

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.)

CHAPTER 4 [CE] COMMERCIAL ENERGY EFFICIENCY

SECTION C401 GENERAL

C401.1 Scope. The provisions in this chapter are applicable to commercial *buildings* and their *building sites*.

C401.2 Application. Commercial buildings shall comply ~~with the fossil fuel compliance path according to Section C401.3,~~ or with one of the following:

1. Prescriptive Compliance. The prescriptive compliance option requires compliance with Sections C402 through C406, and Sections C408, C409, C410, C411, and C412.
2. Total Simulated Building Performance. The total simulated building performance option requires compliance with Section C407.
3. When adopted by the local jurisdiction, the requirements of Appendix F, Outcome-Based Energy Budget, Sections C408, C409, C410, C411, C412 and any specific section in Table C407.2 as determined by the local jurisdiction. The Proposed Total UA of the proposed building shall be no more than 20 percent higher than the Allowed Total UA as defined in Section C402.1.5.

C401.2.1 Application to existing buildings. Additions, alterations, repairs, and changes of space conditioning, occupancy, or use to existing buildings shall comply with Chapter 5.

C401.2.2 Application to process equipment. Energy using equipment used by a manufacturing, industrial, or commercial process other than for conditioning spaces or maintaining comfort and amenities for the occupants shall comply with Section C401.3.1 Item 2, Section C403.3.2, Tables C403.3.2(1) through (16) inclusive, Sections C403.3.4.1 through C403.3.4.3, C403.7.7, C403.9.2.1, C403.10.3, C403.11.2, C403.11.3, Table C404.2, and Sections C405.8, C410, and C412.

~~**C401.3 Fossil fuel compliance path.** Buildings complying with the fossil fuel compliance path shall comply with the prescriptive compliance path of this code as defined in Item 1 of Section C401.2, and as modified by this Section C401.3.~~

~~**C401.3.1 Modification of code requirements.** For use of this compliance path only, the following changes shall be made to this code:~~

1. ~~**Section C403.1.4 – Space heating.** Strike the phrase "...or fossil fuel combustion..." from the first sentence of Section C403.1.4.~~
2. ~~**Section C404.2.1 – Service water heating.** Revise the first sentence of Section C404.2.1 to read: "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."~~
3. ~~**Section C406.2.5 – Renewable energy.** When determining renewable energy credits in Equation 4-17 of Section C406.2.5, strike the phrase "...limited to 50 percent of the required credits in Section C406.1" in the definition of the factor AECRRa.~~
4. ~~**Table C406.2 – Efficiency measure credits.** Use Table C406.2(2) credit values in place of Table C406.2(1) credit values.~~

~~**C401.3.2 Fossil fuel equipment.** Fossil fuel combustion appliances are permitted for HVAC heating, and shall comply with the applicable efficiency standards referenced in Section C403.3.3.2. Fossil fuel combustion appliances are permitted for service water heating, and shall comply with applicable efficiency standards referenced in Table C404.2.~~

~~**C401.3.3 Additional efficiency credits.** The number of additional efficiency credits required by Table C406.1 shall be increased by the number required in Table C401.3.3, modified as permitted in this section, and is in addition to the energy efficiency credits and load management credits required by Section C406.~~

~~**Exception:** The required number of space heating additional efficiency credits are permitted to be reduced in the following instances:~~

1. Low energy spaces in accordance with Section C402.1.1.1 and equipment buildings in accordance with Section C402.1.2 that are served by space heating systems shall comply with sufficient measures from Table C406.2(1) or Table C406.2(2) to achieve a minimum of 50 percent of the efficiency credits required for new construction by Table C401.3.3, modified as permitted in this section.
2. Building additions that have less than 1,000 square feet of conditioned floor area and that comply with sufficient measures from Table C406.2(1) or Table C406.2(2) to achieve a minimum of 50 percent of the additional efficiency credits required for additions by Table C401.3.3, modified as permitted in this section.
3. Semi-heated spaces in accordance with Section C402.1.1.2 that comply with sufficient measures from Table C406.2(1) or Table C406.2(2) to achieve a minimum of 50 percent of the space heating additional efficiency credits required by Table C401.3.3, modified as permitted in this section.
4. Unconditioned spaces, open parking garages and unheated enclosed parking garages are not required to achieve the additional efficiency credits for space heating required by Table C401.3.3.

**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

C401.3.3.1 HVAC credit modification. The number of HVAC heating energy efficiency credits required by Table C401.3.3 is permitted to be decreased according to the following equation:

$$CR = A \times (B - C) / D$$

Where:

- CR = Additional credits required, rounded to the nearest whole number.
- A = Baseline HVAC heating credits from Table C401.3.3.
- B = Installed fossil fuel space heating capacity in kBtu/h of appliances that comply with any of the exceptions to Section C403.1.4.
- C = Total installed fossil fuel space heating capacity in kBtu/h of all HVAC heating appliances.
- D = Total capacity in kBtu/h of all types of space heating appliances.

C401.3.3.2 Service water heating credit modification. The number of service water heating energy efficiency credits required by Table C401.3.3 is permitted to be decreased according to the following equation:

$$CR = A \times (B - C) / D$$

Where:

- CR = Additional credits required, rounded to the nearest whole number.
- A = Baseline credits from Table C401.3.3.
- B = Installed service water heating appliances capacity in kBTU/h of service water heating appliances that comply with any of the exceptions to Section C404.2.1.
- C = Total installed fossil fuel service water heating capacity in kBTU/h of all service water heating appliances.
- D = Total capacity in kBTU/h of all types of service water heating appliances.

C401.3.4 Renewable energy credit limit. No more than 80 percent of the efficiency credits required by Sections C401.3.3.1 and C401.3.3.2 are permitted to be renewable energy credits defined in Section C406.2.5.

C401.3.5 Discrete area weighting of additional required credits. In addition to the area-weighted credit requirements in Section C406.1.2, where a building includes multiple occupancies, the additional required credits per Table C401.3.3 shall be determined separately for each occupancy group. Additional required credits shall be prorated on an area-weighted basis for each occupancy group in the same manner as required project credits per Section C406.1.

