International Energy Conservation Code
Consensus Committee-Residential

Draft Meeting Agenda (6/27/23 posting)

Webex Meeting Link

June 29, 2023
2:00 PM Eastern until complete

Committee Chair: JC Hudgison, CBO, Assoc. AIA
Committee Vice Chair: Bridget Herring

1. Call to order.

2. Meeting Conduct.
   a. Identification of Representation/Conflict of Interest
   b. ICC Council Policy 7 Committees: Section 5.1.10 Representation of Interests
   c. ICC Code of Ethics: ICC advocates commitment to a standard of professional behavior that exemplifies the highest ideals and principles of ethical conduct which include integrity, honesty, and fairness. As part of this commitment it is expected that participants shall act with courtesy, competence and respect for others.
   d. ICC Antitrust Compliance Guideline

3. Roll Call.

4. Approve Agenda

5. Approve Minutes-April 27, 2023

6. Administrative issues-staff
   a) Next steps
   b) Activating Project Team (Richard Truitt, Amy Schmidt, Mark Rodriguez, Vice Chair Bridget Herring selected at 8/30/21 meeting)

7. Action Items-
   RED1-76-22 Off site renewables
   - RECD1-13-22 Table R408 Values. See PNNL document included in agenda and linked excel file. Note: Brick shading – these are cells that are forced to 0 as a part of the measure proposal.

8. Other business.

9. Upcoming meetings. TBD

10. Adjourn.

FOR FURTHER IECC Residential INFORMATION BE SURE TO VISIT THE ICC WEBSITE:
IECC Residential Website

FOR ADDITIONAL INFORMATION, PLEASE CONTACT:

Kristopher Stenger, AIA, CBO
Director of Energy Programs
International Code Council
kstenger@iccsafe.org

Tap to join from a mobile device (attendees only)

1-844-740-1264,,25964789288## USA Toll Free

+1-415-655-0003,,25964789288## US Toll

Join by phone

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+1-415-655-0003 US Toll

RED1-76-22

IECC: SECTION 202, TABLE R408.2, R408.2.7, R408.2.8 (New)

Proponents:

Alex Smith, representing NAHB (asmith@nahb.org)

2024 International Energy Conservation Code [RE Project]

ON-SITE RENEWABLE ENERGY. Energy from renewable energy resources harvested at the building site.

Revise as follows:

TABLE R408.2 CREDITS FOR ADDITIONAL ENERGY EFFICIENCY
Portions of table not shown remain unchanged.

Measure Number	Measure Description	Credit Value							
		Climate Zone 0 & 1	Climate Zone 2	Climate Zone 3	Climate Zone 4	Climate Zone 4C	Climate Zone 5	Climate Zone 6	Climate Zone 7
R408.2.7	On-site renewable energy measures	17	16	17	11	11	9	8	7
R408.2.8	Off-site renewable energy measuress	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD

R408.2.7 On-site renewable energy.

Renewable energy resources shall be permanently installed that have the rated capacity to produce a minimum of 1.0 watt of on-site renewable energy per square foot of conditioned floor area. To qualify for this option, renewable energy certificate (REC) documentation shall meet the requirements of R404.4.

Add new text as follows:

R408.2.8 Off-site renewable energy.

The building shall have a renewable energy power purchase agreement with a duration of not less than 15 years from a utility or a community renewable energy facility and for not less than 80 percent of the estimated whole-building electric use on an annual basis.

Reason:

This proposal adds off-site renewables to the list of options for compliance with Section R408. Off-site renewables have the potential to provide viable strategies for deploying renewable energy resources at-scale. On-site renewable energy measures are already acknowledged in Section R408. The proposed language was adopted from the existing Section R404.6.1 addressing off-site renewables via a renewable energy power purchase agreement with a duration of not less than 15 years from a utility or a community renewable energy facility and for not less than 80 percent of the estimated whole-building electric use on an annual basis.

Cost Impact:

The code change proposal will increase the cost of construction.

This change is in Section R408 and would not have an effect on construction costs.

RED1-76-22 Off site renewables

Voted Affirmative with comment:

Martino, Amy

REASONING: Off-site renewable will be necessary to achieve zero-net energy by 2030 and should be introduced in the 2024 IECC. The future of offsite renewable energy is developing in many forms including community generated (off site and on site), private sources, utility etc. Patricia Chawla referenced the innovative Austin Energy program during our consensus meeting. It really summarizes the great potential which we should include and promote. Perhaps a further definition is warranted.

https://austinenergy.com/green-power (general)

https://resource-solutions.org/g2022/

https://www.green-e.org/ (certification program)

GREEN-E® ENERGY CERTIFIED OPTIONS

Green-e® Energy certified renewable energy products are sold in the following different options:

Green Pricing Programs. Renewable electricity sold by electric utilities in regulated electricity markets, offered in addition to the renewable electricity included in standard electricity service. Includes Green Tariffs offered to larger commercial or industrial customers.

Competitive Renewable Electricity. Similar to a green pricing program, but sold by an electric service provider (ESP) in a deregulated electricity market.

Renewable Energy Certificates (RECs). A REC represents the non-electricity, renewable attributes of one MWh of renewable electricity generation, including all the environmental attributes, and is a tradable commodity that can be sold separately from the underlying electricity. RECs allow for a larger and more efficient national market for renewable energy. The REC product type includes PPAs and VPPAs for which only the REC portion of the purchase is certified.

