R408.2 sample 9 (1919)

IECC RE: TABLE R408.2 (New)

Proponents:

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2024 International Energy Code [RE] [RE Project] R3

Revise as follows:

TABLE R408.2 CREDITS FOR ADDITIONAL ENERGY EFFICIENCY

Measure Number	Measure Description	Credit Value								
		Climate Zone 0 & 1	Climate Zone 2	Climate Zone 3	Climate Zone 4 except Marine	Climate Zone 4 Marine	Climate Zone 5	Climate Zone 6	Climate Zone 7	Climate Zone 8
R408.2.1.1(1)	≥2.5% Reduction in total TC	0	0	0	1	1	1	1	1	1
R408.2.1.1(2)	≥5% reduction in total TC	0	1	1	2	1	2	2	2	2
R408.2.1.1(3)	>7.5% reduction in total TC	0	1	2	2	2	2	3	3	3
R408.2.1.1(4)	>10% reduction in total TC	1	1	2	3	3	4	4	5	5
R408.2.1.1(5)	>15% reduction in total TC	1	2	2	4	4	5	6	7	8
R408.2.1.1(6)	>20% reduction in total TC	2	4	4	5	6	7	8	9	11
R408.2.1.1(7)	>30% reduction in total TC	3	6	6	8	8	11	12	13	16
R408.2.1.2(2)	U-factor and SHGC for vertical fenestration per Table R408.2.1	1	1	1	2	1	1	1	1	
R408.2.1.3	Roof reflectance (roof is part of the *building thermal envelope* and directly above cooled, conditioned space)	1	1	0	0	0	0	0	0	0
R408.2.1.3	Roof reflectance (roof is above an unconditioned space that contains a duct system)	1	1	0	0	0	0	0	0	0
R408.2.1.4	Reduced air leakage	1	1	1	2	1	3	NA	NA	NA

R408.2.2(1)[b]	Ground source heat pump	~~4~~14	~~8~~14	~~12~~14	~~19~~15	~~14~~10	~~25~~15	~~32~~17	~~35~~18	~~46~~21
R408.2.2(2) [b]	High Performance Cooling (Option 1)	5	4	3	2	1	1	1	1	1
R408.2.2(3)[b]	High Performance Cooling (Option 2)	6	4	3	2	1	1	1	1	1
R408.2.2(4) [b]	High Performance Gas furnace (Option 1)	NA	NA	NA	NA	NA	6	7	7	NA
R408.2.2(5)[b]	High Performance Gas furnace (Option 2)	0	1	2	4	3	NA	NA	NA	8
R408.2.2(6)[b]	High Performance Gas furnace (Option 3)	0	1	1	3	NA	NA	NA	NA	NA
R408.2.2(7)[b]	High Performance Gas furnace and cooling (Option 1)	5	5	4	5	NA	NA	NA	NA	NA
R408.2.2(8)[b]	High Performance Gas furnace and cooling (Option 2)	6	5	5	6	NA	NA	NA	NA	NA
R408.2.2(9)[b]	High Performance Gas furnace and heat pump (Option 1)	13	12	9	7	NA	NA	NA	NA	NA
R408.2.2(10)[b]	HIgh Performance Heat pump with electric resistance backup (Option 1)	13	12	11	12	NA	NA	NA	NA	NA
R408.2.2(11)[b]	High Performance Gas furnace and cooling (Option 3)	NA	NA	NA	NA	4	6	7	7	9
R408.2.2(12) [b]	High Performance Gas furnace and cooling (Option 4)	NA	NA	NA	NA	5	7	8	8	10
R408.2.2(13)[b]	High Performance Gas furnace and heat pump (Option 2)	NA	NA	NA	NA	8	0	-1	-3	-7
R408.2.2(14)[b]	High Performance Heat pump with electric resistance backup (Option 2)	NA	NA	NA	NA	8	12	13	14	16

