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Residential Zero Code Plug-in: Zero Energy and Operational Emissions Overlay for Model Energy Codes

Technical Brief

December 2024

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M Rosenberg
Y Chen

U.S. DEPARTMENT OF ENERGY

Prepared for the U.S. Department of Energy
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Pacific Northwest National Laboratory
Richland, Washington 99354

Preamble

The Department of Energy (DOE) and Pacific Northwest National Laboratory (PNNL) are developing a series of technical briefs supporting national, state, and local initiatives to update and advance building energy codes. These technical briefs present specific technologies, measures, or practices that can be incorporated as module-based “plug-ins” via the national model energy codes (MEC), recognized as the International Energy Conservation Code for residential buildings or ASHRAE Standard 90.1 for commercial buildings, and adopted directly by state and local governments pursuing advanced energy savings and greenhouse gas emissions reductions. This collection of briefs is part of a larger effort to provide technical assistance supporting states and local governments and to help them realize their policy goals.

This technical brief presents modified code language that can be amended to adopted residential building MEC to achieve net zero operational energy emissions (NZOEE) and net zero energy (NZE) in newly constructed buildings, either immediately or over several code cycles. The approach includes prescriptive and performance-based compliance paths. The performance path requires meeting two compliance metrics. For NZOEE compliance, the metrics address: 1) minimum site energy efficiency and 2) operational energy emissions that include avoided emissions from onsite and offsite renewable energy generation. For NZE compliance, the metrics include: 1) minimum site energy efficiency and 2) site energy use that account for offsets from onsite and offsite renewable energy generation. The technical brief includes a comparison of the aggregated impact of the metric target values with the energy-use offset potential estimated for impact of 1) advanced efficiency measures currently being installed in buildings but not yet included in MEC and 2) the rooftop solar electricity production estimated for new U.S. residential buildings. The supporting analysis illustrates the magnitude of advancement needed relative to these thresholds to achieve net zero relative to current residential MEC (IECC 2021) requirements. These assessments inform goal setting and help direct future model code development.

Additional assistance may be available from DOE and PNNL to states and local governments interested in adding net zero requirements and other “stretch” provisions to their adopted energy codes. DOE provides this assistance in response to the Energy Conservation and Production Act, which directs the Secretary of Energy to provide technical assistance “to support implementation of state residential and commercial building energy efficiency codes” (42 USC 6833). PNNL supports this mission by evaluating concepts for future code updates, conducting technical reviews and analysis of potential code changes, and assisting states and local jurisdictions who strive to adopt, comply with, and enforce energy codes. This helps assure successful implementation of building energy codes, as well as a range of advanced technologies and construction practices, and encourages building standards that are proven to be practical, affordable, and efficient.

DOE Building Energy Codes Program

The U.S. Department of Energy provides technical assistance to states, municipalities and the design and construction industry supporting building energy codes. Modern building codes offer the latest technologies and cost-effective solutions, contributing to lower energy bills for homes and businesses and ensuring safe, efficient and affordable buildings. Learn more at energycodes.gov.

Acknowledgments

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Acronyms and Abbreviations

BTO	Building Technology Office
DOE	Department of Energy
eGRID	Emissions and Generation Resource Integrated Database
ERI	energy rating index
ICC	International Code Council
IECC	International Energy Conservation Code
LRMER	long run marginal emissions rate
MEC	Model Energy Codes
NZE	net zero net energy
NZOEE	net zero operating energy emissions
OPP	on-site power production
PEI_{site}	site performance energy index site
$PEI_{site,t}$	site performance energy index site target
$PEI_{site,zero,}$	site zero performance energy index
$PEI_{site,zero,t}$	site zero performance energy index target
PEI_{CO2e}	greenhouse gas performance emissions index
$PEI_{CO2e,t}$	greenhouse gas performance emissions index target
PNNL	Pacific Northwest National Laboratory
RESNET	Residential Energy Services Network

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1.0 Existing Initiatives to Achieve Zero Energy or Emissions Model Energy Codes

This tech brief provides model energy code (MEC)[1] language as an overlay to the 2021 International Energy Conservation Code (IECC) to achieve net zero energy (NZE) or net zero operational energy emissions (NZOEE) in new residential buildings. It is intended to be adopted directly by states and local governments. Future tech briefs may address other stretch code provisions for residential buildings.[2] This work builds on existing efforts to drive residential energy codes towards zero energy and emissions initiated by the IECC.

The 2021 IECC includes requirements for zero energy residential buildings as outlined in optional Appendix RC (ICC 2021). That appendix utilizes the Energy Rating Index (ERI) as promulgated by the Residential Energy Services Network (RESNET) to verify a net zero energy home. An ERI of 100 represents a residential building with efficiency equivalent to the 2006 IECC and an ERI of 0 represents a net zero energy home. For compliance with Appendix RC, a home must meet two ERI targets; an ERI without on-site power production (OPP) as an efficiency backstop and an ERI with OPP equal to 0. The ERI without OPP targets are specified in Appendix RC by climate zone. The ERI scores are calculated based on the RESNET 301-2019 Standard (ANSI/RESNET/ICC 2019) using building energy simulation with RESNET accredited software. The ERI methodology allows residential buildings to get credit for achieving a higher level of efficiency, which, in turn means they will require less renewable energy to offset that energy. To meet the ERI of 0, the renewable energy can be generated from on-site or off-site systems. Also in 2021, the International Code Council (ICC) established a goal "to provide optional requirements that lead to achievement of zero energy buildings, presently, and through glidepaths that achieve zero energy buildings by 2030.[3]

[1] The term "model energy code" refers to the current published versions of the IECC for residential buildings and ASHRAE Standard 90.1 for commercial buildings. These documents are referenced by the Energy Conservation and Production Act as modified by the Energy Policy Act of 1992 as the minimum requirements for states adopting energy codes. They are published every three years and most states have adopted some version of the MEC.

[2] This tech brief is part of a series of technical briefs supporting national, state, and local initiatives to update and advance building energy codes developed by the U.S. Department of Energy (DOE) and Pacific Northwest National Laboratory. Each brief is presented in a module-based format, centered on technologies, measures, or practices that can be incorporated as "plug-ins" to building energy codes. These are made available for adoption directly by state and local governments pursuing advanced energy savings and emission reductions. The full collection of briefs is available at https://www.energycodes.gov/stretch-codes.

[3] https://www.iccsafe.org/wp-content/uploads/ICC_Leading_Way_to_Energy_Efficiency.pdf

2.0 Achieving NZE and NZOEE Buildings

The generally accepted process for achieving NZE and NZOEE buildings considers efficiency first, uses low-carbon energy sources, incorporates demand response capabilities, and avoids emissions with on-site renewable energy sources before procuring off-site renewable energy. The NZE and NZOEE code language can help support such a process.[4] The performance path involves meeting two compliance metrics: 1) an efficiency backstop, and 2) a measure of NZE or NZOEE. The efficiency backstop ensures efficiency is considered first before renewable energy resources are procured. The plug-in code language requires higher levels of efficiency than the currently published model energy code (MEC). The NZOEE metric is typically more stringent than the NZE metric, and favors all-electric buildings, especially in areas with clean grids. To calculate the NZOEE metric, annual emission factors are provided for the continental U.S. The electricity values, provided by eGRID region, are 2022 Cambium long-run marginal emission rates for the mid-case scenario, based on a 20-year levelized analysis period, zero discount rate, and a 20-year greenhouse gas global warming period (Gagnon, et al. 2023).[5] Jurisdictions can substitute equivalent local values, as well as hourly data, for the carbon emission factors to meet the requirements of the provided code language.