Community Choice Aggregation. Also known as Municipal Aggregation, CCAs allow cities and counties to aggregate customers in a regulated market within a defined jurisdiction to secure alternative electricity supply contracts on a community-wide basis.

Direct and On-Site Certification. Direct Purchasing is a purchase made directly from renewable generators as an alternative to purchasing from a utility, competitive electricity supplier, or a renewable energy certificate marketer. On-Site renewable energy is consumed at the same location where it is produced.

Wiley, Seth

Please clarify when the complete schedule of R408 Credit Values will be provided for review so my support of this Proposal can be confirmed.

Voted Negative with reason:

Amann, Jennifer

This proposal to provide additional energy efficiency credits in section R408 for off-site renewable energy is problematic in several ways.

1. The proposal would provide an as yet undetermined number of points for off-site renewable energy that could be used in lieu of on-site, permanent energy efficiency measures or on-site renewables. The proposal provides insufficient detail to determine how the points for off-site renewables would compare to the points available for on-site efficiency and renewable energy measures.

2. There are many opportunities to improve efficiency in residential buildings that deliver additional value and benefits to the home/ building owner and occupants; these should be prioritized before turning to off-site renewables.

3. The proposal leaves way too many unanswered questions about the contractual details for off-site renewables eligible to receive points under R408 including the method for estimating whole-building energy use, transfer of the contract upon building resale, and REC requirements, among others. It is also unclear how the proposed term of the power purchase agreement compares with the life expectancy of on-site renewables.

Boyce, Amy

This proposal would disproportionally award credit for a measure that is not part of the actual structure. The proposal has not shown itself to be comparable to an on-site solar option in terms of its longevity with respect to benefits as applied to the project. Recommend that option be removed in its entirety.

Chawla, Patricia

R408.2.8 Off-site renewable energy. The building shall have a renewable energy power purchase agreement with a duration of not less than 15 years from a utility or a community renewable energy facility and for not less than 80 percent of the estimated whole-building electric use on an annual basis.

Voted Negative with Reason

While it is easy to support off-site renewable, this proposal as written is difficult to enforce. For new construction of one- and two-family and townhomes for ownership, electric use during the permit period is by the builder, not the homeowner. After certificate of occupancy and transfer of ownership of the home to the homeowner, the homeowner creates their account with the electric utility. At that time the homeowner can choose from whatever renewable energy options the electric utility offers. Since the contract or account is created after certificate of occupancy, the code official is not able to verify compliance. For R2 occupancies, the electric works similarly however there are more accounts and meters to account for. My initial recommendation would be to narrow the scope to be more applicable to scenarios that are more reasonable to enforce. I am happy to work with the proponent to amend the language to be more enforceable.

Edminster, Ann

1) R408 options are based on onsite energy savings. This proposal could allow significant trade-off to measures which improve efficiency of the building and thus weaken the incentives to include those more permanent onsite efficiency measures. 2) There is no clear mechanism for a contract entered into by a builder or developer to be transferred to the homebuyer. 3) The propopsal as written would make more points available for offsite solar than for onsite solar; the two should be comparable. 4) The proposed contract length is not comparable to the life expectancy of onsite solar; while still not comparable, I would support a 15-year term as a good start and to be consistent with Section R404.6.1.

Finlayson, Ian

The proposal to provide credits in section R408 for off-site renewable energy is problematic in several ways. Based on recent energy code development in Massachusetts we heard repeatedly from building code officials and other stakeholders about concerns with extending the scope of the energy code compliance to contracts pertaining to off-site installations. This is adding complexity to code enforcement in a way that is unnecessary.

In terms of achieving our net-zero goals in a timely manner, we collectively need to be advancing on-site solar installations and this proposal would dilute the incentives for that. Instead, adding this proposal appears intended to dilute the impact of R408 in general by providing for one more way to avoid making meaningful improvements to energy performance and efficiency on site.

Gonzalez-Laders, Emma

In general, I am opposed to trading shorter-term measures for provisions with a longer life-span. While power purchase agreements could be a good idea in principle, the parameters under which credits could be earned need to be better defined to ensure parity with other items on the same table. Such parameters should include, at a minimum, a term that is comparable to the life expectancy of on-site renewable measures; a stipulation that the agreement remain with the building or the building site for which the trade-offs were made, not the current owner or agreement signee; and a better determination of energy used or saved. On a mixed-fuel building, for example, a percentage of electricity used does not paint a full picture of the energy consumption of the building or the potential energy saved to make an appropriate determination on the number of credits to be granted.

Herring, Bridget

RED1-76-22: Opposed to permitting off-site renewable energy to be utilized instead of energy efficiency or onsite generation. Agreements for off-site power generation are not something that a code official should be responsible for reviewing and approving. These agreements are made with individuals and are not tied to the property. Delete as follows:

Measure Number	Measure Description	Credit Value							
		Climate Zone 0&1	Climate Zone 2	Climate Zone 3	Climate Zone 4	Climate Zone 4C	Climate Zone 5	Climate Zone 6	Climate Zone 7
R408.2.7	On-site renewable energy measures	17	16	17	11	11	9	8	7
~~R408.2.8~~	~~Off-site renewable energy measures~~	~~TBD~~	~~TBD~~	~~TBD~~	~~TBD~~	~~TBD~~	~~TBD~~	~~TBD~~	~~TBD~~

~~R408.2.8 Off-site renewable energy. The building shall have a renewable energy power purchase agreement with a duration of not less than 15 years from a utility or a community renewable energy facility and for not less than 80 percent of the estimated whole-building electric use on an annual basis.~~.