R408.2.3(1) (a)[d]	Gas-fired storage water heaters(option 1)	8	7	7	5	6	4	4	3	2
R408.2.3(1) (b)[d]	Gas Fired Storage Water Heater(option 2)	9	8	8	6	7	5	4	4	3
R408.2.3(2) (a)[d]	Gas-fired instantaneous water heaters (option 1)	10	9	9	6	7	5	5	4	3
R408.2.3(2) (b)[d]	Gas-fired instantaneous water heaters (option 2)	11	10	9	6	7	6	5	4	3
R408.2.3(3) (a)[d]	Electric water heaters (option 1)	12	11	11	8	8	5	4	4	3
R408.2.3(3) (b)[d]	Electric water heaters (option 2)	12	11	11	8	8	5	4	4	3
R408.2.3(4)[d]	Electric water heaters (option 3)	11	11	11	8	8	5	4	4	3
R408.2.3(5) (a)[d]	Electric water heaters (option 4)	8	10	11	8	11	7	5	5	
R408.2.3(5) (b)[d]	Electric water heaters (option 5)	9	11	12	8	11	7	6	5	4
R408.2.3(5)[d]	Electric water heaters (option 6)	12	11	11	8	8	5	4	4	3
R408.2.3(6) (a)[d]	Solar hot water heating system (option 1)	13	13	13	9	8	5	4	4	3
R408.2.3(6) (b)[d]	Solar hot water heating system (option 2)	10	9	9	6	7	6	5	4	3
R408.2.3.1 [c]	Compact hot water distribution	2	2	2	2	2	2	2	2	2
R408.2.4(1)[c]	More efficient distribution system	3	4	5	7	8	10	10	10	14
R408.2.4(2)[c]	100% of *duct systems* in conditioned space	2	3	4	6	7	9	9	~~9~~9	13
R408.2.4(3)[c]	≥80% of ductwork inside *conditioned space*	2	3	3	5	6	7	7	7	9
R408.2.4(4)[c]	Reduced total duct leakage	1	1	1	1	1	1	2	2	2
R408.2.5(1)	ERV or HRV installed	0	0	0	0	1	3	2	2	2
R408.2.5(2)[c]	≤2.0 ACH50 with ERV or HRV installed	0	0	0	4	4	8	5	5	5

R408.2.5(3)[c]	≤2.0 ACH50 with a *balanced ventilation system*	0	0	0	0	0	0	4	4	4
R408.2.5(4)[c]	≤1.5 ACH50 with ERV or HRV installed	0	0	0	6	5	10	9	9	9
R408.2.5(5)[c]	≤1.0 ACH50 with ERV or HRV installed	0	0	1	7	6	12	12	12	12
R408.2.6[a]	Energy efficient appliances	1	1	1	1	1	1	0	0	0
R408.2.7	On-site renewable energy measures	17	16	17	11	11	9	8	7	4
R408.2.8	Off-site renewable energy measures	71	65	62	55	46	41	43	41	39
R408.2.8b	Off-site renewable energy measure	1	1	1	1	1	1	1	1	1
R408.2.9[c]	Demand responsive thermostat	1	1	1	1	1	1	1	1	1
R408.2.11	Whole home lighting control	0	0	0	0	0	0	0	0	0
R408.2.12	Higher efficacy lighting	0	0	0	0	0	0	0	0	0

a. Where the measure is selected, each dwelling unit, sleeping unit, and common areas where the measure is applicable must have the measure installed.

b. Where multiple heating or cooling systems are installed, credits shall be determined using a weighted average of the square footage served by each system.

c. Where the measure is selected, each dwelling unit and sleeping unit must comply with the measure.

d. Where the measure is selected, each dwelling unit shall be served by a water heater meeting the applicable requirements. Where multiple service water heating systems are installed, credits shall be determined using a weighted average of the square footage served by each system.

SEER2: Seasonal Energy Efficiency Ratio, HSPF2: Heating Season Performance Factor, EER2: Energy Efficiency Ratio, COP: Coefficient of Performance

Reason:

The points proposed for the GSHP measure seemed higher than I expected. It was explained that the savings & points were calculated outside the software used to simulate the other HVAC measures. In consultation with PNNL and Dandelion Energy, I reviewed their savings calculations and worked with them to modify inputs in their tool to provide different values, while maintaining the inherent savings potential of GSHP beyond traditional ASHP. See next page for original and revised calculations and points.

Cost Impact:

The code change proposal will neither increase nor decrease the cost of construction.

Change will neither increase or decrease the cost of construction

This table shows the calculations that led to the points shown for this measure in PCD2. Since GSHP is not currently able to be simulated, the cooling and heating energy use for the PNNL prototypes were revised based on a ratio of the 'adjusted' efficiencies. Yellow columns show the Baseline efficiencies that were used for the Baseline ASHP. Green columns show the values assumed for the GSHP, which are higher than the 3.1 COP and 16.1 EER that are required for this measure.