A key component in the development of the NZE and NZOEE code language is the establishment of the target value for the net zero performance efficiency backstop. It aims to represent building performance levels that can be achieved with market-ready measures, including those currently being installed in new buildings but not yet included in MEC. It is intended to be updated each code cycle. The second metric target value, which measures net zero performance, can also be stepped over several code cycles, or set to achieve net zero in one code cycle.

The NZE and NZOEE code gross site energy performance, shown in Figure 1 as a green dashed line, is a weighted aggregated value based on U.S. new residential building construction data. The performance level reflects the efficiency back stop associated with the prescriptive and performance compliance requirements specified in the net zero plug-in code. The improved performance represents a 20% reduction in gross site energy use relative to the 2021 IECC. The gray arrow in the figure shows the additional energy reduction needed to meet the second metric if set to zero, which is achieved with on-site and off-site renewable energy offsets and additional efficiency improvements.

The establishment of the efficiency backstop for the net zero code was informed by building simulation analysis of high performance envelope and equipment measures.[6] The black dashed line in Figure 1 shows the normalized, weighted-average site energy use associated with newly constructed residential buildings in the U.S. designed to these performance levels.

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[4] While NZOEE performance compliance does not explicitly include requirements for demand response capabilities, such requirements can be added by adopting plug-in code language from other tech briefs that do. In addition, jurisdictions have the option to adopt hourly carbon emission factors, which can benefit buildings practicing demand response.

[5] While this model energy code plug-in provides a set of criteria that can be used to achieve net zero operational energy emissions in new residential construction, it does not purport to be the best or only method to achieve zero emissions, nor was it designed to necessarily align with other industry definitions or standards that set criteria for achieving zero emissions buildings.

[6] The advanced measures were informed by the 2021 Passive House CORE prescriptive requirements as outlined by Passive House Institute U.S. (PHIUS) at https://www.phius.org/phius-core-prescriptive-standard-specifications

The figure also indicates the potential energy offset attributed to rooftop solar for new residential buildings. The solar offset assessment considers typical building geometries consistent with the DOE code prototype building models used in federal determination analysis. The rooftop solar analysis considers roof area, obstructions, and shading to estimate the implementable rooftop system size and generation potential. The building simulation and rooftop solar analyses provide a technical basis for understanding the performance gap needing to be filled to achieve NZE with MEC (Franconi et al. 2022).

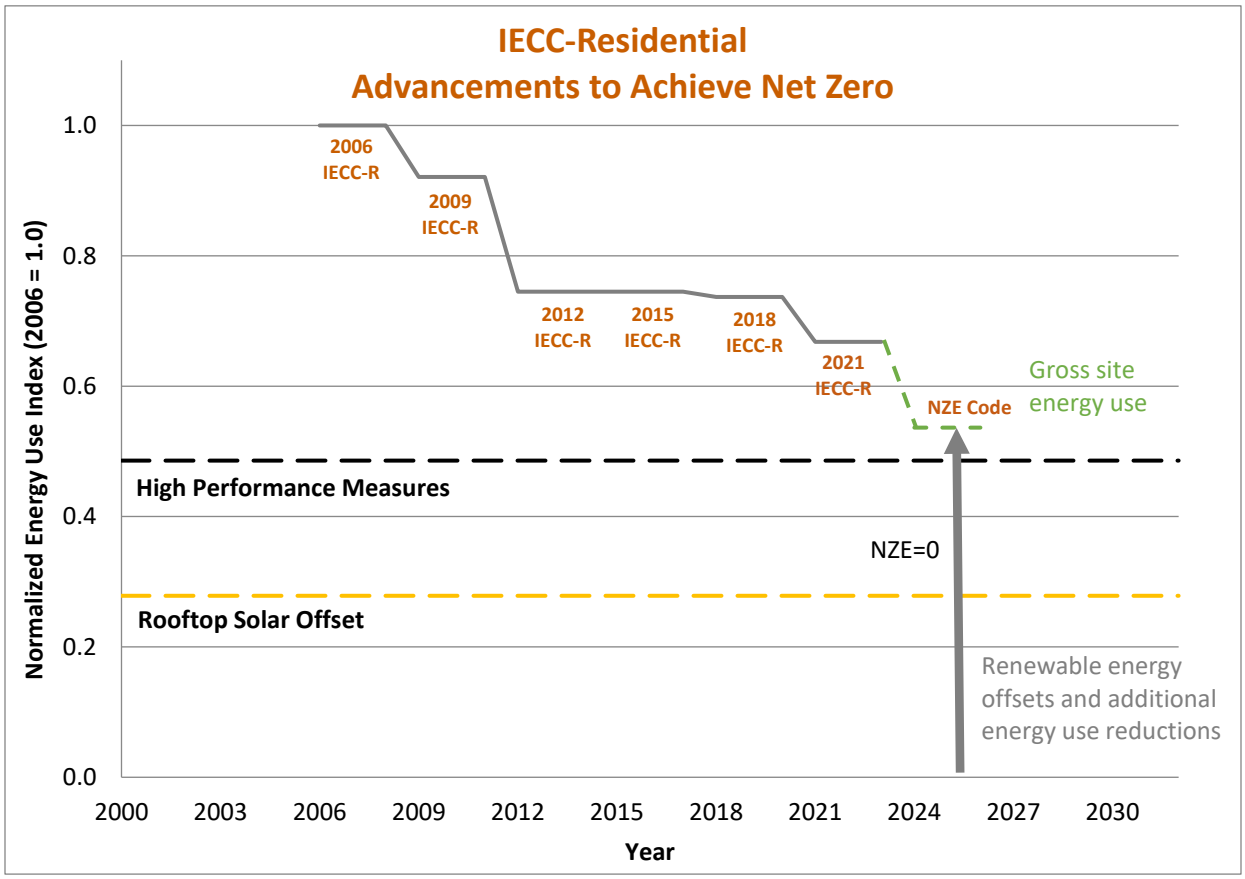

Figure 1. Proposed Residential Model Energy Code National Site Energy Use Reduction

3.0 Zero Net Energy and Emissions Compliance Path Plug-ins for Residential Energy Code

This section provides modified code language that can be amended to the 2021 IECC. Each section is intended to support jurisdictions that choose either an immediate or a glidepath approach for NZE (Section 3.1) or NZOEE (Section 3.2) attainment. Section 3.3 provides example calculations of the compliance metrics, utilizing the equations and data included as part of the overlay language.

3.1 Net Zero Energy

The code language modification below includes changes to Appendix RC Zero Energy Residential Buildings Provisions of the Residential 2021 IECC. . The plug-in code is intended to provide jurisdictions with the ability to amend the adopted code to achieve net zero site energy (NZE) buildings over a defined number of code cycles. The plug-in language provides two compliance paths to achieve net zero: a prescriptive path and a performance path. The prescriptive path includes minimum component efficiency and renewable energy generation requirements that are equivalent to the performance path requirements. The performance path requires projects to meet two performance metric targets based on the R405 Total Building Performance methodology. The Site Performance Energy Index (PEI_{site}) establishes the building efficiency backstop. Target values, referred to as the Site Zero Performance Energy Index target, are specified by building type and climate zone. Compliance target values are listed in Table RC102.2.1. On a U.S. national scale, they result in a 20% reduction in total energy use compared to the 2021 IECC. The Net Zero Site Performance Energy Index ($PEI_{site,zero}$) measures zero net energy achievement. The default target specified in the plug-in code language is zero. However, provisions are provided for rating authorities to establish a glidepath to achieve net zero energy over multiple code cycles.