Kotewa, Lawrence

This proposal to utilize off-site renewable energy as additional energy efficiency credits in section R408 has several issues.

1. This proposal is not equally comparable to other efficiency measures in the R408 Additional Efficiency Path, in that off-site renewables do not physically stay with the home – and thus should not be considered an option instead of other on-site efficiency measures that do meet the "additional efficiency requirement".

2. The proposal is unclear about many important details, such as contracting for off-site renewables eligible to receive points under R408, the method for estimating whole-building energy use, transferring of the contract upon building resale, REC requirements and others.

3. The proposal would provide an undetermined number of points for off-site renewable energy that could be used in lieu of on-site, permanent energy efficiency measures or on-site renewables. The proposal provides insufficient detail to determine how the points for off-site renewables would compare to the points available for on-site efficiency and renewable energy measures. It is also unclear how the proposed term of the power purchase agreement compares with the life expectancy of on-site renewables.

4. There are many opportunities to improve efficiency in residential buildings that deliver additional value and benefits. Energy efficiency/conservation measures such as a tight/well-insulated building envelope and improved mechanical systems/duct systems provide additional benefits such as improved durability and indoor air quality; these should be prioritized before turning to off-site renewables.

Lindburg, Alison

This proposal to utilize off-site renewable energy as additional energy efficiency credits in section R408 has several problems.

1. There are many opportunities to improve efficiency in residential buildings that deliver additional value and benefits. Energy efficiency/conservation measures such as a tight/well-insulated building envelope and improved mechanical systems/duct systems provide additional benefits such as improved durability and indoor air quality; these should be prioritized before turning to off-site renewables.

2. This proposal is not equally comparable to other efficiency measures in the R408 Additional Efficiency Path, in that off-site renewables do not physically stay with the home – and thus should not be considered an option instead of other on-site efficiency measures that do meet the "additional efficiency requirement".

3. The proposal is unclear about many important details, such as contracting for off-site renewables eligible to receive points under R408, the method for estimating whole-building energy use, transferring of the contract upon building resale, REC requirements and others.

4. The proposal would provide an undetermined number of points for off-site renewable energy that could be used in lieu of on-site, permanent energy efficiency measures or on-site renewables. The proposal provides insufficient detail to determine how the points for off-site renewables would compare to the points available for on-site efficiency and renewable energy measures. It is also unclear how the proposed term of the power purchase agreement compares with the life expectancy of on-site renewables.

Lyles, Mark

Comment: RED1-76 provides a "to be determined" number of additional energy efficiency credits for off-site renewable energy in section R408. This proposal lacks sufficient information for determining parity with the on-site renewable energy option in R408 and provides a trade-off opportunity with other more permanent building features available in Table R408.2. At a minimum this proposal should include terms for power purchase agreement that are comparable to the life expectancy of onsite solar and include a clearly defined mechanism for transferring the renewable energy power purchase agreement to the building site.

Reason: Analysis developed in support of REPI-114 determined that on-site renewable energy is cost effective in most climate zones for residential dwellings. As such on-site renewable energy systems should be prioritized through R408 as more permanent benefit to the building and home owner.

Rossmiller, Gil

I am changing my original approval. I now agree that giving credit for any off-site renewable energy can be an issue. Verification that the relationship with the off-site provider after the C.O. would be difficult at best. Ownership transfer is another issue.

Salcido, Rob

The approved version of RED1-076 would provide energy credits across all climate zones in the 40-60 range. This is well above the required 10 credits. A builder could simply apply the measure for off-site renewable energy and select a second measure with only one credit to meet the requirements. There is no provision that on-site energy must be proved unfeasible before off-site renewable energy can be selected as a measure. If on-site renewable energy is cost-effective and feasible, this should be the first choice. To offset 80% of the annual electricity load, mixed fuel homes would need much smaller off-site renewable energy generation thus incentivizing mixed fuel homes. How does a builder/architect complying under the prescriptive requirements ascertain the annual electric consumption of the dwelling/building to determine the amount of off-site renewable energy requirement? I believe this should be spelled out as part of the requirements for this credit.

Potential changes for approval (might exclude this portion).

- Put in place restrictions for this measure that only in cases where on-site renewable energy is not feasible because of shading, area restrictions or lack of solar ready space.
- Only allow 5 credits across all climate zones for off-site renewable energy
- Provide procurement adjustments on off-site renewable energy similar to commercial off-site solar
- Require that off-site renewable energy to offset 80% of total energy, not just electric energy. All electric homes would then require smaller off-site renewable energy.

Schmidt, Amy

A 15 year contract for a home that is expected to be in service for 17-100 years is completely unreasonable.

Urbanek, Lauren

While I fully support both on-site and off-site renewable energy, this proposal raises significant questions in its current form. I have concerns with the following:

- We do not yet know the number of points off-site renewable energy could receive. While I would be OK with a proposal that made on-site and off-site renewable energy worth roughly the same number of points, there should be parity. It is not clear that will be the case.
- If the point system was structured in such a way that builders could comply with R408 using only renewable energy, I would be very concerned about this replacing the permanent efficiency measures which also have comfort and health benefits.

