of the sum of a building's annual heating and cooling load in thousands of BTUs to the sum of the annual carbon emissions in pounds from energy consumption of the building HVAC systems.



- TSPR analysis is only required for systems that provide **mechanical cooling**
- **Does not apply** to buildings where the total SF area of all spaces that are required to comply with TSPR is **less than 5,000 SF**

**Proposed building score must be equal to or higher than the Baseline building score**

C403.1.1



TABLE D602.11  
 STANDARD REFERENCE DESIGN HVAC SYSTEMS

Parameter	Building Type				
	Large Office <sup>a</sup>	Small Office and Libraries <sup>a</sup>	Retail	School	Multifamily
<b>System Type</b>	<b>Water-source Heat Pump</b>	<b>Packaged air-source Heat Pump</b>	<b>Packaged air-source Heat Pump</b>	<b>Packaged air-source Heat Pump</b>	<b>Packaged air-source Heat Pump</b>
Fan control <sup>b</sup>	Cycle on load	Cycle on load	Cycle on load	Cycle on load	Cycles on load
Space condition fan power (W/cfm) Proposed < MERV 13	0.528	0.528	0.522	0.528	0.528
Space Condition Fan Power (W/cfm) Proposed ≥ MERV 13	0.634	0.634	0.634	0.634	0.634
Heating/Cooling sizing factor <sup>c</sup>	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15	1.25/1.15
Supplemental heating availability	NA	<40°F	<40°F	<40°F	<40°F
Modeled cooling COP (Net of fan) <sup>d</sup>	4.46	3.83	4.25	3.83	3.83
Modeled heating COP (Net of fan) <sup>d</sup>	4.61	3.81	3.57	3.81	3.86
Cooling Source	DX (heat pump)	DX (heat pump)	DX (heat pump)	DX (heat pump)	DX (Heat Pump)
Heat source	Heat Pump	Heat Pump	Heat Pump	Heat Pump	Heat Pump
Number of Stages of Cooling	Single	Single	Two	Single	Single
OSA Economizer <sup>e</sup>	No	No	Yes	Yes	Yes
Occupied ventilation source <sup>f</sup>	DOAS	DOAS	DOAS	DOAS	DOAS
DOAS Fan Power (W/cfm of outside air)	0.819	0.819	0.730	0.742	0.780
DOAS Fan Power (W/cfm) Proposed ≥ MERV 13	1.042	1.042	0.928	0.944	0.944
DOAS temperature control $\phi_{-h}$	Bypass	Wild	Bypass	Bypass	Wild
ERV efficiency (sensible only)	70%	70%	70%	70%	70 percent

- Standard reference design HVAC system criteria added for **Multifamily** buildings (Appendix D)
- **If an HVAC system is designed to meet or exceed the standard reference design requirements, the system is exempt from TSPR**



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## 2021 WSEC-C Prescriptive SWH Compliance Path

**C404.2.1 – Service water heating system type**

- **Prescriptive Primary SWH Baseline = Air-Source Heat Pump Water Heaters (HPWH)**
- *“Service hot water shall be provided by an electric air-source heat pump water heating (HPWH) system meeting the requirements of this section. Supplemental service water heating equipment is permitted to use electric resistance or fossil fuel.”*
- Primary HPWH system shall be **sized to deliver  $\geq 50\%$**  of the total required capacity for SWH during peak demand. Remaining capacity may be met by fossil fuel, electric resistance, or heat pump water heating systems.
- **Prescriptive alternate performance criteria** – Northwest Energy Efficiency Alliance (NEEA) Commercial Electric Advanced Water Heating Specification

**C404.2.1**

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## 2021 WSEC-C Prescriptive Space Heating Compliance Path

HPWH are required, however, there are a few **EXCEPTIONS** that allow electric resistance (ER) and/or fossil fuel (FF) heating equipment

- **ER Base Allowance** – Up to 24 kW plus 0.1 watts/SF per building
- **Commercial food service and process equipment** – ER booster heaters are permitted for systems that require supply water temperature  $\geq 120^{\circ}\text{F}$
- **Essential facilities** – Groups I-2 and I-3 occupancies that by regulation are required to have redundant emergency backup systems are permitted to have **ER and/or FF** service water heating equipment