3.1.1 CHANGES TO 2021 IECC CHAPTER 2

Add new definitions to Chapter 2 Definitions as follows:

community renewable energy facility: a facility that produces energy harvested from renewable energy resources and is qualified as a community energy facility under applicable jurisdictional statutes and rules.

financial renewable energy purchase agreement: a financial arrangement between a renewable energy provider and a purchaser wherein the purchaser pays or guarantees a price to the provide for the project's renewable energy.

physical renewable energy power purchase agreement: a contract for the purchase of renewable energy from a specific renewable energy provider to a purchaser of renewable energy.

renewable energy certificate (RECs): a market-based instrument that represents and conveys the environmental, social, and other non-power attributes of 1 megawatt hour of renewable electricity generation or 3,412 kBtu of renewable thermal energy or bioenergy production and could be sold separately from the underlying physical energy associated with renewable energy resources; also known as "energy attribute" and "energy attribute certificate" (EAC).

3.1.2 CHANGES TO 2021 IECC APPENDIX RC PRESCRIPTIVE COMPLIANCE

Add following language to Appendix RC. The following changes describe the prescriptive zero energy code requirements. .

RC101.1 Compliance. Existing residential buildings shall comply with Chapter 5. New residential buildings shall comply with Table RC101.1.1 for all mandatory requirements and one of the following:

1. Section RC102.1 General Prescriptive Requirements
2. Section RC102.2 Total Building Performance
3. Section RC102.3 Energy Rating Index

TABLE RC101.1.1 - MANDATORY REQUIREMENTS

SECTION	TITLE
General	
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration U-factor and SHGC
Mechanical	
R403.1	Controls
R403.3 except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water calculation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas
R403.11	Portable spas
R403.12	Residential pools and permanent spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls

RC102.1 General Prescriptive Requirements. New residential buildings shall comply with Section RC102.1.1 through RC102.1.5.

RC102.1.1 Envelope Prescriptive Requirements. Envelope assemblies must have insulation R-values not less than and U-factors not greater than those specified in Table RC102.1.1 and Table RC102.1.2.

TABLE RC102.1.1
INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT (ZERO ENERGY)

Climate Zone	1A	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Fenestration U-factor	0.48	0.30	0.28	0.23	0.29	0.32	0.18	0.18	0.25	0.16	0.16	0.24	0.13	0.14	0.13	0.10
Fenestration SHGC	0.25	0.25	0.25	0.25	0.25	0.25	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Skylight U-factor	0.75	0.75	0.65	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Ceiling Insulation R-Value	50	56	56	60	60	60	66	66	65	72	70	70	77	75	85	106
Above Grade Wall Insulation R-Value	21	27	27	31	30	30	36	36	35	42	40	40	46	45	53	74
Floor Insulation R-Value	13	17	19	20	20	17	24	24	23	27	25	26	31	30	38	55
Below Grade Wall Insulation R-Value	6	10	13	13	13	10	18	18	16	22	19	19	25	24	32	49
Slab Insulation - Perimeter R-Value	0	0	0	10	10	10	10	10	10	10	10	10	10	10	10	10
Slab Insulation Depth (ft)	0	0	0	2	2	2	4	4	4	4	4	4	4	4	4	4
Slab Insulation - Under Slab R-Value	6	10	13	13	13	10	18	18	16	22	19	19	25	24	32	49
Crawlspace Wall Insulation R-Value	6	10	13	13	13	10	18	18	16	22	19	19	25	24	32	49

TABLE RC102.1.2
MAXIMUM ASSEMBLY U-FACTORS AND FENESTRATION REQUIREMENTS (ZERO ENERGY)

Climate Zone	1A	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Fenestration U-factor	0.48	0.30	0.28	0.23	0.29	0.32	0.18	0.18	0.25	0.16	0.16	0.24	0.13	0.14	0.13	0.10
Fenestration SHGC	0.25	0.25	0.25	0.25	0.25	0.25	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Skylight U-factor	0.75	0.75	0.65	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Ceiling Insulation	0.021	0.019	0.018	0.017	0.017	0.019	0.014	0.016	0.016	0.013	0.015	0.015	0.013	0.013	0.012	0.010
Above Grade Wall Insulation	0.077	0.050	0.037	0.032	0.034	0.040	0.026	0.029	0.029	0.023	0.026	0.027	0.022	0.023	0.020	0.014
Floor Insulation	0.083	0.071	0.053	0.053	0.053	0.067	0.042	0.045	0.045	0.036	0.042	0.042	0.032	0.033	0.029	0.020
Below Grade Wall Insulation	0.360	0.073	0.055	0.055	0.055	0.078	0.045	0.048	0.048	0.040	0.045	0.045	0.037	0.038	0.033	0.026
Slab Insulation - Perimeter	0.730	0.730	0.730	0.540	0.540	0.540	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480
Slab Insulation - Under Slab	0.440	0.390	0.320	0.320	0.320	0.420	0.280	0.290	0.290	0.250	0.280	0.280	0.230	0.240	0.220	0.180
Crawlspace Wall Insulation	0.360	0.088	0.061	0.061	0.061	0.096	0.047	0.052	0.052	0.039	0.047	0.047	0.035	0.036	0.031	0.022

RC102.1.2 Leakage rate. Where complying with Section RC102.1, the building or dwelling unit shall have an air leakage rate not exceeding 0.60 air changes per hour (ACH50) when tested in accordance with Section R402.4.1.2.

RC102.1.3 Ducts. Ducts and air handlers shall be located inside the conditioned space and installed in accordance with Sections R403.3.2 through R403.3.7.

RC102.1.4 Heat or energy recovery ventilation. Dwelling units shall be provided with a heat recovery or energy recovery ventilation system. The system shall be balanced with a minimum sensible heat recovery efficiency of 75 percent at 32°F (0°C) at a flow greater than or equal to the design airflow.

RC102.1.5 Prescriptive on-site renewable energy. On-site renewable energy shall comply with the following:

a. Where HVAC and service water heating equipment meets the efficiency requirements in Table RC102.1.4, on-site renewable energy shall be installed at the power level (Watts / sq ft of conditioned floor area) specified in Table RC102.1.5 based on climate zone and HVAC and service water heating fuel. Otherwise,

b. On-site renewable energy shall be installed at the power level (Watts / sq ft of conditioned floor area) specified in Table RC102.1.3 based on climate zone and HVAC and service water heating fuel.

TABLE RC102.1.3 ON-SITE RENEWABLE ENERGY PRESCRIPTIVE REQUIREMENTS (W / FT^2 CONDITIONED FLOOR AREA)*

	HVAC-HP		HVAC-Elec Furnace		HVAC-Gas Furnace			HVAC Oil Furnace	
Climate Zone	SWH-HPHW	SWH-Elec Res	SWH-HPWH	SWH-Elec Res	SWH-Gas Storage	SWH-HPWH	SWH-Elec Res	SWH-Elec Res	SWH-HPWH
1A	4.8	5.4	4.9	5.5	5.3	4.8	6.0	5.9	4.8
2A	4.6	5.3	4.8	5.4	5.3	4.8	5.9	5.8	4.8
2B	4.1	4.6	4.2	4.7	4.6	4.1	5.1	5.0	4.2
3A	4.4	5.2	4.8	5.4	5.4	4.9	5.9	5.9	4.9
3B	3.9	4.5	3.9	4.5	4.5	4.0	5.0	4.9	4.0
3C	3.7	4.5	3.8	4.6	4.5	3.9	5.1	5.0	3.9
4A	5.1	6.1	5.8	6.6	6.5	6.0	7.1	7.1	6.0
4B	4.0	4.8	4.3	5.0	4.9	4.4	5.4	5.3	4.4
4C	5.9	7.1	6.5	7.5	7.6	6.8	8.2	8.1	6.8
5A	5.2	6.2	6.1	6.9	7.0	6.5	7.5	7.7	6.6
5B	4.5	5.4	5.1	5.8	5.8	5.3	6.3	6.2	5.3
5C	5.8	7.1	6.4	7.4	7.5	6.7	8.1	8.0	6.7
6A	5.5	6.5	6.5	7.3	7.6	7.0	8.0	8.2	7.3
6B	5.1	6.1	6.0	6.7	6.9	6.3	7.3	7.2	6.3
7	6.3	7.4	7.6	8.4	8.9	8.2	9.3	9.2	8.2
8	9.9	11.6	12.8	14.1	14.9	13.8	15.5	15.4	13.8