• I am unclear on exactly how the contractual details would work and am concerned that this lack of uncertainty will cause confusion in the market. Furthermore, without lock-tight contractual agreements, the long-term savings could be put in jeopardy, at the expense of permanent efficiency measures.

Vijayakumar, Gayathri (revised comment from Ballot #1)

In ballot #1, I proposed a modification to RED1-76 to address some objections I have with the original proposal. This modification attempts to further address objections noted by members in Ballot 1, by adding a cap on the points awarded in R408, adding a needed definition for CREF and FPPA, and using language in REDI-91 (Appendix RI).

Add CREF, PPPA, and FPPA definitions from Appendix RC & RED1-91 to the Main Body

SECTION R202 DEFINITIONS

COMMUNITY RENEWABLE ENERGY FACILITY (CREF). A facility that produces energy from renewable energy resources and that is qualified as a community energy facility under applicable jurisdictional statutes and rules.

FINANCIAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (FPPA). A financial arrangement between a renewable electricity generator and a purchaser wherein the purchaser pays or guarantees a price to the generator for the project's renewable generation. Also known as a financial power purchase agreement and virtual power purchase agreement.

PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT. A contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.

Revise R408.2.7 as follows

SECTION R408 ADDITIONAL EFFICIENCY REQUIREMENTS

R408.2.7 Renewable energy. For renewable energy credits, one of the following measures shall be implemented and renewable energy certificate (REC) documentation shall comply with Section R404.4.

R408.2.7.1 On-site Renewable energy. *Renewable energy resources* shall be permanently installed on-site that have the rated capacity to produce ~~a minimum of~~ not less than 1.0 watt of *on-site renewable energy* per square foot of *conditioned floor area*. ~~To qualify for this option, renewable energy certificate (REC) documentation shall meet the requirements of Section R404.4.~~

R408.2.7.2 Renewable Energy Power Purchase Agreements. For Group R-2 occupancies, *renewable energy* shall be purchased from a utility or a *community renewable energy facility (CREF)* using a *physical renewable energy power purchase agreement* (PPPA) or *financial renewable energy power purchase agreement* (FPPA). The agreement shall have a duration of not less than 15 years and for not less than 1.0 kWh

per square foot of *conditioned floor area* on an annual basis. The contract shall be structured to survive a partial or full transfer of ownership of the building property. Not more than 3 credits shall be allocated for compliance with Section R408.2. To qualify for this measure, the PPPA or FPPA shall not be used to meet R404.6.2.

~~**R408.2.8 Off-site renewable energy** The building shall have a renewable energy power purchase agreement with a duration of not less than 15 years from a utility or a community renewable energy facility and for not less than 80 percent of the estimated whole-building electric use on an annual basis.~~

Williams, Jeremy

DOE strongly supports the use of on-site and off-site renewable energy as a means of optimizing energy efficiency and clean energy sources and believe both belong in the energy code. However, DOE does not believe that RED1-076 is an appropriate addition to the energy credit section for the following reasons:

- While the committee supported including options for the procurement of off-site energy in the R408 points tables, it has not yet achieved consensus on how those points should be evaluated relative to other measures, specifically whether those points should be evaluated based on site energy (as is the case for all other measures in the table). From a technical standpoint, whether off-site power comes from a renewable source or a non-renewable source, the site energy will not change.

- The requirement to offset 80% of the annual electric load could incentivize the use of off-site energy credit to use fossil fuel for space heating and water heater. The relative electric load of a home that uses fossil fuels for space and water heating is relatively smaller than a similar all-electric home. This would negate many of the greenhouse gas savings that would result from the use of off-site renewable energy.

Potential fixes could include limiting the number of credits awarded or set requirements at a whole-building energy use level (and not just electrical).

Zigich, Daren

RED1-076-22 and RED1-089-22, allowing off-site generation to count towards a buildings net energy consumption fails to realize the overall impact to the servicing power grid. Especially, in states where mandated RPS and zero carbon targets are established and the utilities are already working on that energy transition. What is the goal this provision is trying to achieve? This seems like a self-serving proposition to prop up retail competition in regulated markets, providing an unknown long-term benefit (or possible detriment) to the homeowner. If net benefit is afforded the homeowner by community solar, or the like, please forward that information.

PROPOSED MODIFICATION FROM THE PROPONENT 6/23/23

Add CREF, PPPA, and FPPA definitions from Appendix RC & RED1-91 to the Main Body

SECTION R202 DEFINITIONS

COMMUNITY RENEWABLE ENERGY FACILITY (CREF). A facility that produces energy from renewable energy resources and that is qualified as a community energy facility under applicable jurisdictional statutes and rules.

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PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT. A contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.

Revise R408.2.7 as follows
SECTION R408 ADDITIONAL EFFICIENCY REQUIREMENTS
R408.2.7 Renewable energy. For renewable energy credits, one of the following measures shall be implemented and renewable energy certificate (REC) documentation shall comply with Section R404.4.