C404.2.1

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## 2021 WSEC-C Prescriptive Space Heating Compliance Path

Other allowed **ALTERNATIVE** sources of SWH energy

**Waste heat recovery sources including –**

- Wastewater heat recovery (shower drain and other sources)
- Energy recovery from water-source and ground-source heat pump systems
- **C403.9.2.1 Condenser heat recovery for service water heating** – Applies to facilities that operate 24/7 where design SWH load  $> 250,000$  Btu/h and total heat rejection capacity of all water-cooled systems  $> 1,500,000$  Btu/h
- **C403.9.2.2 Steam condensate heat recovery system** – Includes energy recovery from on-site steam systems and off-site generated steam where the condensate is not returned to the source
- Other sources of heat energy, as pre-approved by the Code Official



C404.2.1  
C403.9.2.1  
C403.9.2.2

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## 2021 WSEC-C Prescriptive Space Heating Compliance Path

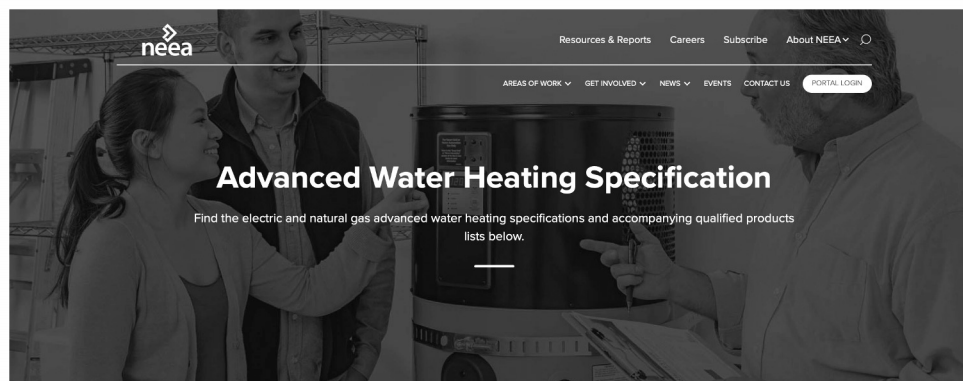
### Other allowed ALTERNATIVE sources of SWH energy

- **Pre-existing district energy** – Service HW district energy systems that serve multiple buildings, that utilize **FF and/or ER** equipment as the primary source of heat energy. Must be pre-existing to effective date of the 2021 WSEC-C.
- **Low carbon district energy** – Complies with the 2021 WSEC-C definition for *low-carbon district energy exchange system*, OR, *low-carbon district cooling and heating or heating only systems*
- **On-site & off-site renewable energy** – Heat energy derived from renewable energy sources



C404.2.1

65



### Advancing the market for heat pump water heaters

Utilities, energy efficiency organizations and market partners developed the Advanced Water Heating Specification (AWHS) to advance higher performing electric and gas heat pump water heaters. While this specification is rooted in ensuring performance in cooler northern climates, its applicability and benefits extend well beyond the Northwest. The specification also enhances the end goals of NEEA's water heating programs - to influence the passage of federal standards requiring heat pump levels of performance for both gas and electric storage water heaters.

The latest version of the AWHS is version 8.0. Additional resources such as qualified products lists (GPLs) are available in the listed resources below.

[VIEW ALL RESOURCES](#)



C404.2.1

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# NEEA Advanced Water Heating Specification

## ELECTRIC ADVANCED WATER HEATING SPECIFICATION Version 8.0

This document succeeds NEEA's previous Advanced Water Heating Specification (AWHS Version 7.0). This version has been expanded to include commercial, multifamily, and industrial water heating systems in addition to residential water heaters. Notably, this version has no substantive changes to the residential water (Unitary and split system) heater portion of the specification compared to Version 7.0.