* Prescriptive renewable energy requirements are based on crystalline silicon panels with a glass cover, 19.1% nominal efficiency and temperature coefficient of -0.47%/°C. Performance based on a reference temperature of 77°F (25°C) and irradiance of 317 Btu/ft^2-hr (1,000 W/m^2). Array type was a rack mounted with installed nominal operating cell temperature (INOCT) of 103°F (45°C). Total system losses were 11.3% with 0 tilt and azimuth of 180 degrees.

Table RC102.1.4 HIGH PERFORMANCE HVAC/SWH EQUIPMENT EFFICIENCIES

Equipment	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8
Gas/Oil Furnace AFUE	80	90	90	96	96	96	96	96
Air Conditioner SEER2	19.1	17.2	17.2	17.2	14.4	13.4	13.4	13.4
Heat Pump HSPF2/SEER2	8 / 19.1	8 / 17.2	8 / 17.2	8 / 17.2	8 / 17.2	8 / 17.2	8 / 17.2	8 / 17.2
HPWH UEF	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45
Gas Storage UEF	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82

TABLE RC102.1.5 ON-SITE RENEWABLE ENERGY PRESCRIPTIVE REQUIREMENTS WITH HIGH EFFICIENCY HVAC/SWH EQUIPMENT (W / FT^2 COND. FLOOR AREA)*

	HVAC-HP		HVAC-Elec Furn.		HVAC-Gas Furnace			HVAC Oil Furnace	
Climate Zone	SWH-HPHW	SWH-Elec Res	SWH-HPWH	SWH-Elec Res	SWH-Gas Storage	SWH-HPHW	SWH-Elec Res	SWH-HPWH	SWH-Elec Res
1A	4.3	4.9	4.4	5.0	4.8	4.4	5.5	5.3	4.4
2A	4.2	4.9	4.4	5.0	4.9	4.4	5.5	5.4	4.4
2B	3.7	4.3	3.8	4.4	4.3	3.8	4.8	4.7	3.8
3A	4.1	4.9	4.4	5.1	5.0	4.5	5.6	5.5	4.5
3B	3.5	4.2	3.7	4.3	4.2	3.7	4.7	4.6	3.7
3C	3.5	4.3	3.7	4.4	4.3	3.7	4.9	4.8	3.7
4A	4.7	5.7	5.3	6.1	5.9	5.3	6.5	6.6	5.4
4B	3.7	4.4	3.9	4.6	4.4	3.9	4.9	4.8	3.9
4C	5.5	6.7	6.2	7.1	7.1	6.2	7.7	7.6	6.3
5A	4.8	5.8	6.1	6.8	6.8	6.1	7.3	7.5	6.3
5B	4.1	5.0	5.0	5.7	5.6	5.0	6.1	6.0	5.0
5C	5.4	6.7	6.4	7.3	7.3	6.4	7.9	7.8	6.4
6A	4.9	5.9	6.5	7.3	7.3	6.6	7.8	8.0	6.9
6B	4.6	5.6	5.9	6.7	6.7	6.0	7.1	7.1	6.0
7	5.6	6.7	7.5	8.4	8.5	7.7	9.0	8.9	7.8
8	8.4	10.3	12.8	14.1	14.2	12.9	14.8	14.7	13.0

* Prescriptive renewable energy requirements are based on crystalline silicon panels with a glass cover, 19.1% nominal efficiency and temperature coefficient of -0.47%/°C. Performance based on a reference temperature of 77°F (25°C) and irradiance of 317 Btu/ft^2-hr (1,000 W/m^2). Array type was a rack mounted with installed nominal operating cell temperature (INOCT) of 103°F (45°C). Total system losses were 11.3% with 0 tilt and azimuth of 180 degrees.

3.1.3 CHANGES TO 2021 IECC APPENDIX RC PERFORMANCE COMPLIANCE

Add following language to Appendix RC. The following changes describe the performance zero energy code requirements.

RC102.2 Total Building Performance. Compliance based on total building performance requires that a proposed design meets the requirements of Sections RC102.2.1, RC102.2.2 and RC102.2.3.

RC102.2.1 Minimum Design Requirements.

The building thermal envelope greater than or equal to levels of efficiency and solar heat gain coefficients in Table R402.1.1 or R402.1.3 of the 2021 International Energy Conservation Code.

RC102.2.2 Site Performance Energy Index

The Site Performance Energy Index (PEI_{site}), calculated in accordance with Equation RC-1, shall not be greater than the Site Performance Energy Index Target ($PEI_{site,t}$), from Table

RC102.2.1.

$$PEI_{site} = \frac{PDEU_{site}}{SDEU_{site}} \leq PEI_{site,t} \qquad \text{(Eq. RC-1)}$$

Where:

PEI_{site} = Site Performance Energy Index based on site energy determined for the *proposed design*.

$PDEU_{site}$ = *proposed design* total site energy use; the value excludes energy offsets associated with on-site or off-site renewable energy production.

$SDEU_{site}$ = *standard reference design* total site energy use. *Standard reference design* shall be configured and analyzed as specified by Table R405.4.2(1).

$PEI_{site,t}$ = Site Performance Energy Index target from Table RC102.2.1

TABLE RC102.2.1 SITE PERFORMANCE ENERGY INDEX TARGET BY CZ ($PEI_{site,t}$)

	Climate Zone															
	1A	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
Multifamily[1]	0.96	0.94	0.91	0.92	0.93	1.00	0.83	0.90	0.88	0.74	0.81	0.86	0.68	0.73	0.73	0.66
Single-Family[2]	0.89	0.82	0.74	0.76	0.78	0.88	0.64	0.72	0.68	0.52	0.62	0.66	0.46	0.51	0.47	0.42

1. R-2, R-3 and R-4 buildings three stories or less in height above grade plane
2. One and two family detached dwellings and townhouses

RC102.2.3 Site Zero Performance Energy Index

The Site Zero Performance Energy Index ($PEI_{site,\ ZERO}$), calculated in accordance with Equation RC-2, shall be less than or equal to the Site Zero Performance Energy Index Target ($PEI_{site,\ ZERO,t}$), calculated in accordance with Equation RC-4.

$$PEI_{site,ZERO} = 1 - \frac{AE_{site}}{PDEU_{nre,ZERO}} \geq PEI_{site,ZERO,t} \qquad \text{(Eq RC-2)}$$

Where:

$PEI_{site,ZERO}$ = Net Zero Site Energy Index

$PDEU_{nre,ZERO}$ = *proposed design* total site energy use without renewable energy offsets.

$PEI_{site,ZERO,t}$ = Net Zero Site Energy Index Target for greenhouse gas emissions specified in Equation RC-4.

$$AE_{site} = \sum_{i=1}^{n} RE_i \quad \text{(Eq RC-3)}$$

Where:

AE_{site} = adjusted annual avoided energy from on-site and off-site renewable energy generation specified in Equation RC-3 shall be credited against building site energy use.