Climate Zone	Annual Avg OAT	Avg 99% OAT	Avg 1% OAT	Location Adjusted ASHP HSPF	Location Adjusted ASHP SEER	Location Adjusted GSHP COPavg	Location Adjusted GSHP EERavg	Reduction Factor: Heating Energy Use with Geo	Reduction Factor: Cooling Energy Use with Geo	Geo Energy Reduction % of Total from Baseline	Geo Compared to Baseline Heating/Cooling
Climate Zone 1	76.33	53.65	91.63	11.77	12.94	4.66	14.34	73.80%	90.19%	3.6%	30.4%
Climate Zone 2	69.38	34.60	94.82	8.98	12.69	4.61	15.38	57.04%	82.54%	8.3%	25.5%
Climate Zone 3	62.26	28.02	92.68	8.16	12.86	4.42	17.05	54.07%	75.41%	12.0%	20.5%
Climate Zone 4	55.90	15.23	91.30	6.79	12.96	4.21	18.93	47.29%	68.46%	18.6%	20.4%
Climate Zone 4C	52.39	33.24	73.95	8.80	14.28	4.09	20.08	63.09%	71.08%	13.7%	25.4%
Climate Zone 5	49.63	6.59	87.07	6.02	13.28	4.00	21.03	44.07%	63.15%	25.3%	21.9%
Climate Zone 6	44.08	-2.75	83.18	5.34	13.58	3.88	23.00	40.37%	59.02%	32.1%	23.0%
Climate Zone 7	38.14	-9.25	74.63	4.96	14.22	3.84	25.14	37.86%	56.58%	34.7%	21.8%
Climate Zone 8	24.55	-30.65	66.52	4.22	14.84	3.63	29.65	34.11%	50.04%	45.8%	24.0%

Measure Number	Measure Description	Climate Zone								
		Zone 0 & 1	Zone 2	Zone 3	Zone 4	Zone 4C	Zone 5	Zone 6	Zone 7	Zone 8
R408.2.2(11)	Ground Source Heat Pump	4	8	12	19	14	25	32	35	46

In reviewing the approach above, the proponent suggested using the same Baseline ASHP efficiencies used in the other measure calculations and to also use the 3.1 COP and 16.1 EER that is listed in the measure description in all CZs. This results in lower points in some colder climates zones and higher points in some warmer climate zones. While during operation GSHP may achieve different efficiencies than rated, for consistency, the rated efficiencies should be used. While the points have changed, in each CZ, they still reflect a higher point value than an ASHP.

Inputs:						
Home Type:	All	**IECC:**	IECC_2021			
	GSHP:	**COP:**	3.1	**EER:**	16.1	https://www.energystar.gov/products/heat_pumps_geothermal/key_product_criteria
	ASHP Option 1 (Zones 0-3):	**HSPF2:**	7.8	**SEER2:**	15.2	[From IECC-RE-PCD2, p. 75]
	ASHP Option 2 (Zones 4-8):	**HSPF2:**	8.1	**SEER2:**	15.2	[From IECC-RE-PCD2, p. 75]

Measure Number	Measure Description	Climate Zone								
		Zone 0 & 1	Zone 2	Zone 3	Zone 4	Zone 4C	Zone 5	Zone 6	Zone 7	Zone 8
R408.2.2(1)	Ground Source Heat	14	14	14	15	10	15	17	18	21

Measure Number	Measure Description	Climate Zone									
		Zone 0 & 1	Zone 2	Zone 3	Zone 4	Zone 4C	Zone 5	Zone 6	Zone 7	Zone 8	
R408.2.2(10)	High Performance	13	12	11	NA	NA	NA	NA	NA	NA	[From RE2D-59-23]

Measure Number	Measure Description	Climate Zone									
		Zone 0 & 1	Zone 2	Zone 3	Zone 4	Zone 4C	Zone 5	Zone 6	Zone 7	Zone 8	
R408.2.2(14)	High Performance	NA	NA	NA	12	8	12	13	14	16	[From RE2D-59-23]

GSHP vs. High-Performance ASHP					Heating		Cooling		
Climate Zone	ASHP HSPF2	ASHP SEER2	GSHP COP	GSHP EER	ASHP Heating Use (kBtu)	GSHP : ASHP Heating Efficiency Ratio	ASHP Cooling Use (kBtu)	GSHP : ASHP Cooling Efficiency Ratio	Geo Performance vs. ASHP - Weighted by Usage
Climate Zone 1	7.8	15.2	3.1	16.1	877.0	1.36	15,564.1	1.06	1.08
Climate Zone 2	7.8	15.2	3.1	16.1	4,530.7	1.36	12,043.2	1.06	1.14
Climate Zone 3	7.8	15.2	3.1	16.1	9,266.4	1.36	6,823.0	1.06	1.23
Climate Zone 4	8.1	15.2	3.1	16.1	16,765.7	1.31	5,240.2	1.06	1.25
Climate Zone 4C	8.1	15.2	3.1	16.1	16,765.7	1.31	5,240.2	1.06	1.25
Climate Zone 5	8.1	15.2	3.1	16.1	28,221.7	1.31	4,069.0	1.06	1.28
Climate Zone 6	8.1	15.2	3.1	16.1	42,444.6	1.31	3,437.8	1.06	1.29
Climate Zone 7	8.1	15.2	3.1	16.1	48,036.8	1.31	2,007.7	1.06	1.30
Climate Zone 8	8.1	15.2	3.1	16.1	91,183.3	1.31	1,736.6	1.06	1.30