[VIEW DOCUMENT](#)

## RESIDENTIAL HEAT PUMP WATER HEATERS Qualified Product List

The Residential HPWH QPL contains information on Residential HPWH products that meet the Advanced Water Heating Specification requirements. These products are found in Single Family or low rise multifamily (in residential dwelling units). The list also indicates if the listed product qualifies for the Inflation Reduction Act (IRA) 2023 tax credit.

[VIEW THE QPL](#)

## COMMERCIAL HEAT PUMP WATER HEATERS Qualified Product List

The Commercial HPWH QPL contains information on Residential Multifamily Commercial products that meet the Advanced Water Heating Specification requirements. These products generally serve five or more dwelling units and have a central plant attached to a circulation system. Commercial product systems include a heat pump engine, storage tanks, mixing valves, control systems and connectivity.

[VIEW THE QPL](#)



C404.2.1



# NEEA Advanced Water Heating Specification

Performance specifications are based upon system configuration

Advanced Water Heating Specification Version 8.0—Commercial

Figure 4. Single-Pass Primary HPWH with Series Temperature Maintenance Tank System (Swing Tank)

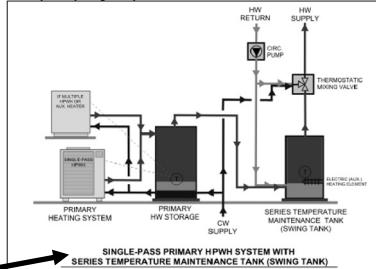
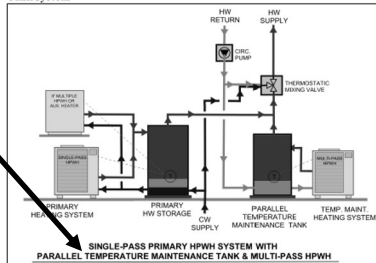


Figure 5. Single-Pass Primary HPWH with Parallel Temperature Maintenance Tank System



C404.2.1



## 2021 WSEC-C Fossil Fuel Service Water Heating Compliance Path

**C401.3 Allows fossil fuel and electric resistance equipment to be used as the primary source of service water heating**

**C404.2 Modifications –**

- *“Service hot water shall be provided **by fossil fuel water heating equipment, electric air-source heat pump water heating equipment, electric resistance water heating equipment, or a combination of these equipment types** meeting the requirements of this section.*
- *... Supplemental service water heating equipment is permitted to use electric resistance or fossil fuel.”*



**C401.3**  
**C404.2**

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## 2021 WSEC-C Fossil Fuel Service Water Heating Compliance Path

**C401.3 Allows fossil fuel and electric resistance equipment to be used as the primary source of service water heating**

- **C401.3.3 Additional efficiency credits** – The number of additional energy efficiency credits required per Section C406 shall be increased by the number of Additional Credits Required in Table C401.3.3.
- **C401.3.3.2 SWH Credit Modification** – For mixed fuel buildings, the number of Additional Credits Required is adjusted based on the total fossil fuel service water heating output capacity, relative to the overall output capacity of all service water heating systems in the project.



**C401.3.3**  
**C401.3.3.2**

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## 2021 WSEC-C Fossil Fuel Service Water Heating Compliance Path

TABLE C401.3.3  
ADDITIONAL CREDITS REQUIRED

Measure Title	Applicable Section	Occupancy Group					
		Group R-1	Group R-2	Group B	Group E	Group M	All Other
New building - Additional efficiency credits required for space heating systems using the fossil fuel pathway	C401.3.3.1	7	24	101	38	111	56
New building - Additional efficiency credits required for service water heating systems using the fossil fuel pathway	C401.3.3.2	198	212	27	17	79	107
Building additions - Additional efficiency credits required for space heating systems using the fossil fuel pathway	C401.3.3.1	4	12	51	19	56	28
Building additions - Additional efficiency credits required for service water heating systems using the fossil fuel pathway	C402.3.3.2	99	106	14	9	40	54

For mixed fuel buildings –  
**CR = A x (C-B)/D**

CR = Additional Credits Required

A = Baseline additional credits required

(C-B) = Total fossil fuel SWH capacity minus the total capacity of all equipment eligible for a C403.1.4 exception