RE_i = annual energy production for the i^{th} on-site and off-site renewable energy system.

and

$$PEI_{site,\ ZERO,t} = 0 \quad \text{(Eq RC-4)}$$

Informative Note

The target can be set to align with the authority having jurisdiction's timeline for achieving net zero site energy with energy codes. For example, if the jurisdiction plans to achieve zero energy in the current code cycle, the target value would be equal to zero. If the authority having jurisdiction plans to achieve zero energy over two code cycles, the target equals 0.5 in the current code cycle and 0 in the second code cycle. If the goal is to achieve zero energy over three code cycles, the target equals 0.67 in the current code cycle, 0.5 in the second code cycle and 0 in the third code cycle. Rating authorities may choose to adopt a different timeframe for achieving zero energy for alterations.

RC102.2.3.1 Off-site renewable energy

The proposed design shall be credited for the total amount of off-site renewable energy using one or more of the following:

1. A physical renewable energy purchase agreement.
2. A financial renewable energy purchase agreement.
3. A community renewable energy facility.
4. Off-site renewable energy system owned by the building property owner.

The renewable energy source shall be located where the energy can be delivered to the building site by any of the following:

1. Direct connection to the off-site renewable energy facility.
2. The local utility or distribution entity.
3. An interconnected electrical or pipeline network where energy delivery capacity between the generator and the building site is available.

RC102.2.3.2 Off-site renewable energy contract terms

The total off-site renewable energy shall be delivered or credited to the proposed design under an energy contract with a duration of not less than 15 years. The contract shall be

structured to survive a partial or full transfer of ownership of the building property.

RC102.2.3.3 Renewable energy certificate documentation
The property owner or owner's authorized agent shall demonstrate that for an on-site or off-site renewable energy system, no RECs or EACS are associated with the renewable energy system or the following provisions for RECS and EACS shall be met:

1. The RECS and EACS are retained and retired by or on behalf of the property owner or tenant for a period of not less than 15 years;
2. The RECS and EACS are created within a 12-month period of the use of the REC; and
3. The RECS and EACS are from an asset placed in service no more than 5 years before the issuance of the certificate of occupancy.

3.1.4 CHANGES TO 2021 IECC APPENDIX RC ENERGY RATING INDEX COMPLIANCE

RC102.3 Energy Rating Index. New residential buildings shall comply with Section RC102.3.1.

RC102.3.1 Energy Rating Index zero energy score. Compliance with this section requires that the rated design be shown to have a score less than or equal to the values in Table RC102.3.1 when compared to the Energy Rating Index (ERI) reference design determined in accordance with RESNET/ICC 301 for all of the following:

1. ERI value not including on-site power production (OPP) calculated in accordance with RESNET/ICC 301.

2. ERI value including on-site power production calculated in accordance with RESNET/ICC 301 with the OPP in Equation 4.1.2 of RESNET/ICC 301 adjusted in accordance with Equation RC-5.

$$Adjusted\ OPP = OPP + CREF + REPC \qquad \text{(Equation RC-5)}$$

CREF = Community Renewable Energy Facility power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from a community renewable energy facility that is qualified under applicable state and local utility statutes and rules, and that allocates bill credits to the rated home.

REPC = Renewable Energy Purchase Contract power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from an energy facility that generates energy with photovoltaic, solar thermal, geothermal energy or wind systems, and that is demonstrated by an energy purchase contract or lease with a duration of not less than 15 years.

TABLE RC102.3.1 MAXIMUM ENERGY RATING INDEX[a]

Climate Zone	Energy Rating Index Not Including OPP	Energy Rating Index Including Adjusted OPP (as proposed)
1	55	0
2	54	0
3	45	0
4	47	0
5	48	0
6	37	0
7	39	0
8	35	0

a. The building shall meet the requirements of Table RC102.1.4, and the building thermal envelope shall not be less than the levels of efficiency and SHGC in Table R402.1.2 or R402.1.3.

3.2 Net Zero Operational Energy Emissions Code Language

The code language modification below includes changes to Appendix RC Zero Energy Residential Buildings Provisions of the Residential 2021 IECC. The plug-in code is intended to provide jurisdictions with the ability to amend the adopted code to achieve net zero operational energy emission (NZOEE) buildings over a defined number of code cycles. The plug-in language provides two new compliance paths to achieve net zero emissions: a prescriptive and a performance path. The prescriptive path includes minimum component efficiency and renewable energy generation requirements that are equivalent to the performance paths. The performance path requires projects to meet two metric targets based on the R405 Total Building Performance methodology. The Site Performance Energy Index (PEI_{site}) establishes the building efficiency backstop. Target values, referred to as the Site Zero Performance Energy Index target, are specified by building type and climate zone. The compliance target values are listed in Table RC102.2.1. On a U.S. national scale, they result in a 20% reduction in total energy use compared to the 2021 IECC. The Greenhouse Gas Performance Emissions Index (PEICO2e) measures the net zero fraction. The default target value specified in the plug-in code language is zero. However, provisions are provided for rating authorities to establish a glidepath to achieve net zero operational emissions over multiple code cycles.

3.2.1 CHANGES TO 2021 IECC CHAPTER 2

Add new definitions to Chapter 2 Definitions as follows:

community renewable energy facility: a facility that produces energy harvested from renewable energy resources and is qualified as a community energy facility under applicable jurisdictional statutes and rules.

financial renewable energy purchase agreement: a financial arrangement between a renewable energy provider and a purchaser wherein the purchaser pays or guarantees a price to the provide for the project's renewable energy.

physical renewable energy power purchase agreement: a contract for the purchase of renewable energy from a specific renewable energy provider to a purchaser of renewable energy.

renewable energy certificate (RECs): a market-based instrument that represents and conveys the environmental, social, and other non-power attributes of 1 megawatt hour of renewable electricity generation or 3,412 kBtu of renewable thermal energy or bioenergy production and could be sold separately from the underlying physical energy associated with renewable energy resources; also known as “energy attribute” and “energy attribute certificate” (EAC).

3.2.2 CHANGES TO 2021 IECC APPENDIX RC FOR ZERO OPERATIONAL EMISSIONS PRESCRIPTIVE COMPLIANCE

Add following language to Appendix RC. The following changes describe the prescriptive zero operational emissions requirements. .

RC101.1 Compliance. Existing residential buildings shall comply with Chapter 5. New residential buildings shall comply with Table RC101.1.1 for all mandatory requirements and one of the following:

4. Section RC102.1 General Prescriptive Requirements
5. Section RC102.2 Total Building Performance
6. Section RC102.3 Energy Rating Index

TABLE RC101.1.1 MANDATORY REQUIREMENTS

SECTION	TITLE
General	
R401.3	Certificate
Building Thermal Envelope	
R402.1.1	Vapor retarder
R402.2.3	Eave baffle
R402.2.4.1	Access hatches and doors
R402.2.10.1	Crawl space wall insulation installation
R402.4.1.1	Installation
R402.4.1.2	Testing
R402.5	Maximum fenestration U-factor and SHGC
Mechanical	
R403.1	Controls
R403.3 except Sections R403.3.2, R403.3.3 and R403.3.6	Ducts
R403.4	Mechanical system piping insulation
R403.5.1	Heated water calculation and temperature maintenance systems
R403.5.3	Drain water heat recovery units
R403.6	Mechanical ventilation
R403.7	Equipment sizing and efficiency rating
R403.8	Systems serving multiple dwelling units
R403.9	Snow melt and ice systems
R403.10	Energy consumption of pools and spas

SECTION	TITLE
R403.11	Portable spas
R403.12	Residential pools and permanent spas
Electrical Power and Lighting Systems	
R404.1	Lighting equipment
R404.2	Interior lighting controls

RC102.1 General Prescriptive Requirements. New residential buildings shall comply with Section RC102.1.1 through RC102.1.5.