R408.2.7.1 On-site Renewable energy. *Renewable energy resources* shall be permanently installed on-site that have the rated capacity to produce ~~a minimum of~~ not less than 1.0 watt of *on-site renewable energy* per square foot of *conditioned floor area*. ~~To qualify for this option, renewable energy certificate (REC) documentation shall meet the requirements of Section R404.4.~~

R408.2.7.2 Renewable Energy Power Purchase Agreements. A renewable energy power agreement shall be in accordance with Section R408.2.7.2.1 or R408.2.7.2.2. The agreement shall have a duration of not less than 15 years and for not less than 1.0 kWh per square foot of *conditioned floor area* on an annual basis. The contract shall be structured to survive a partial or full transfer of ownership of the building property. Not more than 5 credits shall be allocated for compliance with Section R408.2.7.2.1 or R408.2.7.2.2. ~~To qualify for this measure, the PPPA or FPPA shall not be used to meet R404.6.2.~~ Where the building complies with Section R404.6.2 using a *physical renewable energy power purchase agreement* (PPPA) or a *financial renewable energy power purchase agreement* (FPPA), the purchase agreement shall be for sufficient *renewable energy* to satisfy the combined requirements of Section R404.6.2 and this section.

R408.2.7.2.1 One- and two- family dwellings and townhouses. For one- and two- family dwellings and townhouses, *renewable energy* shall be purchased from a *community renewable energy facility (CREF)* using a PPPA.

R408.2.7.2.2 Group R-2. For Group R-2 occupancies, *renewable energy* shall be purchased from a utility or a *CREF* using a PPPA or a FPPA. ~~The agreement shall have a duration of not less than 15 years and for not less than 1.0 kWh per square foot of *conditioned floor area* on an annual basis. The contract shall be structured to survive a partial or full transfer of ownership of the building property. Not more than 3 credits shall be allocated for compliance with Section R408.2. To qualify for this measure, the PPPA or FPPA shall not be used to meet R404.6.2.~~

~~**R408.2.8 Off-site renewable energy** The building shall have a renewable energy power purchase agreement with a duration of not less than 15 years from a utility or a community renewable energy facility and for not less than 80 percent of the estimated whole-building electric use on an annual basis.~~

MEMORANDUM

Pacific Northwest NATIONAL LABORATORY

Date:	**June 15, 2023**	Project No.:	**PNNL-SA-186418**
To:	**Kristopher Stenger, ICC**		
From:	**Salcido, Victor R; Ben Taube - PNNL**		
Subject:	**R408 Energy Credits for 2024 IECC**		

Hello Kris,

PNNL has simulated all current R408 additional energy efficiency measures (53 at current count) to generate credit amounts.

The number of energy efficiency measures are separated into the following categories:

- Envelope measures 11
- HVAC measures 14
- SWH measures 13
- Duct measures 4
- Air leakage/ventilation measures 5
- Appliance measures 1
- Renewable energy measures 2
- Demand response measures 1
- Lighting measures 2
- **Total** **53**

The simulation methodology for each section of measures is outlined below to help explain how PNNL determined the credit amounts for the measures. Reminder that each energy credit represents a 1% reduction in total annual site energy use. Credits were rounded up if the fraction was greater than or equal to 0.5. Since section R408.2 specifies that residential buildings shall not earn less than ten credits from not less than 2 measures, any measure receiving more than 10 credits through the simulation methodology will be reset to 10 credits.

Envelope measures (11)

The prescriptive R-values from Table R402.1.3 from the 2024 IECC Residential Public Comment Draft #1 dated 5/9/2023 served as the baseline model for all prototype building simulations. The Component Performance Alternative approach was used to determine the updated R-values/U-factors of the building thermal envelope components that correspond to UA reductions of 2.5%, 5%, 7.5%, 10%, 20% and 30% for both single family and multifamily cases. That exercise was based on the building thermal envelope components net areas from the PNNL single family and multifamily dwelling unit prototypes. The baseline prototype model used a roof reflectance of 0.25.

HVAC measures (14)

Each of the 14 HVAC measures used a similar sized baseline HVAC system with the current federal minimum efficiencies, single speed fan and compressor operation, and standard operating performance curves.

High performance cooling (2) – simple comparison of 15.2 and 16.0 SEER2 to federal minimum cooling efficiency based on location.

High performance gas-furnace (3) – comparison of 90, 95 and 97 AFUE gas furnaces to the federal minimum efficiency based on location.

High performance gas-furnace and cooling (4) – same methodology as above with high performance gas-furnace and cooling systems.

High performance heat pump with gas-furnace backup (2) – compared the high performance heat pump with a gas-furnace for backup heating options with a minimum efficiency split system central heat pump. Federal minimum efficiencies are based on location. The heat pump compressor switch-over temperature to the gas furnace is set at 25°F.

High performance heat pump with electric resistance backup (2) – compared the high performance heat pump options (standard and cold climate heat pump) with a minimum efficiency split system central heat pump. Federal minimum efficiencies are based on location. The cold climate heat pump compressor cut-off temperature is set to -10°F. Electric backup heating is used as necessary to meet the heating load prior to compressor shut-off.

Ground source heat pump (1) – the ground source heat pump results were provided by Dandelion Energy based on national simulation results for the 2024 IECC prescriptive requirements for all prototypes across all climate zones. Using the results of the national level simulations, a curve fit was developed by Dandelion Energy that predicts average GSHP system COP/EER as a function of average air temperature for a given location. Dandelion Energy ground source heat pump

calculations were performed with LoopLink in accordance with the method presented in IGSHPAs Residential and Light Commercial Design and Installation Manual. The basis for the curve fit is the ES5 YT series heat pump, a representative system for typical ground source heat pumps: https://tetcogeo.com/residential-products/item/es5-yt-multi-position-vertical-packaged

SWH measures (13)
Each of the 13 SWH measures used similar sized hot water heating systems with the current federal minimum efficiencies.