D = Total capacity of all SWH equipment

C401.3.3



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## SWH Equipment & Systems Serving Dwelling Units

### Prescriptive Primary SWH Capacity

- **HPWH, packaged unit** – Packaged heat pump & storage tank is located within a vented storage closet either on a balcony or other location adjacent to the dwelling unit
- **HPWH, split system** – Storage tank is located within the dwelling unit, condensing unit is located outdoors either on the roof or on-grade
- **Central HPWH system** – Each dwelling unit is served via a SWH circulation loop
- **Supplemental heating capacity** – ER and/or FF supplemental heating capacity is permitted for: circulation system temp maintenance; compressor coil defrost; heat trace for freeze protection; back-up heating capacity for low ambient temp conditions



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## SWH Equipment & Systems Serving Dwelling Units

### Prescriptive Remaining Primary SWH Capacity or Fossil Fuel Compliance Path

- **Electric resistance water heater** – Packaged ER equipment is located within the dwelling unit
- **Electric resistance instantaneous tankless & mini-tank water heater** – ER equipment is located within the dwelling unit at or near the point of use
- **Central fuel-fired water heating system** – Each dwelling unit is served via a SWH circulation loop. Equipment types include: standard fuel-fired water heaters; standard boilers; high efficiency condensing water heaters and boilers.
- **Supplemental heating capacity** – ER and/or FF are permitted



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## EF vs UEF Ratings

- DOE has changed the rating metric for residential water heaters from Energy Factor (EF) to Uniform Energy Factor (UEF)
- UEF ratings vary depending on daily usage and first hour draw pattern
- Minimum efficiency requirements in the 2021 WSEC-C are in UEF
- Per SBCC Opinion #18-09, it is acceptable to use UEF ratings to demonstrate compliance with the 2018 WSEC-C

UEF Rating Draw Pattern

BIN	BIN Daily Usage (Gallons)	First Hour Rating (Tank-Type Water Heaters)	Max GPM (Tankless Water Heaters)
Very Small	10	Less than 18 gallons	Less than 1.7
Low	38	18 to 51 gallons	1.7 to 2.8
Medium	55	51 to 75 gallons	2.8 to 4
High	84	75 gallons or larger	4 or more

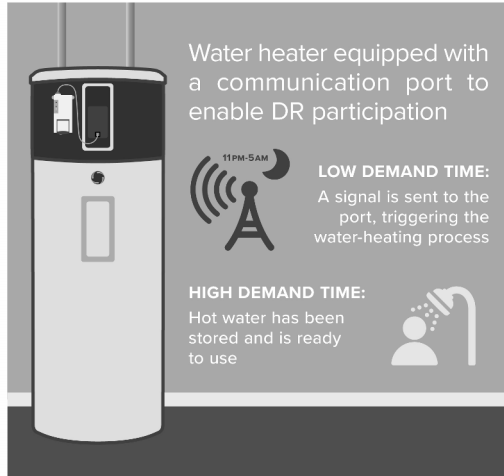


Table C404.2

74



## Dwelling Units – Grid-Enabled Electric Resistance Water Heater



- Electric resistance tank-type water heater
- Equipped with a Demand Response (DR) communication port
- Provides a future opportunity for electric service providers to reduce peak system demand and keep energy rates low



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## Dwelling Units – Electric Resistance Instantaneous Water Heaters

Tankless electric resistance water heater



*Image courtesy of AO Smith*

**Point of use water heaters**

Mini-tank electric resistance water heater



*Image courtesy of Steibel Eltron*



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# Dwelling Units – Heat Pump Water Heaters