1. Where a single space heating or service water heating system serves multiple occupancies, the number of additional required credits shall be prorated on an area-weighted basis for each occupancy served.
2. Additional required credits for envelope systems shall be prorated on an area-weighted basis for all occupancies.
3. Occupancies are permitted to be subdivided into discrete areas, with required and achieved credits for each area prorated on an area-weighted basis as required for the occupancy group.

C401.3.6 Electrification readiness. Additionally, the following provisions shall be required for new construction for each fossil fuel space heating or service water heating appliance installed:

1. Provide a spare electrical branch circuit conduit to the location of a future replacement heat pump appliance to support an equivalent heating capacity.
2. Provide spare electrical service entrance conduits for the purpose of upgrading the main electrical service to support all heat pump appliances throughout the building.
3. The main electrical room has sufficient space to accommodate increasing the main electrical service's size to support all heat pump appliances throughout the building.
4. Additional accommodations for the equipment comprised of transformer(s) and other equipment necessary to support an electrical service upgrade. These accommodations shall include adequate space on the site. If the equipment is located in a transformer vault, that vault must include not only the space to support electrical service upgrade but also include accommodations for additional cooling for larger transformer(s).

C403.1.4 Use of electric resistance and fossil fuel-fired HVAC heating equipment. HVAC heating energy shall not be provided by electric resistance or fossil fuel combustion appliances. For the purposes of this section, electric resistance HVAC heating appliances include, but are not limited to, electric baseboard, electric resistance fan coil and VAV electric resistance terminal reheat units and electric resistance boilers.

For the purposes of this section, fossil fuel combustion HVAC heating appliances include, but are not limited to, appliances burning natural gas, heating oil, propane, or other fossil fuels.

Exceptions:

1. **Low heating capacity.** Buildings or areas of buildings, other than *dwelling units* or sleeping units, that meet the interior temperature requirements of Chapter 12 of the *International Building Code* with a total installed HVAC heating capacity no greater than 8.5 Btu/h (2.5 watts) per square foot of *conditioned space* are permitted to be heated using electric resistance appliances.
2. **Dwelling and sleeping units.** Dwelling or sleeping units are permitted to be heated using electric resistance appliances as long as the installed HVAC heating capacity in any separate space is not greater than:
 - 2.1. Seven hundred fifty (750) watts in Climate Zone 4, and 1000 watts in Climate Zone 5 in each habitable space

with fenestration.

- 2.2. One thousand (1,000) watts in Climate Zone 4, and 1300 watts in Climate Zone 5 for each habitable space that has two primary walls facing different cardinal directions, each with exterior fenestration. Bay windows and other minor offsets are not considered primary walls.
- 2.3. Two hundred fifty (250) watts in spaces adjoining the *building thermal envelope* but without fenestration.

For the purposes of this section, habitable space is as defined in the International Building Code. For buildings in locations with exterior design conditions below 4°F (-16°C), an additional 250 watts above that allowed for Climate Zone 5 is permitted in each space with fenestration.

3. **Small buildings.** Buildings with less than 2,500 square feet (232 m²) of *conditioned floor area* are permitted to be heated using electric resistance appliances.
4. **Defrost.** Heat pumps are permitted to utilize electric resistance heating when a heat pump defrost cycle is required and is in operation.
5. **Air-to-air heat pumps.** Buildings are permitted to utilize ~~electric resistance~~ supplemental heating for air-to-air heat pumps that meet all of the following conditions:
 - 5.1. Internal electric resistance heaters have controls that prevent supplemental heater operation when the heating load can be met by the heat pump alone during both steady-state operation and setback recovery.
 - 5.2. The heat pump controls are configured to use the compressor as the first stage of heating down to an outdoor air temperature of 17°F (-8°C) or lower except when in defrost.

Exceptions to 5.2:

 1. Packaged terminal heat pumps (PTHPs) that comply with the minimum heating efficiency requirements in Table C403.3.2(4) are exempt from heat pump controls capable of operating the compressor as the first stage of heating down to an outdoor air temperature of 17°F (-8°C) or lower.
 2. Heat pumps whose minimum efficiency is regulated by NAECA and whose ratings meet the requirements shown in Table C403.3.2(2) and include all usage of internal electric resistance heating are exempt from heat pump controls capable of operating the compressor as the first stage of heating down to an outdoor air temperature of 17°F (-8°C) or lower.
 - 5.3. The heat pump complies with one of the following:
 - 5.3.1. Controlled by a digital or electronic thermostat designed for heat pump use that energizes the supplemental heat only when the heat pump has insufficient capacity to maintain set point or to warm up the space at a sufficient rate.
 - 5.3.2. Controlled by a multistage space thermostat and an outdoor air thermostat wired to energize supplemental heat only on the last stage of the space thermostat and when outdoor air temperature is less than 32°F (0°C) except when in defrost.
 - 5.3.3. The minimum efficiency of the heat pump is regulated by NAECA, its rating meets the requirements shown in Table C403.3.2(2), and its rating includes all usage of internal electric resistance heating.
 - 5.4. The heat pump rated heating capacity is sized to meet the heating load at an outdoor air temperature of 32°F (0°C) or lower and has a rated heating capacity at 47°F (8°C) no less than 2 times greater than supplemental heating capacity in Climate Zone 4 and no less than the supplemental heating capacity in Climate Zone 5, or utilizes the smallest available factory-available internal electric resistance heater.
6. **Air-to-water heat pumps.** Buildings are permitted to utilize electric resistance (for Climate Zone 4 or 5) ~~or fossil-fuel-fired (for Climate Zone 5)~~ auxiliary heating to supplement heat pump heating for hydronic heating systems that meet all of the following conditions:
 - 6.1. Controls for the auxiliary heating sources are configured to lock out the supplemental heat when the outside air temperature is above 36°F (2°C), unless the hot water supply temperature setpoint to the building heat coils cannot be maintained for 20 minutes.
 - 6.2. The heat pump controls are configured to use the compressor as the first stage of heating down to the lowest exterior design temperature for which the equipment is rated except during startup or defrost operation.
 - 6.3. The heat pump rated heating capacity at 47°F (8°C) is no less than 75 percent of the design heating load at 29°F (-2°C).
7. **Ground source heat pumps.** Buildings are permitted to utilize ~~electric resistance~~ supplemental heating for heat pump heating for hydronic heating systems with ground source heat pump equipment that meets all of the following conditions:
 - 7.1. Controls for the auxiliary heating sources are configured to lock out the supplemental heat when the equipment source-side entering water temperature is above 42°F (6°C), unless the hot water supply temperature setpoint to the building heat coils cannot be maintained for 20 minutes.
 - 7.2. The heat pump controls are configured to use the compressor as the first stage of heating.
 - 7.3. The ground source heat exchanger shall be sized so that the heat pump annual heating output is no less than 70 percent of the total annual heating output in the final year of a 30-year simulation using IGSHPA listed simulation