RC102.1.1 Envelope Prescriptive Requirements. Envelope assemblies must have insulation R-values not less than and U-factors not greater than those specified in Table RC102.1.1 and Table RC102.1.2.

TABLE RC102.1.1
INSULATION MINIMUM R-VALUES AND FENESTRATION REQUIREMENTS BY COMPONENT (ZERO ENERGY)

Climate Zone	1A	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Fenestration U-factor	0.48	0.30	0.28	0.23	0.29	0.32	0.18	0.18	0.25	0.16	0.16	0.24	0.13	0.14	0.13	0.10
Fenestration SHGC	0.25	0.25	0.25	0.25	0.25	0.25	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Skylight U-factor	0.75	0.75	0.65	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Ceiling Insulation R-Value	50	56	56	60	60	60	66	66	65	72	70	70	77	75	85	106
Above Grade Wall Insulation R-Value	21	27	27	31	30	30	36	36	35	42	40	40	46	45	53	74
Floor Insulation R-Value	13	17	19	20	20	17	24	24	23	27	25	26	31	30	38	55
Below Grade Wall Insulation R-Value	6	10	13	13	13	10	18	18	16	22	19	19	25	24	32	49
Slab Insulation - Perimeter R-Value	0	0	0	10	10	10	10	10	10	10	10	10	10	10	10	10
Slab Insulation Depth (ft)	0	0	0	2	2	2	4	4	4	4	4	4	4	4	4	4
Slab Insulation - Under Slab R-Value	6	10	13	13	13	10	18	18	16	22	19	19	25	24	32	49
Crawlspace Wall Insulation R-Value	6	10	13	13	13	10	18	18	16	22	19	19	25	24	32	49

TABLE RC102.1.2
MAXIMUM ASSEMBLY U-FACTORS AND FENESTRATION REQUIREMENTS (ZERO ENERGY)

Climate Zone	1A	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Fenestration U-factor	0.48	0.30	0.28	0.23	0.29	0.32	0.18	0.18	0.25	0.16	0.16	0.24	0.13	0.14	0.13	0.10
Fenestration SHGC	0.25	0.25	0.25	0.25	0.25	0.25	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Skylight U-factor	0.75	0.75	0.65	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55	0.55
Ceiling Insulation	0.021	0.019	0.018	0.017	0.017	0.019	0.014	0.016	0.016	0.013	0.015	0.015	0.013	0.013	0.012	0.010
Above Grade Wall Insulation	0.077	0.050	0.037	0.032	0.034	0.040	0.026	0.029	0.029	0.023	0.026	0.027	0.022	0.023	0.020	0.014
Floor Insulation	0.083	0.071	0.053	0.053	0.053	0.067	0.042	0.045	0.045	0.036	0.042	0.042	0.032	0.033	0.029	0.020
Below Grade Wall Insulation	0.360	0.073	0.055	0.055	0.055	0.078	0.045	0.048	0.048	0.040	0.045	0.045	0.037	0.038	0.033	0.026
Slab Insulation - Perimeter	0.730	0.730	0.730	0.540	0.540	0.540	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480	0.480
Slab Insulation - Under Slab	0.440	0.390	0.320	0.320	0.320	0.420	0.280	0.290	0.290	0.250	0.280	0.280	0.230	0.240	0.220	0.180
Crawlspace Wall Insulation	0.360	0.088	0.061	0.061	0.061	0.096	0.047	0.052	0.052	0.039	0.047	0.047	0.035	0.036	0.031	0.022

RC102.1.2 Leakage rate. Where complying with Section RC102.1, the building or dwelling unit shall have an air leakage rate not exceeding 0.60 air changes per hour (ACH50) when tested in accordance with Section R402.4.1.2.

RC102.1.3 Ducts. Ducts and air handlers shall be located inside the conditioned space and installed in accordance with Sections R403.3.2 through R403.3.7.

RC102.1.4 Heat or energy recovery ventilation. Dwelling units shall be provided with a heat recovery or energy recovery ventilation system. The system shall be balanced with a minimum

sensible heat recovery efficiency of 75 percent at 32°F (0°C) at a flow greater than or equal to the design airflow.

RC102.1.5 Prescriptive on-site renewable energy. On-site renewable energy shall comply with the following:

a. Where HVAC and service water heating equipment meets the efficiency requirements in Table RC102.1.4, on-site renewable energy shall be installed at the power level (Watts / sq ft of conditioned floor area) specified in Table RC102.1.5 based on climate zone and HVAC and service water heating fuel. Otherwise,

b. On-site renewable energy shall be installed at the power level (Watts / sq ft of conditioned floor area) specified in Table RC102.1.3 based on climate zone and HVAC and service water heating fuel.

TABLE RC102.1.3 ON-SITE RENEWABLE ENERGY PRESCRIPTIVE REQUIREMENTS (W / FT^2 CONDITIONED FLOOR AREA)*

		HVAC-HP		HVAC-Elec Furn.		HVAC-Gas Furnace			HVAC Oil Furnace	
Climate Zone	eGRID SR**	SWH-HPHW	SWH-Elec Res	SWH-HPWH	SWH-Elec Res	SWH-Gas Storage	SWH-HPWH	SWH-Elec Res	SWH-Elec Res	SWH-HPWH
1A	ERCT	4.8	5.4	4.9	5.5	6.2	4.9	6.0	5.9	4.9
1A	FRCC	4.8	5.4	4.9	5.5	5.2	4.8	6.0	5.9	4.8
2A	ERCT	4.6	5.3	4.8	5.4	6.6	5.1	6.1	6.0	5.2
2A	FRCC	4.6	5.3	4.8	5.4	5.2	4.8	5.9	5.8	4.8
2A	SRMV	4.6	5.3	4.8	5.4	4.9	4.7	5.9	5.7	4.7
2A	SRSO	4.6	5.3	4.8	5.4	4.9	4.7	5.9	5.7	4.7
2A	SRVC	4.6	5.3	4.8	5.4	5.4	4.8	5.9	5.8	4.9
2B	AZNM	4.1	4.6	4.2	4.7	4.8	4.2	5.1	5.0	4.2
2B	CAMX	4.1	4.6	4.2	4.7	7.3	4.7	5.3	5.3	4.9
2B	ERCT	4.1	4.6	4.2	4.7	5.6	4.4	5.2	5.1	4.4
3A	ERCT	4.4	5.2	4.8	5.4	7.3	5.7	6.4	6.6	6.2
3A	RFCW	4.4	5.2	4.8	5.4	4.9	4.6	5.8	5.8	4.8
3A	SPSO	4.4	5.2	4.8	5.4	5.7	5.0	6.0	6.1	5.2
3A	SRMV	4.4	5.2	4.8	5.4	4.9	4.7	5.8	5.8	4.8
3A	SRMW	4.4	5.2	4.8	5.4	5.4	4.9	5.9	5.9	5.0
3A	SRSO	4.4	5.2	4.8	5.4	4.9	4.6	5.8	5.8	4.8
3A	SRTV	4.4	5.2	4.8	5.4	4.8	4.6	5.8	5.7	4.7
3A	SRVC	4.4	5.2	4.8	5.4	5.6	5.0	6.0	6.0	5.2
3B	AZNM	3.9	4.5	3.9	4.5	4.8	4.1	5.1	5.0	4.2
3B	CAMX	3.9	4.5	3.9	4.5	8.1	5.1	5.5	5.5	5.3
3B	ERCT	3.9	4.5	3.9	4.5	5.8	4.4	5.2	5.2	4.6