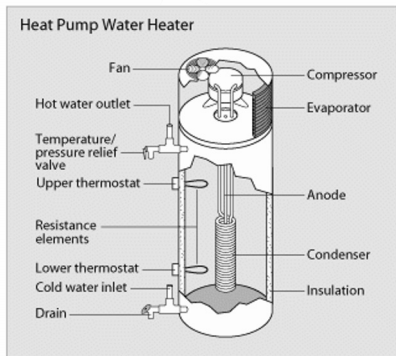


Image courtesy of US DOE – Energy Saver

Single packaged unitary HPWH



Image courtesy of Rheem

Split system HPWH



Image courtesy SANCO2



# Central SWH System – Condensing Gas-Fired Boiler Plant

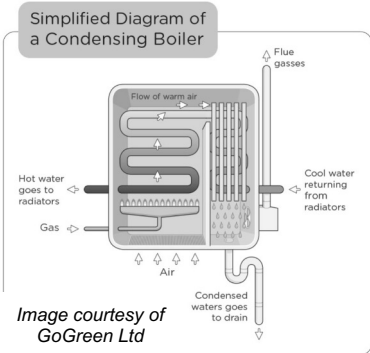


Image courtesy of GoGreen Ltd

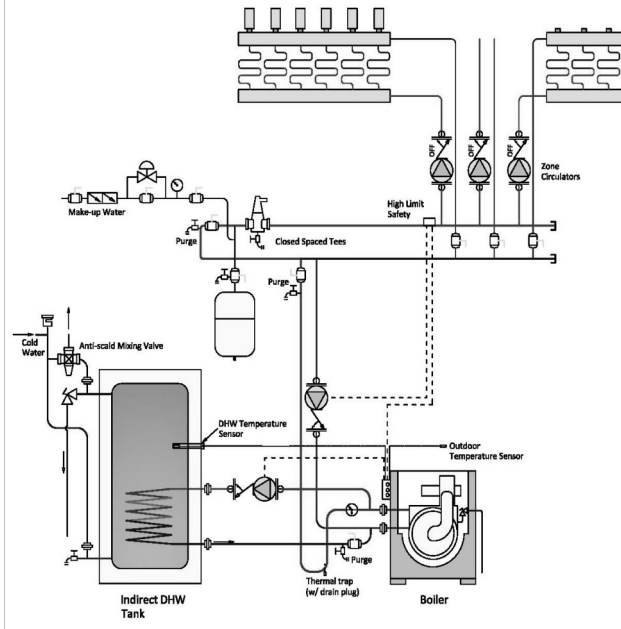
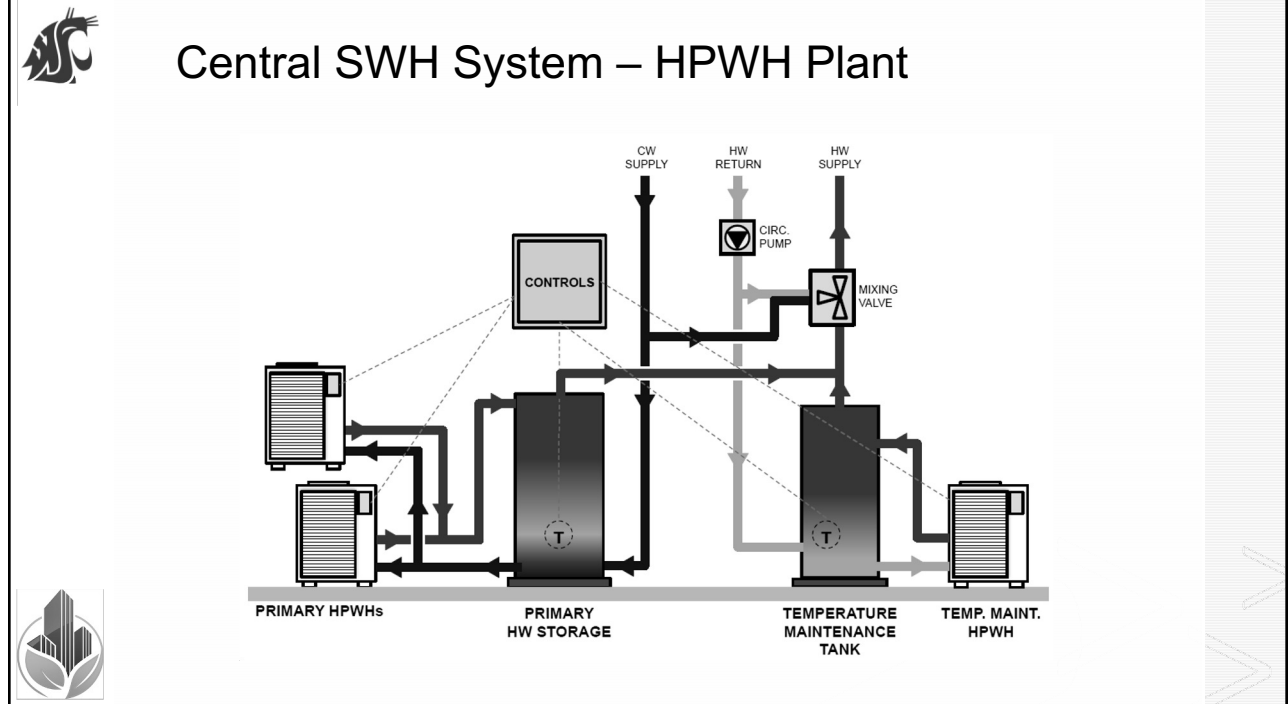