software.

8. **Small systems.** Buildings in which electric resistance or fossil fuel appliances, including decorative appliances, either provide less than 5 percent of the total building HVAC system heating capacity or serve less than 5 percent of the conditioned floor area.
9. **Specific conditions.** Portions of buildings that require fossil fuel or electric resistance space heating for specific conditions approved by the code official for research, health care, process or other specific needs that cannot practicably be served by heat pump or other space heating systems. This does not constitute a blanket exception for any occupancy type.
10. **Kitchen make-up air.** Make-up air for commercial kitchen exhaust systems required to be tempered by Section 508.1.1 of the *International Mechanical Code* is permitted to be heated by using fossil fuel in Climate Zone 5 or electric resistance in Climate Zone 4 or 5.
11. **District energy.** Steam or hot water district energy systems that utilize fossil fuels or electric resistance as their primary source of heat energy, that serve multiple buildings, and that were already in existence prior to the effective date of this code, including more energy-efficient upgrades to such existing systems, are permitted to serve as the primary heating energy source.
12. **Heat tape.** Heat tape is permitted where it protects water-filled equipment and piping located outside of the building thermal envelope, provided that it is configured and controlled to be automatically turned off when the outside air temperature is above 40°F (4°C).
13. **Temporary systems.** Temporary electric resistance heating systems are permitted where serving future tenant spaces that are unfinished and unoccupied, provided that the heating equipment is sized and controlled to achieve interior space temperatures no higher than 40°F (4°C).
14. **Pasteurization.** Electric resistance heat controls are permitted to reset the supply water temperature of hydronic heating systems that serve service water heating heat exchangers during pasteurization cycles of the service hot water storage volume. The hydronic heating system supply water temperature shall be configured to be 145°F (63°C) or lower during the pasteurization cycle.
15. **Freeze protection.** Heating systems sized for spaces with indoor design conditions of 45°F (7°C) and intended for freeze protection are permitted to use electric resistance. The building thermal envelope of any such space shall be insulated in compliance with Section C402.1.
16. **DOAS ERV auxiliary heat.** Dedicated outdoor air systems with energy recovery ventilation are permitted to utilize fossil fuel for Climate Zone 5 or electric resistance in Climate Zone 4 or 5 for auxiliary heating to preheat outdoor air for defrost or as auxiliary supplemental heat to temper supply air to 55°F (13°C) or lower for buildings or portions of buildings that do not have hydronic heating systems.
17. ~~Low-carbon district energy systems. Low-carbon district energy systems that meet the definitions of low-carbon district energy exchange system or low-carbon district heating and cooling or heating only systems.~~
18. ~~Essential facilities. Groups 1-2 and 1-3 occupancies that by regulation are required to have in place redundant emergency-backup systems.~~

C404.2 Service water-heating equipment performance efficiency. Water-heating equipment and hot water storage tanks shall meet the requirements of Table C404.2. The efficiency shall be verified through certification and listed under an approved certification program, or if no certification program exists, the equipment efficiency ratings shall be supported by data furnished by the manufacturer. Water-heating equipment intended to be used to provide space heating shall meet the applicable provisions of Table C404.2.

C404.2.1 Heat pump service water heating system design. Heat pump service water heating systems shall be configured to conform to the requirements of the Northwest Energy Efficiency Alliance Advanced Water Heater Specification v8.1.

Exception: Custom system designs with the review and written approval of the heat pump manufacturer or authorized representative.

C404.2.1 Service water heating system type. 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 in compliance with Section C404.2.1.4.

Exceptions:

1. 24 kW plus 0.1 watts per square foot of building area of electric resistance service water heating capacity is allowed per building.
2. Solar thermal, wastewater heat recovery, other approved waste heat recovery, ground source heat pumps, water source heat pump systems utilizing waste heat, and combinations thereof, are permitted to offset all or any portion of the required HPWH capacity where such systems comply with this code and the *Uniform*

Commented [1]: include per Gary Henikens proposal

Plumbing Code.

- 3.—Systems that comply with the Northwest Energy Efficiency Alliance (NEEA) Commercial Electric Advanced Water Heating Specification.
- 4.—Service hot water systems served by a district energy system that serves multiple buildings and that was in service before the effective date of this code.
- 5.—Commercial dishwashers, commercial food service equipment, and other *approved* process equipment are permitted to utilize electric booster heaters for supply water temperatures 120°F (49°C) or higher.
- 6.—Systems connected to a *low-carbon district energy exchange system* or a *low-carbon district heating and cooling or heating only system*.
- 7.—Essential facilities. Groups 1-2 and 1-3 occupancies that by regulation are required to have in place redundant emergency backup systems.