		HVAC-HP		HVAC-Elec Furn.		HVAC-Gas Furnace			HVAC Oil Furnace	
Climate Zone	**eGRID SR****	**SWH-HPHW**	**SWH-Elec Res**	**SWH-HPWH**	**SWH-Elec Res**	**SWH-Gas Storage**	**SWH-HPWH**	**SWH-Elec Res**	**SWH-Elec Res**	**SWH-HPWH**
3B	NWPP	3.9	4.5	3.9	4.5	5.4	4.3	5.1	5.1	4.4
3B	SPSO	3.9	4.5	3.9	4.5	4.7	4.1	5.1	5.0	4.2
3C	CAMX	3.7	4.5	3.8	4.6	8.6	5.0	5.5	5.6	5.2
4A	NYST	5.1	6.1	5.8	6.6	10.6	8.2	8.3	8.6	8.6
4A	RFCE	5.1	6.1	5.8	6.6	5.8	5.6	6.9	7.0	5.8
4A	RFCW	5.1	6.1	5.8	6.6	5.7	5.5	6.8	7.0	5.7
4A	SPNO	5.1	6.1	5.8	6.6	7.4	6.4	7.3	7.5	6.7
4A	SPSO	5.1	6.1	5.8	6.6	7.0	6.2	7.2	7.4	6.5
4A	SRMV	5.1	6.1	5.8	6.6	5.8	5.5	6.8	7.0	5.7
4A	SRMW	5.1	6.1	5.8	6.6	6.5	5.9	7.1	7.2	6.2
4A	SRTV	5.1	6.1	5.8	6.6	5.5	5.4	6.8	6.9	5.6
4A	SRVC	5.1	6.1	5.8	6.6	6.8	6.1	7.2	7.3	6.4
4B	AZNM	4.0	4.8	4.3	5.0	5.4	4.5	5.5	5.4	4.7
4B	CAMX	4.0	4.8	4.3	5.0	9.5	6.1	6.2	6.4	6.5
4B	NWPP	4.0	4.8	4.3	5.0	6.1	4.8	5.6	5.6	5.0
4B	RMPA	4.0	4.8	4.3	5.0	5.3	4.5	5.5	5.4	4.6
4B	SPSO	4.0	4.8	4.3	5.0	5.2	4.5	5.5	5.4	4.6
4C	CAMX	5.9	7.1	6.5	7.5	16.6	11.4	10.3	10.9	12.5
4C	NWPP	5.9	7.1	6.5	7.5	9.9	8.0	8.8	8.9	8.4
5A	MROE	5.2	6.2	6.1	6.9	6.9	6.4	7.5	7.8	6.8
5A	MROW	5.2	6.2	6.1	6.9	8.3	7.2	8.0	8.4	7.8
5A	NEWE	5.2	6.2	6.1	6.9	6.9	6.4	7.5	7.8	6.8
5A	NYST	5.2	6.2	6.1	6.9	12.3	9.7	9.5	10.1	10.6
5A	RFCE	5.2	6.2	6.1	6.9	6.2	5.9	7.2	7.5	6.3
5A	RFCM	5.2	6.2	6.1	6.9	5.8	5.7	7.0	7.4	6.0
5A	RFCW	5.2	6.2	6.1	6.9	6.0	5.8	7.1	7.5	6.2
5A	RMPA	5.2	6.2	6.1	6.9	7.8	6.9	7.8	8.2	7.4
5A	SPNO	5.2	6.2	6.1	6.9	8.2	7.2	8.0	8.4	7.7
5A	SRMW	5.2	6.2	6.1	6.9	6.0	5.8	7.1	7.5	6.2
5A	SRVC	5.2	6.2	6.1	6.9	7.4	6.7	7.6	8.0	7.1
5B	AZNM	4.5	5.4	5.1	5.8	6.5	5.6	6.5	6.6	5.9
5B	CAMX	4.5	5.4	5.1	5.8	13.0	9.1	8.6	9.2	10.0
5B	NWPP	4.5	5.4	5.1	5.8	7.7	6.2	6.9	7.1	6.6
5B	RMPA	4.5	5.4	5.1	5.8	6.4	5.5	6.5	6.6	5.8
5C	NWPP	5.8	7.1	6.4	7.4	9.9	8.0	8.7	8.8	8.5

		HVAC-HP		HVAC-Elec Furn.		HVAC-Gas Furnace			HVAC Oil Furnace	
Climate Zone	**eGRID SR****	**SWH-HPHW**	**SWH-Elec Res**	**SWH-HPWH**	**SWH-Elec Res**	**SWH-Gas Storage**	**SWH-HPWH**	**SWH-Elec Res**	**SWH-Elec Res**	**SWH-HPWH**
6A	MROE	5.5	6.5	6.5	7.3	7.4	6.9	7.9	8.5	7.6
6A	MROW	5.5	6.5	6.5	7.3	9.0	7.9	8.7	9.4	9.0
6A	NEWE	5.5	6.5	6.5	7.3	7.4	6.8	7.9	8.5	7.6
6A	NYST	5.5	6.5	6.5	7.3	13.7	11.1	10.8	12.2	12.9
6A	RFCM	5.5	6.5	6.5	7.3	6.1	6.0	7.3	7.7	6.5
6A	RFCW	5.5	6.5	6.5	7.3	6.3	6.2	7.4	7.8	6.7
6A	RMPA	5.5	6.5	6.5	7.3	8.4	7.5	8.4	9.1	8.4
6B	CAMX	5.1	6.1	6.0	6.7	16.4	12.1	11.1	12.1	13.5
6B	MROW	5.1	6.1	6.0	6.7	8.1	7.0	7.8	8.0	7.5
6B	NWPP	5.1	6.1	6.0	6.7	9.3	7.8	8.3	8.6	8.4
6B	RMPA	5.1	6.1	6.0	6.7	7.6	6.7	7.6	7.8	7.1
7	MROE	6.3	7.4	7.6	8.4	8.7	8.0	9.2	9.6	8.6
7	MROW	6.3	7.4	7.6	8.4	10.7	9.4	10.2	10.8	10.3
7	NEWE	6.3	7.4	7.6	8.4	8.6	8.0	9.2	9.5	8.6
7	NWPP	6.3	7.4	7.6	8.4	12.5	10.6	11.1	11.9	11.8
7	RMPA	6.3	7.4	7.6	8.4	9.9	8.9	9.8	10.3	9.6

* Prescriptive renewable energy requirements are based on crystalline silicon panels with a glass cover, 19.1% nominal efficiency and temperature coefficient of -0.47%/°C. Performance based on a reference temperature of 77°F (25°C) and irradiance of 317 Btu/ft^2-hr (1,000 W/m^2). Array type was a rack mounted with installed nominal operating cell temperature (INOCT) of 103°F (45°C). Total system losses were 11.3% with 0 tilt and azimuth of 180 degrees.

** The U.S. Environmental Protection Agency's (EPA's) maintains the Emissions and Generation Resource Integrated Database (eGRID), which provides environmental attributes of electric power systems for all U.S. electricity generating plans that provide power to the electric grid (https://www.epa.gov/egrid). The EPA data are aggregated by twenty-six eGRID subregions. The eGRID subregions referenced in the table refer to the National Renewable Energy Laboratory's (NREL's) Cambium data sets are simulated hourly emission, cost, and operational data for a range of modeled futures of the U.S. electric sector with metrics designed to be useful for long-term decision making. The Cambium eGRID regions are based on the EPA eGRID regions but they are not identical since they are based on balancing areas and not utility service territories.