Gas-fired storage water heater (2) – both high performance gas-fired storage water heaters were simulated as 40-gallon storage water heaters in the PNNL prototype models and compared with federal minimum gas-storage water heaters rated with a medium draw pattern (UEF – 0.58)

Gas-fired instantaneous water heater (2) – both high performance gas-fired instantaneous water heaters were compared against a 40-gallon storage water heater with federal minimum gas-storage water heaters rated with a medium draw pattern (UEF – 0.58)

Electric water heaters (6) – all high performance electric water heaters were compared to a 52-gallon electric resistance storage water heater (UEF – 0.93).

Solar water heaters (2) – Solar water heating with fossil fuel backup (SUEF of 1.8) was estimated by using simulated results from the gas storage water heater (UEF 0.86) and the solar thermal generation potential in each climate zone. Solar water heating with electric backup (SUEF of 3.0) was estimated by using simulated results from the heat pump storage water heater (UEF of 2.2) and the solar thermal generation potential in each climate zone.

Compact hot water distribution (1) - For the compact hot water distribution system, a 15% water use reduction factor was utilized to reduce hot water use over the 2021 IECC water use due to lower stored volume and reduced water consumption at the fixtures. The assumption that the compact design would have a compactness ratio factor not greater than 15% for single family dwelling units and not greater than 7.5% for multifamily dwelling units. The result is a factor for the compactness of the hot water distribution system of 0.15. This methodology is from Table R405.4.2(1) of the 2021 IECC.

Duct measures (4)
For the baseline case in all duct system simulations, the ducts were located by foundation type in the PNNL prototype models as specified below:

- Slab Home – 75% of ducts in the attic, 25% of ducts in conditioned space.
- Crawlspace – 75% of ducts in the crawlspace, 25% of ducts in conditioned space.
- Unheated basement – 75% of ducts in the basement, 25% of ducts in conditioned space.
- Heated basement – 75% of ducts in basement (conditioned space), 25% of ducts in the attic.

Ductless systems (1) – Ductless systems were approximated by reducing the leakage ratio of modeled duct components to zero, moving ducts into the condition space to approximate the reduction in conductive losses, and reducing HVAC supply fan static pressure by 50%.

100% of ducts in conditioned space (1) - Any ducts that were originally located in unconditioned spaces such as attics, crawlspaces, and/or unheated basements were moved into the conditioned living space in the models.

80% of ducts in conditioned space (1) - 80% of the ducts that were originally located in unconditioned spaces such as attics, crawlspaces, and/or unheated basements were moved into the conditioned living space.

Reduced total duct leakage (1) - Reduced total duct leakage was modeled by reducing the leakage ratio of modeled duct components to meet the required total duct leakage of 2.0 CFM25/100 sq ft of conditioned floor area. The assumption is that all space conditioning equipment has been installed at the time of duct leakage testing.

Air leakage/ventilation measures (5)
The baseline conditions for all air leakage and ventilation measures are based on the following IECC 2024 prescriptive criteria:

- air leakage levels; 4 ACH50 in CZ 0-2, 3.0 ACH50 in CZ 3-5 and 2.5 ACH50 in CZ 6-8
- a single exhaust fan was modeled at 2.8 CFM/watt and meeting the mechanical ventilation requirements in terms of flow based on the single family and multifamily dwellings.
- heat recovery ventilator (HRV) units in climate zones 6-8 with a sensible recovery efficiency (SRE) of 65%.

HRV/ERV – Prototype models added an HRV with 75% sensible recovery efficiency (SRE) at 32°F. The fan efficacy was simulated at 1.2 CFM/Watt.

2.0 ACH50 with HRV/ERV - Reduced air leakage was modeled by reducing the effective leakage area of exterior surfaces to achieve an overall air leakage of 2.0

ACH50 combined with a heat recovery ventilator with 75% SRE. The fan efficacy was simulated at 1.2 CFM/Watt.

2.0 ACH50 with balanced ventilation - Reduced air leakage was modeled by reducing the effective leakage area of exterior surfaces to achieve an overall air leakage of 2.0 ACH50 in all climate zones combined with a balanced ventilation system running at the same ventilation flow and with a fan efficacy of 2.8 CFM/Watt in climate zones 1-5.

1.5 ACH50 with HRV/ERV - Reduced air leakage was modeled by reducing the effective leakage area of exterior surfaces to achieve an overall air leakage of 1.5 ACH50 combined with an HRV with 75% SRE. The fan efficacy was simulated at 1.2 CFM/Watt.

1.0 ACH50 with HRV/ERV - Reduced air leakage was modeled by reducing the effective leakage area of exterior surfaces to achieve an overall air leakage of 1.0 ACH50 combined with an HRV with 75% SRE. The fan efficacy was simulated at 1.2 CFM/Watt.

Energy efficient appliances (1)
The baseline model for the ENERGY STAR appliances measure used the standard prototype appliance efficiency values from the 2014 Building America House Simulation Protocols (https://www.nrel.gov/docs/fy14osti/60988.pdf).

For the purposes of simulating the site energy savings from the ENERGY STAR appliances, PNNL used the methodology specified in RESNET 301-2019 Addendum A (https://www.resnet.us/wp-content/uploads/ANSI_RESNET_ICC-301-2019-Addendum-A-2019_7.16.20-1.pdf). The RESNET 301-2019 standard uses Energy Guide label data based on DOE test procedures to calculate appliance energy consumption based on the size of the home and number of bedrooms. The calculated appliance annual energy use data using these procedures aligned with the baseline appliance loads used in the PNNL prototypes.