C404.2.1.1 Primary heat pump system sizing. The primary heat pump service water heating system shall be sized to deliver no less than 50 percent of the calculated demand for service hot water production during the peak demand period. Demand shall be calculated using the equipment manufacturer's selection criteria or another *approved* methodology with entering dry bulb or wet bulb outdoor air temperature at 40°F (4°C) for air source heat pumps, or 44°F (7°C) ground temperature for ground source heat pumps. Electric air source heat pumps shall also be sized to deliver no less than 25 percent of the calculated demand for service hot water production during the peak demand period when entering dry bulb or wet bulb outdoor air temperature is 24°F (-4°C). The remaining primary service output may be met by fossil fuel, electric resistance, or heat pump water heating systems.

Exception: Twenty five percent sizing at entering dry bulb or wet bulb air temperature of 24°F (-4°C) is not required for air source heat pumps located in a below grade enclosed parking structure or other ventilated and unconditioned space that is not anticipated to fall below 40°F (4°C) at any time.

C404.2.1.2 Primary hot water storage sizing. The system shall provide sufficient hot water to satisfy peak demand period requirements.

C404.2.1.3 System design. The service water heating system shall be configured to conform to one of the following provisions:

- 1.—For *single-pass heat pump water heaters*, *temperature maintenance* heating provided for reheating return water from the building's heated water circulation system shall be physically decoupled from the primary service water heating system storage tank(s) in a manner that prevents destratification of the primary system storage tanks. *Temperature maintenance* heating is permitted to be provided by electric resistance, fossil fuel, or a separate dedicated heat pump system.
- 2.—For *multi-pass heat pump water heaters*, *recirculated temperature maintenance* water is permitted to be returned to the primary water storage tanks for reheating.
- 3.—For unitary heat pump water heaters, located in conditioned space, are permitted, where they are sized to meet all calculated service water heating demand using the heat pump compressor, and not supplementary heat.

C404.2.1.3.1 Mixing valve. A thermostatic mixing valve capable of supplying hot water to the building at the user temperature setpoint shall be provided, in compliance with requirements of the *Uniform Plumbing Code* and the HPWH manufacturer's installation guidelines. The mixing valve shall be sized and rated to deliver tempered water in a range from the minimum flow of the *temperature maintenance* recirculation system up to the maximum demand for the fixtures served.

C404.2.1.4 Supplemental water heating. Total supplemental water heating equipment shall not have an output capacity greater than the total summed capacity of all primary water heating equipment. For the purposes of determining this supplemental water heating allowance, the capacity of primary water heating equipment shall be evaluated at 40°F (4°C) entering dry bulb or wet bulb outdoor air temperature for air source heat pumps, 44°F (7°C) ground temperature for ground source heat pumps, and at the nameplate input rate for all other water heater system types. Supplemental heating is permitted for the following uses:

- 1.—*Temperature maintenance* of heated water circulation systems, physically separate from the primary service water heating system.
- 2.—Defrost of compressor coils.
- 3.—Heat tracing of piping for freeze protection or for *temperature maintenance* in lieu of recirculation of hot water.
- 4.—Backup or low ambient temperature conditions, where all of the following are true:
 - 4.1.—During normal operations, the supplemental heating is controlled to operate only when the entering air temperature at the air source HPWH is below 40°F (4°C), and the primary HPWH compressor continues to operate together with the supplemental heating.
 - 4.2.—The primary water heating equipment cannot satisfy the system load due to equipment failure or entering

air temperature below 40°F (4°C).

C404.2.1.5 System fault detection. The control system shall be capable of and configured to send automatic error alarms to building or maintenance personnel upon detection of equipment faults, low leaving water temperature from primary storage tanks, or low hot water supply delivery temperature to building distribution system.

SECTION C406 EFFICIENCY PACKAGES

C406.1 Additional energy efficiency and load management measures credit requirements. The project as defined in the building permit shall meet the following requirements as applicable:

1. New buildings, changes in space conditioning category, change of occupancy group, and building additions in accordance with Chapter 5 shall comply with sufficient measures from Section C406.2 so as to achieve the minimum number required efficiency credits shown in Table C406.1.
2. New buildings greater than 5000 gross square feet of floor area shall comply with sufficient measures from Section C406.3 so as to achieve the minimum number of required load management credits shown in Table C406.1.
3. Tenant spaces shall comply in accordance with Section C406.1.1.
4. Projects using discrete area credit weighting shall comply in accordance with Section C406.1.2.

Exceptions:

1. Low energy spaces in accordance with Section C402.1.1.1, equipment buildings in accordance with Section C402.1.2, unconditioned spaces, open parking garages, and enclosed parking garages that comply with sufficient measures from Table C406.2(1) to achieve a minimum of 50 percent of the efficiency credits required for new construction. Such projects shall be exempt from the load management requirements in Table C406.1.
2. Building additions that have less than 1,000 square feet of *conditioned floor area* that comply with sufficient measures from Table C406.2(1) to achieve a minimum of 50 percent of the efficiency credits required for additions.
3. Warehouses are exempt from the load management credit requirements in Table C406.1.

**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	259 54 108	290 41 82	170 42 84	102 48 96	263 74 148	217 49 98
Building additions energy efficiency credit requirement	C406.2	130 27 54	145 20 40	85 21 42	51 23 46	132 36 72	109 21 42
New building load management credit requirement	C406.3	42	45	27	45	43	26

Commented [GH2]: Credit requirements should be recalculated by PNNL to be based on source energy. The proposed concept is to double the amount of credits required.

C406.2 Additional energy efficiency credit measures. Each energy efficiency credit measure used to meet credit requirements for the project shall include efficiency that is greater than the energy efficiency required for the building type and configuration requirements in Sections C402 through C405. Measures installed in the project that meet the requirements in Sections C406.2.1 through C406.2.14 shall achieve the credits listed for the measure and occupancy group in Table C406.2(1) or Table C406.2(2) or where calculations required by Sections C406.2.1 through C406.2.14 create or modify the table credits, the credits achieved shall be based upon the section calculations.

Projects that chose to comply with the fossil fuel pathway in Section C401.3 shall use Table C406.2(2) to achieve credits.