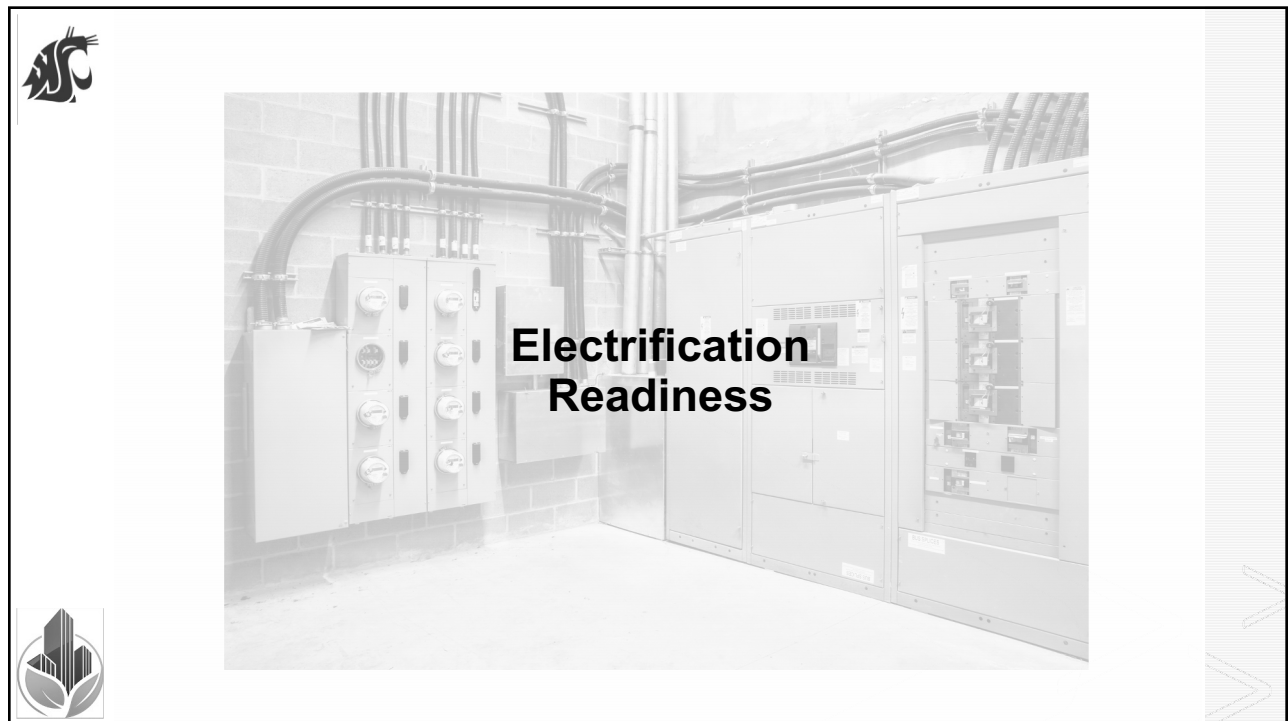


Image courtesy of US DOE – EERE



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## 2021 WSEC-C Fossil Fuel Compliance Path

### **C401.3.6 Electrification readiness for Space Heating and Service Water Heating Appliances**

**PURPOSE** – For projects utilizing fossil fuel appliances, provide electrical system infrastructure to support an upgrade to heat pump appliances in the future.