ENERGY STAR appliances (1) – the measure for high efficiency appliances specifies the following proposed case energy requirements

- Refrigerators – less than or equal to 620 kWh/yr
- Dishwashers – less than or equal to 240 kWh/yr
- Clothes washers – less than or equal to 130 kWh/yr and Integrated Modified Energy Factor (IMEF) no less than 1.84 cu. Ft/kWh/cycle

Renewable energy measures (2)
The baseline models for renewable energy measures were the 2024 IECC prescriptive requirements based on the PNNL prototype designs.

On-site renewable energy (1) - Photovoltaic generation of 1.0 W/ft2 of conditioned floor area was simulated.

Off-site renewable energy (1) – Energy credits are calculated based on percent reductions of on-site energy use. Given that off-site renewable will not generate any on-site energy reductions, it was unclear if the credits given should be 0 for all climate zones or based on the expected electric energy offset from the off-site renewable energy power purchase agreement. For this case, energy credits were post processed based on the requirement that 80% of the annual electric consumption of a dwelling unit would be served by a renewable energy power purchase agreement of not less than 15 years. The post processing calculated the savings if 80% of the total building annual on-site electric energy consumption were avoided by the off-site renewable energy purchase agreement. PNNL is looking for guidance on the strategy to use for developing energy credits for off-site renewable energy.

Demand response measures (1)
Demand response thermostat (1) – the current R408.2 table contains a single credit for the demand responsive thermostat across all climate zones, so no adjustments were deemed necessary at this time. As a result, no analysis was conducted for this measure.

Efficient lighting measures (2)
The baseline model for the lighting measures used the lighting levels from the 2014 Building America House Simulation Protocols and adjusted the lamp efficacy levels to the requirements of the 2024 IECC (https://www.nrel.gov/docs/fy14osti/60988.pdf).

Whole house lighting control (1) – the energy savings for the whole house lighting control were simulated by accounting for a 10% reduction in overall lighting load in the PNNL prototype models. Sources provided by the proponent of RED1-166 point to studies that show a potential 11% in lighting savings from a whole house lighting control. The 10% reduction in the model lighting load aligned with the commercial simulation methodology for whole building lighting control.

Higher efficacy lighting (1) – the energy savings for higher efficacy lighting were calculated by increased the lamp efficacy in the baseline PNNL prototype models from 65 lumens/Watt to 90 lumens/Watt.

The Table R408.2 Credits for Additional Energy Efficiency based on the simulation methodology outlined above are shown in an attached spreadsheet.

Attachments (1)
Table R408.2 Credits for Additional Energy Efficiency

Amy Schmidt
I know there is a credit that snuck through that allows a decrease in envelope efficiency for electric equipment. Is the lost energy being accounted for?

It was not modeled as R408.2.10 Opaque Walls does not have a credit in Table R408.2. It is just that a builder must use a heat pump, heat pump water heater, 3 additional credits or renewable energy resources to comply if using the decrease in wall insulation R-value for CZ 4 or 5.

Thank you Rob. I can appreciate that but I do hope you all reconsider modeling the potential losses associated despite the fact that credits are not at stake. I do think it is a major rollback for efficiency overall that will greatly affect the efficacy of the building for years to come.

We could definitely look at reducing the wall insulation on climate zone 5 and what the comparative efficiency (by climate zone) with the added heat pump, or heat pump water heater or 3 extra credits.

Again, this would only be a year 0 comparison of energy and/or energy cost savings. A full lifecycle cost analysis would show the lifetime effect of these rollbacks.

Daren Zigich

1. *Compact hot water distribution (1)* - For the compact hot water distribution system, a 15% water use reduction factor was utilized to reduce hot water use over the 2021 IECC water use due to lower stored volume and reduced water consumption at the fixtures. The assumption that the compact design would have a compactness ratio factor not greater than 15% for single family dwelling units and not greater than 7.5% for multifamily dwelling units. The result is a factor for the compactness of the hot water distribution system of 0.15. This methodology is from Table R405.4.2(1) of the 2021 IECC. Can you provide some drawings showing how these systems work and how the reductions listed are calculated? I somewhat understand the lower stored volume but not the reduced water consumption. Are low flow fixtures part of a compact system or is it simply the on-demand hot water is closer to the fixtures?

   No drawings were created or do we have any drawings for the plumbing layout. Our infrastructure does not have a plumbing layout in EnergyPlus. There are just sources of hot water consumption and schedules, pipe lengths, water heater types and efficiencies. To estimate hot water savings from compact design or lower volumes to reduce hot water consumption or losses, we have to use savings estimates in how much consumption is reduced.

   We do not model pipes in our prototypes. The reduced water consumption comes directly from Table R405.4.2(1) of the 2021 IECC, in which water use, in gal/day is reduced based on compactness ratio factor. Low flow fixtures are not part of a compact system.

2. *Ductless systems (1)* – Ductless systems were approximated by reducing the leakage ratio of modeled duct components to zero, moving ducts into the condition space to approximate the reduction in conductive losses, and reducing HVAC supply fan static pressure by 50%. Are line losses of the refrigerant running throughout the home accounted for? How about conductive losses from the refrigerant lines? Where are the refrigerant supply and

return lines assumed to be routed (conditioned or unconditioned space)? Are the lines insulated per the code requirements?