For mixed fuel space heating systems, the number of space heating energy efficiency credits available for measures with a prorating flag "Heat" are calculated using the following equation:

$$C_{SH} = CHP_{SH} \times B/C + CFF_{SH} \times (1 - B/C)$$

Where:

- C_{SH} = Blended credits for mixed fuel systems.
- CHP_{SH} = Credits available in Table C406.2(1).
- CFF_{SH} = Credits available in Table C406.2(2).
- B = Installed space heating capacity in kBTU/h of space heating appliances that comply with any of the exceptions to Section C403.1.4.
- C = Total installed space heating capacity in kBTU/h of all space heating appliances.

For mixed fuel service water heating systems, the number of service water heating energy efficiency credits available for measures with a prorating flag "SWH" are calculated using the following equation:

$$C_{WH} = CHP_{WH} \times B/C + CFF_{WH} \times (1 - B/C)$$

Where:

- C_{WH} = Blended credits for mixed fuel systems.
- CHP_{WH} = Credits available in Table C406.2(1).
- CFF_{WH} = Credits available in Table C406.2(2).
- B = Installed service water heating capacity in kBTU/h of service water heating appliances that comply with any of the exceptions to Section C404.2.1.
- C = Total installed service water heating capacity in kBTU/h of all service water heating appliances.

Commented [3]: Go back to having two tables, one for each, that can be pro-rated.

TABLE C406.2(1)
EFFICIENCY MEASURE CREDITS

Measure Title	Applicable Section	Prorating Flag	Occupancy Group					
			Group R-1	Group R-2	Group B	Group E	Group M	All Other
1. Dwelling unit HVAC control	C406.2.2	Heat	NA	7	NA	NA	NA	NA
2. Improved HVAC TSPR ^a	C406.2.2.1	Heat	NA	8	11	17	22	NA
3. Improve cooling and fan efficiency	C406.2.2.2	Heat	2	2	3	4	3	2
4. Improve heating efficiency	C406.2.2.3	Heat	2	3	3	10	16	7
5. Improved low-carbon district energy system (10% better)	C406.2.2.4		3	3	4	11	17	8
6. Improved low-carbon district energy system (20% better) ^b	C406.2.2.5		9	10	12	33	52	24
7. High performance DOAS	C406.2.2.6	Heat	31	31	21	39	40	21/ (A) 40 ^c
8. Fault detection & diagnostics (FDD)	C406.2.2.7	Heat	2	2	2	6	9	4
9. 10% reduced lighting power	C406.2.3.1	Heat	7	4	18	16	20	15
10. 20% reduced lighting power ^d	C406.2.3.2	Heat	13	8	36	32	40	29
11. Lamp efficacy improvement	C406.2.3.3	Heat	5	6	NA	NA	NA	NA
12. Residential lighting control	C406.2.4.1	Heat	NA	8	NA	NA	NA	NA
13. Enhanced lighting control	C406.2.4.2	Heat	1	1	6	6	11	6
14. Renewable energy	C406.2.5			12	13	13	40	11
15. Shower drain heat recovery	C406.2.6.1	SWH	9	30	NA	3	NA	NA
16. Service water heat recovery	C406.2.6.2	SWH	35	111	13	14	(Grocery) 41 ^e	NA
17. Heat pump water heating	C406.2.6.3	SWH	72	54	1	13	(Grocery) 5 ^e	20 ^f
18. High efficiency service water heating, gas-fired	C406.2.6.4	SWH	NA	NA	NA	NA	NA	NA
19. Heat trace system	C406.2.7.1	SWH	6	13	4	1	NA	6
20. Point of use water heater	C406.2.7.2	SWH	NA	NA	10	5	NA	NA

-Continued-

**TABLE C406.2(1)Continued
EFFICIENCY MEASURE CREDITS**

Measure Title	Applicable Section	Prorating Flag	Occupancy Group					
			Group R-1	Group R-2	Group B	Group E	Group M	All Other
21. Service hot water distribution right sizing	C406.2.8	13		42	NA	NA	NA	NA
22. High performance service hot water temperature maintenance system	C406.2.9	6		13	4	1	NA	6
23. High efficiency service hot water circulation system	C406.2.10	3		6	2	1	NA	4
24. Low flow residential showerheads	C406.2.11	SWH	3	3	NA	NA	NA	NA
25. Enhanced envelope performance ^g	C406.2.12	Heat	24	20	13	5	19	14
26. Base reduced air leakage ^g	C406.2.13.1		29	24	6	3	9	11
27. Enhanced reduced air leakage ^g	C406.2.13.2	Heat	53	44	11	5	16	20
28. Enhanced commercial kitchen equipment	C406.2.14	Heat	30 ^h	18 ^h	18 ^h	30 ^h	30 ^h	34 ^h
29. Enhanced residential kitchen equipment	C406.2.15	Heat	12	19	NA	NA	NA	NA
30. Enhanced residential laundry equipment	C406.2.16	Heat	NA	6	NA	NA	NA	NA
31. Heat pump clothes dryers	C406.2.17	Heat	6	6	NA	NA	NA	NA
32. Efficient elevator equipment	C406.2.18	Heat	3	5	5	5	4	4

- a. Projects using Item 2 shall not use Items 3 through 5.
- b. Projects using C406.2.2.5 shall not use C406.2.2.4.
- c. For C406.2.2.6, occupancy Group A achieves 40 credits while other occupancy groups within the "all other" category achieve 24 credits.
- d. Projects using C406.2.3.2 shall not use C406.2.3.1.
- e. Service water heat recovery and heat pump water heating are available in Group M only for grocery stores larger than 10,000 ft². Large mixed retail with full grocery and butcher sections shall achieve half the credits. This credit is not available where refrigeration recovery to heat service hot water is used to meet the requirements of Section C403.9.2.3.
- f. Heat pump water heating efficiency credits are available in the "all other" category only for Group A-2.
- g. Buildings or building areas that are exempt from the thermal envelope requirements in accordance with Sections C402.1.1 and C402.1.2, do not qualify for this package.
- h. Additional energy efficiency credits, up to the maximum shown in Table C406.2(1), shall be calculated according to Section C406.2.11.