Electrical accommodations shall include:

- Spare electrical branch circuit conduit to the locations of future replacement heat pump appliances, sized for an equivalent capacity as the fossil fuel appliances
- Spare electrical service entrance conduits for the purpose of upgrading the main electrical service
- Ensure main electrical room has sufficient space to accommodate increasing the electrical service size
- Additional necessary accommodations to support a future electrical service upgrade (transformers, adequate space on site)

**C401.3.6**



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## On-site Renewable Energy Systems

### What is required?

- Minimum energy generation capacity not less than **0.5 watt/SF or 1.7 Btu/SF** multiplied by the sum of all gross conditioned floor areas of the building or building additions
- Renewable energy generation system may be located on or within the building or located on or within another structure elsewhere on the project site
- There are exceptions for buildings with limited available roof area or where a substantial portion of the roof area is shaded



C411.1

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## Off-site Renewable Energy

Eligible off-site renewable energy sources that are delivered or credited to the building to demonstrate compliance with C411

- Self-generation via an off-site renewable energy system owned by the building project owner
- Community renewable energy facility systems
- Renewable power purchase agreement (PPA)



*Community solar system at Greenbank Farm, Whidbey Island -  
Image courtesy of Greenbank Farm*



C411.2.1

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## Solar Readiness



### PURPOSE

- Encourages utilization of on-site renewable energy systems
- Requires accommodations when a new building is constructed that will support the installation of future renewable energy systems
- If these accommodations are not incorporated when the building is first constructed, it is often difficult and expensive to add renewable energy systems in the future



C411.3

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## When do the renewable energy systems and solar readiness provisions apply?

	<b>C411 Renewable Energy &amp; Solar Readiness</b>	Project conditioned floor area ≤ 10,000 sf	Project conditioned floor area > 10,000 sf	Building height ≤ 20 stories	Building height > 20 stories
New Building	Renewable Energy	NA	✓	✓	✓
	Solar Readiness	✓	✓	✓	NA
Building Additions	Renewable Energy	NA	✓	✓	✓
	Solar Readiness	✓	✓	✓	NA
Change in Space Conditioning or Occupancy	Renewable Energy	NA	NA	NA	NA
	Solar Readiness	✓	✓	✓	NA
Existing Building Alterations	Renewable Energy	NA	NA	NA	NA
	Solar Readiness	NA	NA	NA	NA

There are also exemptions for small buildings & additions < 500 SF



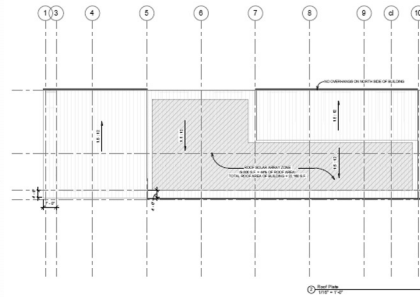
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## Solar Zone Minimum Area

**Solar zone areas shall be designated on the architectural, electrical & structural plans**

1. Min required solar zone area is either:
  - 40% of the roof area
  - 20% of the electrical service size – Area calculated using 10 peak watts of photovoltaic per SF
  - Roof area = Gross roof SF area minus skylights, occupied roof decks, mech equipment including clearances, and vegetated areas
2. Solar zone area does not have to be contiguous



*Image courtesy Lewellen Associates*

**C411.3.1**  
**C411.3.2**



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## Multifamily Mash-up 2021 WSEC Commercial & Residential Comparison

Jonathan Jones & Rick Blumenthal, WSU Energy Extension  
(360) 956-2042 | [energycode@energy.wsu.edu](mailto:energycode@energy.wsu.edu)

Lisa Rosenow, Evergreen Technology Consulting  
Duane Lewellen, Lewellen Associates  
(360) 539-5300 | [com.techsupport@waenergycodes.com](mailto:com.techsupport@waenergycodes.com)



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