The ductless system is purely about how much is saved without the use of ducts to deliver conditioned air. So line losses from refrigerant are not accounted for in this measure credit analysis. I do not believe EnergyPlus has the capability to estimate losses from refrigerant lines but you bring up a good point that there might be losses associated with the refrigerant lines running in the home. Hopefully the line lengths will be minimized based on compressor location related to the fan units.

Refrigerant lines are not modeled in our prototypes. We assume that line conductive losses in the refrigerant lines are minimal because refrigerant lines are required to be insulated per R403.4 Mechanical system piping insulation, and the ductless distribution system is located completely on the conditioned side of the building thermal envelope per R408.2.4 More efficient thermal distribution system option in RED1-285-22.

Ben Rabe

- Firstly, does your model use a EUI or cost baseline? EUI - cost baseline would give a very similar result given we use a constant value for utility rates.
- Why is whole home lighting control credit only available for CZs 0-3? Each prototype will have similar amount of savings but since the overall energy use of homes gets higher in colder climate zones, the savings is less than 1%
- What was the metric used to determine the off-site renewable credits and why are the values so close to the on-site renewable values? We post processed the results to remove 80% of the electric energy consumption and determine the level of total energy savings to determine the credits. Remember we maxed out the credits at 10 but they were in the 40-70 range before the max reset.
- Why do cold climate heat pumps with a gas backup only receive credits in CZ 3? We are hoping to improve on these models – that is why they are yellow as they will be updated. We are looking at behavior in the performance curves for the AC and HPs. Hoping to update prior to the committee meeting.

  After the updates - the credit is actually CZ 4C. The dual fuel heat pump shows more energy consumption in CZ 5-8 than the baseline standard heat pump since the fuel switchover temp for the DFHP is 25F and the baseline compressor will continue to run until backup electric resistance heat will run. Thus there are negative savings in the colder climates for the dual fuel heat pump.

Alison Lindburg

18 – Why does a 97 AFUE furnace get 0 points in CZ 8, when 7 points can be had in CZ7? It appears that you could get more points in CZ8 by doing a 95 AFUE (line 19)?

That is because the proponent (AHRI) only wanted credit for climate zones 5-7. Thus CZ8 was set to 0 as part of the proposal. Something to discuss for sure as the credit is big.

Why does a Heat Pump with electric backup (28) receive fewer points than a High performance gas furnace and AC unit (26)?

Different baselines - High Performance Gas Furnace/AC is compared to federal minimum furnace/AC units. The heat pump with electric backup heating uses a federal minimum heat pump as the baseline. This is something that could be up for discussion is should all HVAC units use the

entire set of prototypes as the baseline or the same type of HVAC? If we chose the entire set of prototypes, the savings for all would go down.

27 – Why does a cold climate heat pump with gas backup only have points in climate zone 4 but not in higher climate zones?
This is one of the results we want to look deeper into. What is happening is this is a high performance dual fuel heat pump compared to a federal minimum heat pump with electric backup. Each has differences in compressor switchover temperature. However, in the colder climates, the use of the backup fuel for the dual fuel heat pumps uses more energy than the electric backup heat pump and has negative savings. Maybe the baseline be a standard heat pump with a minimum efficiency furnace as the backup? We could use some guidance on this.

55 – Why does on-site renewables decrease in higher climate zones but not for off-site?
We maxed out the credits at 10, so the offsite generates more than 10 over all climate zones. On-site in colder climates will not quite generate above 10 credits, thus the lowering values.

56 & 57 – They are the same thing but have different values?
Discussion for the committee. Technically credits are calculated based on site energy reduction. Off-site renewables do not reduce site energy so we could say that the credits are 0. Or if they are rewarded and the assumption is that 80% of the electric consumption is avoided, then the credits are in the 40-70 range but again, we maxed them out at 10.

Shilpa Surana

Lighting control

- Why do the updated results not list any points for the 'high efficacy lighting' measure. The measure raises the luminaire efficacy from 65 to 90 lumens/watt.
  The results did not get high enough for 1% savings so they are all zero. Might recommend that this be removed.

Off-site renewable energy

- We are supportive of the changes PNNL has suggested in the ballot. Would you recommend revising the requirement to 80% of total energy use or capping the credits at maximum of five? (Proponent seems to be leaning towards to latter option as per the ballot)
  We are going to discuss this today at our internal DOE/PNNL meeting and determine if we would support the 5 credits. I personally would be comfortable with the 5 credit level.

Cold climate heat pump options

- It appears that the points for cold climate heat pump options have significantly reduced compared to the previous run you had shared with AHRI couple of weeks back. Now that option seems to get lower points compared to the gas furnace and AC option in Row 25 and 26. Your last email notes that you were still looking into these options. Has this been resolved from your end? Any recommendations you have for the committee this week?
  We do have updated results for the CCHPs. Our models for the CCHPs were good, but we were having issues with our baseline models/performance curves so we had to look deeper into them and update them to get accurate results at lower temperatures. We will send out an update to Kris today

Few minor suggestions:

Roof reflectance

- Suggest striking the option R408.2.13b as it yields similar points.

  Agreed

Reduced air leakage

- Points in CZ 6-8 should also be in brick shading as they are not available in those climate zones.

  True - we will shade those on the update sheet.