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

Measure Title	Applicable Section	Prorating Flag	Occupancy Group					
			Group R-1	Group R-2	Group B	Group E	Group M	All Other
1. Dwelling unit HVAC control	C406.2.2	Heat	NA	<u>78</u>	NA	NA	NA	NA
2. Improved HVAC TSPR ^a	C406.2.2.1	Heat	NA	<u>89</u>	<u>1442</u>	<u>2249</u>	<u>2924</u>	NA
3. Improve cooling and fan efficiency	C406.2.2.2	Heat	<u>1042</u>	<u>68</u>	<u>1344</u>	<u>88</u>	<u>840</u>	<u>940</u>
4. Improve heating efficiency	C406.2.2.3	Heat	2	3	<u>83</u>	<u>344</u>	<u>948</u>	<u>58</u>
5. Improved low- carbon district energy system (10% better)	C406.2.2.4		3	3	4	<u>1142</u>	<u>1749</u>	<u>89</u>
6. Improved low- carbon district energy system (20% better) ^b	C406.2.2.5		<u>940</u>	<u>1044</u>	<u>1243</u>	<u>3336</u>	<u>5257</u>	<u>2426</u>
7. High performance DOAS	C406.2.2.6	Heat	<u>2734</u>	<u>2734</u>	<u>1823</u>	<u>3443</u>	<u>3544</u>	<u>1823/</u> <u>(A) 35^c</u> <u>40</u>
8. Fault detection & diagnostics (FDD)	C406.2.2.7	Heat	2	2	2	<u>56</u>	<u>89</u>	4
9. 10% reduced lighting power	C406.2.3.1	Heat	<u>87</u>	<u>4</u>	<u>2048</u>	<u>1846</u>	<u>2220</u>	<u>1745</u>
10. 20% reduced lighting power ^d	C406.2.3.2	Heat	<u>1443</u>	<u>98</u>	<u>4036</u>	<u>3532</u>	<u>4440</u>	<u>3229</u>
11. Lamp efficacy improvement	C406.2.3.3	Heat	<u>65</u>	<u>76</u>	NA	NA	NA	NA
12. Residential lighting control	C406.2.4.1	Heat	NA	<u>98</u>	NA	NA	NA	NA
13. Enhanced lighting control	C406.2.4.2	Heat	1	1	<u>76</u>	<u>76</u>	<u>1244</u>	<u>76</u>
14. Renewable energy	C406.2.5		7	12	13	13	10	11
15. Shower drain heat recovery ⁱ	C406.2.6.1	SWH	<u>940</u>	<u>3033</u>	NA	3	NA	NA
16. Service water heat recovery ⁱ	C406.2.6.2	SWH	35	111	13	14	(Grocery) 41 ^e	NA
17. <u>Service water heating equipment efficiency</u> Heat pump water heating	C406.2.6.3	SWH	<u>43518</u>	<u>46320</u>	<u>472</u>	<u>334</u>	(Grocery) 956 ^e	(A-2) 9510 ^f
18. High efficiency service water heating, gas-fired	C406.2.6.4	SWH	59	65	6	44	48	32
19. Heat trace system ⁱ	C406.2.7.1	SWH	6	13	4	1	NA	6

-Continued-

Commented [GH4]: Request that PNNL recalculate all credit values based source energy using the new baseline efficiencies.

Table C406.2(2) - continued
Efficiency Measure Credits
EFFICIENCY MEASURE CREDITS
For Use With Fossil Fuel Compliance Path

Measure Title	Applicable Section	Prorating Flag	Occupancy Group					
			Group R-1	Group R-2	Group B	Group E	Group M	All Other
19 20. Point of use water heater ⁱ	C406.2.7.2	SWH	NA	NA	19	5	NA	NA
20 24. Service hot water distribution right sizing	C406.2.8		13	42	NA	NA	NA	NA
212. High performance service hot water temperature maintenance system	C406.2.9		6	13	4	1	NA	6
223. High efficiency service hot water circulation system	C406.2.10		3	6	2	1	NA	4
234. Low flow residential showerheads	C406.2.11	SWH	3	3	NA	NA	NA	NA
245. Enhanced envelope performance ^{9,i}	C406.2.12	Heat	21 24	18 20	11 13	4 5	17 19	12 14
256. Base reduced air leakage ⁹	C406.2.13.1		29	24	6	3	9	11
267. Enhanced reduced air leakage ⁹	C406.2.13.2	Heat	53	44	11	5	16	20
278. Enhanced commercial kitchen equipment	C406.2.14	Heat	3033 ^h	1820 ^h	1820 ^h	3033 ^h	3033 ^h	3134 ^h
289. Enhanced residential kitchen equipment	C406.2.15	Heat	13 12	21 19	NA	NA	NA	NA
293. Enhanced residential laundry equipment	C406.2.16	Heat	NA	76	NA	NA	NA	NA
304. Heat pump clothes dryers	C406.2.17	Heat	6	6	NA	NA	NA	NA
312. Efficient elevator equipment	C406.2.18	Heat	3	6 5	6 5	6 5	4	4

- a. Projects using Item 2 shall not use Items 3 through 5.
- b. Projects using C406.2.2.5 shall not use C406.2.2.4.
- c. For C406.2.2.6, occupancy Group A achieves 40 credits while other occupancy groups within the "all other" category achieve 21 credits.
- d. Projects using C406.2.3.2 shall not use C406.2.3.1.
- e. Service water heat recovery and heat pump water heating are available in Group M only for grocery stores larger than 10,000 ft². Large mixed retail with full grocery and butcher sections shall achieve half the credits. This credit is not available where refrigeration recovery to heat service hot water is used to meet the requirements of Section C403.9.2.3.
- f. Heat pump water heating efficiency credits are available in the "all other" category only for Group A-2.
- g. Buildings or building areas that are exempt from the thermal envelope requirements in accordance with Sections C402.1.1 and C402.1.2, do not qualify for this package.
- h. Additional energy efficiency credits, up to the maximum shown in Table C406.2(2), shall be calculated according to Section C406.2.1
- i. Credits for these measures should be reduced by 60% if more than 50% of the primary service water heating load is met by appliances with a UEF greater than 1.0.

C406.2.2.3.2 Heating equipment efficiency. Equipment shall exceed the minimum heating efficiency requirements of the least efficient equipment for the size category in all of the tables in Section C403.3.2 by at least 5 percent. Where equipment exceeds the minimum annual heating efficiency requirements of the least efficient equipment for the size category in all of the tables in Section C403.3.1 by more than 5 percent, energy efficiency credits for heating shall be determined using Equation 4-176, rounded to the nearest whole number. Electric resistance heaters for primary heating are not permitted to be used for this credit.

Commented [5]: Mike Kennedy and Greg Johnson: How do we deal with supplemental vs primary capacity?
Commented [6]: Modified based on PNNL input

$$EEC_{SH} = EEC_5 \times \frac{HEI}{\left(1 - \frac{1}{1.05}\right)} \quad \text{Equation 4-176}$$

Where:

EEC_{HESH} = Energy efficiency credits for heating efficiency improvement.

EEC₅ = Section C406.2.2.3.2 credits from Table C406.2(4).

HEI = The ~~lesser of the improvement above minimum heating efficiency requirements or 20 percent (0.20)~~. Where heating efficiency varies by system, use the capacity weighted average percentage for all heating equipment combined. For metrics that increase as efficiency increases, HEI shall be calculated as follows:

$$HEI = 1 - \left[\frac{SHM_{DES MIN}}{SHM_{MIN DES}} \right] - 1$$

Where:

HMSH_{DES} = Design heating efficiency metric, part-load or annualized where available. For heat pumps rated at multiple ambient temperatures, the efficiency at 17°F (- 8.3°C) shall be used. For heat pumps, COPH shall be used. HSPF2 values shall be divided by 3.412 to calculate approximate COP_H, E_r, E_c, or AFUE efficiency metrics are allowed to be used for combustion appliances. The efficiency values shall then be divided by the source energy factor (SEF) from Table C406.2(3) for the appropriate energy source.

HMSH_{MIN} = Minimum required heating efficiency metric, part-load or annualized where available from Section C403.3.2. 0.8 / 1.09 = .734

Table C406.2(3)

Energy Source	Source Energy Factor (SEF)
Electricity	3.17
Natural Gas	1.09
Propane	1.15
Fuel Oil	1.19

Note:

- SEF for electricity from ASHRAE Std 105-2021, Table K-6 Grid Electricity Primary Energy Conversion Factors for Avoided Primary Energy Comparison for the NWPP.
- SEFs for fuels from ASHRAE Std 105-2021, Table K-2 Primary Annual Energy Conversion Factors for National Comparisons

Exceptions:

- In low energy spaces complying with Section C402.1.1 and *semi-heated spaces* complying with Section C402.1.1.2, no less than 90 percent of the installed heating capacity is provided by

Commented [GH7]: The Std 105-2021 SEFs for electricity are based on 2018 eGrid data. We've got an updated SEF for electricity based on 2022 eGrid data that was calculated in exactly the same way using the same tool used to generate the SEFs in Std 105. That updated SEF is 3.03.

electric infrared or gas-fired radiant heating equipment for localized heating applications. Such spaces shall achieve credits for EEC5.

C406.2.6.3 Heat pump water heating. Projects shall achieve credits through compliance with Section C406.2.6.3.1.

C406.2.6.3.1 Heat pump water heater. Credit shall be achieved where the primary heat pump service water heating system is sized to deliver no less than 100 percent of the net calculated demand for service water production during the peak demand period with entering dry bulb or wet bulb outdoor air temperatures at 40°F (4°C) for air source heat pumps, or 44°F (7°C) ground temperature for ground source heat pumps, as calculated using the equipment manufacturer's selection criteria or another approved methodology. For this credit, the net calculated demand shall be the gross building demand less any portion of the demand complying with the exceptions to Section C404.2.1. Supplemental heating is permitted in accordance with Section C404.2.1, but cannot use fossil fuels. Heat pump water heaters shall comply with one of the following:

The COP rating shall be a minimum COP of 3.0 reported at the design leaving heat pump water temperature with an entering air temperature of 60°F (16°C) or lower. For water source equipment, the COP rating will be reported at the design leaving load water temperature with an entering load water temperature of 74°F (23°C) or lower.

The uniform energy factor (UEF) shall be a minimum of 3.40 rated based on U.S. Department of Energy requirements. **Service water heating equipment efficiency.** Service water heating equipment shall exceed the minimum heating efficiency requirements of the least efficient equipment for the size category in all of the tables in Section C404.2 by at least 5 percent. Where service water heating equipment exceeds the minimum annual heating efficiency requirements of the least efficient equipment for the size category in all of the tables in Section C404.2 by more than 5 percent, energy efficiency credits for heating shall be determined using Equation 4-19, rounded to the nearest whole number. This credit is only available for equipment with medium draw pattern or higher.

$$EEC_{WH} = EEC_5 \times \left[1 + \frac{HEI - 0.05}{0.05} \right] \quad \text{Equation 4-19}$$

Where:

- EEC_{WH} ≡ Energy efficiency credits for service water heating efficiency improvement.
- EEC_5 ≡ Section C406.2.6.3 credits from Table C406.2.
- HEI ≡ The improvement above minimum service water heating efficiency. Where the service water heating system include equipment with multiple efficiencies, use the capacity weighted average average for all primary service water heating equipment combined. For metrics that increase as service water heating efficiency increases, HEI shall be calculated as follows:

Where:

$$HEI = 1 - \frac{WH_{MIN}}{WH_{DES}}$$

WH_{DES} = Design heating efficiency metric, part-load or annualized where available. Et, UEF, or COP efficiency metrics are allowed to be used. The efficiency values shall then be divided by the source energy factor (SEF) from Table C406.2(3) for the appropriate energy source.

$WH_{MIN} = 0.6/1.09 = 0.55$ if WH_{DES} is based on UEF and $0.8/1.09 = 0.734$ if WH_{DES} is based on Et or COP.

Renumber all further equations in Section C406.

Suggestion for TAG: Request PNNL or other trusted third part to recalculate Building Performance Factors in Table C407.3(2) and Table C407.3(3)

**TABLE C407.3(2)
BUILDING PERFORMANCE FACTORS (BPF) TO BE
USED FOR COMPLIANCE WITH SECTION C407.3**

Building Area Type	Building Performance Factor
Multifamily	0.51
Healthcare/hospital	0.70
Hotel/motel	0.51
Office	0.44
Restaurant	0.33
Retail	0.41
School	0.35
Warehouse	0.18
All Others	0.43

**TABLE C407.3(3)
SITE ENERGY PERFORMANCE TARGETS TO BE USED
FOR COMPLIANCE WITH SECTION C407.3**

Building Area Type	Building Performance Factor
Multifamily	0.59
Healthcare/hospital	0.72
Hotel/motel	0.62
Office	0.58
Restaurant	0.59
Retail	0.46
School	0.52
Warehouse	0.29
All Others	0.55

C503.4.6 Addition or replacement of heating appliances. Where a mechanical heating appliance is added or replaced, the added or replaced appliance shall comply with Section C401.3, Section C403.1.4, or with an alternate compliance option in Table C503.4.6. Where use of heat pump equipment for space heating is required by this section, it is permissible to utilize the Fossil Fuel Compliance Path in Section C401.3 to attain the credits required for building additions shown in Table C401.3.3.

Exceptions:

1. Terminal unit equipment including, but not limited to, hydronic VAV boxes, electric resistance VAV boxes, electric duct heaters, water source heat pumps, fan coils, or VRF indoor units that are served by an unaltered central system.
2. Air handling equipment with hydronic coils.
3. Air handling equipment designed for 100 percent outdoor air that is not subject to the requirements in Section C403.3.5 or that qualifies for an exception to Section C403.3.5.
4. Replacement of existing oil-fired boilers.
5. Replacement of existing steam boilers with steam distribution to terminal units and the associated boiler feed equipment.
6. Where compliance with Section C403.1.4 would trigger an unplanned utility electrical service upgrade

based on the NEC 220.87 method for determining existing loads.

7. Replacement of heating equipment with equipment that is the same type as where the rated capacity of the new equipment does not exceed the rated capacity of the existing equipment.

**TABLE C503.4.6
COMPLIANCE OPTIONS FOR MECHANICAL HEATING EQUIPMENT ALTERATIONS**

Proposed Heating Equipment Type ^a	Heating Efficiency Table Reference	Alternate Compliance Options to Section C403.1.4
1 Air-Cooled Unitary Heat Pumps	Table C403.3.2(2)	<ol style="list-style-type: none"> 1. Compliance with C403.1.4, except heat pump rated capacity in accordance with Section C403.1.4 exception 5d is permitted to be sized equal to the supplemental internal resistance heating capacity in Climate Zone 4 or 5c 2. Compliance with C403.1.4, except electric resistance mixed-air preheat is permissible^c
2 Packaged terminal, single-package vertical, and room air-conditioner heat pumps	Table C403.3.2(4)	<ol style="list-style-type: none"> 1. Compliance with C403.1.4, except heat pump rated capacity in accordance with Section C403.1.4 Exception 5d is permitted to be sized equal to the supplemental internal resistance heating capacity in Climate Zone 4 or 5
3 Furnaces, duct furnaces, and unit heaters	Table C403.3.2(5)	Efficiency: +5% ^b
4 Gas-fired hot water boilers with fewer than 80% of served coils replaced	Table C403.3.2(6)	Efficiency: +5% ^b
5 Variable-refrigerant flow air-to-air and applied heat pumps	Table C403.3.2(9)	No alternate compliance option
6 DX-DOAS equipment	Table C403.3.2(12) and Table C403.3.2(13)	1. DX-DOAS is provided with heat recovery if not required by C403.3.5.1.
7 Water-source heat pumps	Table C403.3.2(14)	No alternate compliance option

- a. Includes replacement of equipment with a unit that is the same type or higher efficiency and the same or lower capacity, or a replacement of one equipment type with a different equipment type.
- b. Equipment shall have a capacity-weighted average heating system efficiency that is five percent better than that shown in the reference table (1.05 x values in reference table).
- c. Option 1 and Option 2 can be combined.

Commented [8]: Lisa Rosenow: Can we keep this somehow?

C503.5 Service water heating equipment. All new service water heating systems, equipment, and components of existing systems that are altered or replaced shall comply with Section C407 or Sections C404., C408.3, C409.5, and C501.6. Additions or alterations shall not be made to an existing service water heating system that will cause the existing system to become out of compliance. Where use of heat pump equipment for service water heating is required by this section, it is permissible to utilize the Fossil Fuel Compliance Path in Section C401.3 to attain the credits required for building additions shown in Table C401.3.3.

Exceptions:

1. The following equipment is not required to comply with Section C401.3 or Section C404.2.1, as applicable:

- 1.1. ~~Replacement of service water heating appliances with equipment that is the same type and has the same or higher efficiency and the same or lower capacity, provided there are no other alterations made to the existing service water heating system size or configuration.~~
- 1.2. ~~Replacement of any of the following water heater appliances:
 - 1.2.1. ~~Electric water heaters with an input of 12 kW or less.~~
 - 1.2.2. ~~Gas storage water heaters with an input of 75,000 Btu/h or less.~~
 - 1.2.3. ~~Gas instantaneous water heaters with an input of 200,000 Btu/h or less and 2 gallons or less of storage.~~~~
- 1.3. ~~Where it has been determined by the code official that existing building constraints including, but not limited to, available floor space or ceiling height, limitations of the existing structure, or electrical service capacity, make compliance technically infeasible.~~
2. ~~Systems included in Section C403.5 that serve individual dwelling units and sleeping units~~