TABLE RC102.1.4 HIGH PERFORMANCE HVAC/SWH EQUIPMENT EFFICIENCIES

Equipment	CZ 1	CZ 2	CZ 3	CZ 4	CZ 5	CZ 6	CZ 7	CZ 8
Gas/Oil Furnace AFUE	80	90	90	96	96	96	96	96
Air Conditioner SEER2	19.1	17.2	17.2	17.2	14.4	13.4	13.4	13.4
Heat Pump HSPF2/SEER2	8 / 19.1	8 / 17.2	8 / 17.2	8 / 17.2	8 / 17.2	8 / 17.2	8 / 17.2	8 / 17.2
HPWH UEF	3.45	3.45	3.45	3.45	3.45	3.45	3.45	3.45

Gas Storage UEF	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82

TABLE RC102.1.5 ON-SITE RENEWABLE ENERGY PRESCRIPTIVE REQUIREMENTS WITH HIGH EFFICIENCY HVAC/SWH EQUIPMENT (W / FT^2 CONDITIONED FLOOR AREA)*

		HVAC-HP		HVAC-Elec Furn.		HVAC-Gas Furnace			HVAC Oil Furnace	
Climate Zone	**eGRID SR****	**SWH-HPHW**	**SWH-Elec Res**	**SWH-HPWH**	**SWH-Elec Res**	**SWH-Gas Storage**	**SWH-HPWH**	**SWH-Elec Res**	**SWH-Elec Res**	**SWH-HPWH**
1A	ERCT	4.3	4.9	4.4	5.0	5.7	4.4	5.5	5.4	4.5
1A	FRCC	4.3	4.9	4.4	5.0	4.7	4.3	5.5	5.3	4.4
2A	ERCT	4.2	4.9	4.4	5.0	6.2	4.7	5.7	5.6	4.8
2A	FRCC	4.2	4.9	4.4	5.0	4.8	4.4	5.5	5.4	4.4
2A	SRMV	4.2	4.9	4.4	5.0	4.6	4.3	5.5	5.3	4.3
2A	SRSO	4.2	4.9	4.4	5.0	4.6	4.3	5.5	5.3	4.3
2A	SRVC	4.2	4.9	4.4	5.0	5.0	4.4	5.5	5.4	4.5
2B	AZNM	3.7	4.3	3.8	4.4	4.5	3.9	4.8	4.7	3.9
2B	CAMX	3.7	4.3	3.8	4.4	7.0	4.4	5.0	4.9	4.5
2B	ERCT	3.7	4.3	3.8	4.4	5.3	4.0	4.8	4.8	4.1
3A	ERCT	4.1	4.9	4.4	5.1	6.8	5.2	5.9	6.0	5.5
3A	RFCW	4.1	4.9	4.4	5.1	4.5	4.3	5.5	5.4	4.4
3A	SPSO	4.1	4.9	4.4	5.1	5.3	4.6	5.6	5.6	4.8
3A	SRMV	4.1	4.9	4.4	5.1	4.6	4.3	5.5	5.4	4.4
3A	SRMW	4.1	4.9	4.4	5.1	5.0	4.5	5.6	5.5	4.6
3A	SRSO	4.1	4.9	4.4	5.1	4.5	4.3	5.5	5.4	4.4
3A	SRTV	4.1	4.9	4.4	5.1	4.4	4.3	5.4	5.4	4.3
3A	SRVC	4.1	4.9	4.4	5.1	5.2	4.6	5.6	5.6	4.7
3B	AZNM	3.5	4.2	3.7	4.3	4.5	3.8	4.7	4.7	3.9
3B	CAMX	3.5	4.2	3.7	4.3	7.7	4.6	5.1	5.1	4.9
3B	ERCT	3.5	4.2	3.7	4.3	5.5	4.1	4.9	4.8	4.2
3B	NWPP	3.5	4.2	3.7	4.3	5.1	4.0	4.8	4.8	4.1
3B	SPSO	3.5	4.2	3.7	4.3	4.4	3.8	4.7	4.7	3.9
3C	CAMX	3.5	4.3	3.7	4.4	8.4	4.7	5.3	5.3	5.0
4A	NYST	4.7	5.7	5.3	6.1	9.6	7.0	7.4	7.7	7.7
4A	RFCE	4.7	5.7	5.3	6.1	5.3	5.0	6.3	6.5	5.3
4A	RFCW	4.7	5.7	5.3	6.1	5.2	5.0	6.3	6.5	5.2
4A	SPNO	4.7	5.7	5.3	6.1	6.7	5.7	6.7	6.9	6.1

		HVAC-HP		HVAC-Elec Furn.		HVAC-Gas Furnace			HVAC Oil Furnace	
Climate Zone	**eGRID SR****	**SWH-HPHW**	**SWH-Elec Res**	**SWH-HPWH**	**SWH-Elec Res**	**SWH-Gas Storage**	**SWH-HPWH**	**SWH-Elec Res**	**SWH-Elec Res**	**SWH-HPWH**
4A	SPSO	4.7	5.7	5.3	6.1	6.4	5.5	6.6	6.8	5.9
4A	SRMV	4.7	5.7	5.3	6.1	5.2	5.0	6.3	6.5	5.2
4A	SRMW	4.7	5.7	5.3	6.1	5.9	5.3	6.5	6.7	5.6
4A	SRTV	4.7	5.7	5.3	6.1	5.1	4.9	6.3	6.4	5.1
4A	SRVC	4.7	5.7	5.3	6.1	6.2	5.4	6.5	6.7	5.7
4B	AZNM	3.7	4.4	3.9	4.6	4.8	4.0	4.9	4.9	4.1
4B	CAMX	3.7	4.4	3.9	4.6	8.7	5.2	5.5	5.6	5.5
4B	NWPP	3.7	4.4	3.9	4.6	5.5	4.2	5.0	5.0	4.3
4B	RMPA	3.7	4.4	3.9	4.6	4.7	4.0	4.9	4.9	4.1
4B	SPSO	3.7	4.4	3.9	4.6	4.7	3.9	4.9	4.9	4.0
4C	CAMX	5.5	6.7	6.2	7.1	15.6	10.2	9.5	10.1	11.5
4C	NWPP	5.5	6.7	6.2	7.1	9.2	7.2	8.2	8.3	7.8
5A	MROE	4.8	5.8	6.1	6.8	6.6	6.0	7.2	7.6	6.5
5A	MROW	4.8	5.8	6.1	6.8	7.9	6.8	7.7	8.1	7.4
5A	NEWE	4.8	5.8	6.1	6.8	6.6	6.0	7.2	7.6	6.5
5A	NYST	4.8	5.8	6.1	6.8	11.6	8.9	9.0	9.6	9.9
5A	RFCE	4.8	5.8	6.1	6.8	5.9	5.6	7.0	7.3	6.0
5A	RFCM	4.8	5.8	6.1	6.8	5.6	5.4	6.8	7.2	5.8
5A	RFCW	4.8	5.8	6.1	6.8	5.8	5.5	6.9	7.2	5.9
5A	RMPA	4.8	5.8	6.1	6.8	7.4	6.5	7.5	7.9	7.0
5A	SPNO	4.8	5.8	6.1	6.8	7.8	6.7	7.6	8.0	7.3
5A	SRMW	4.8	5.8	6.1	6.8	5.8	5.5	6.9	7.3	5.9
5A	SRVC	4.8	5.8	6.1	6.8	7.0	6.3	7.4	7.7	6.8
5B	AZNM	4.1	5.0	5.0	5.7	6.2	5.3	6.3	6.4	5.6
5B	CAMX	4.1	5.0	5.0	5.7	12.4	8.3	8.1	8.6	9.2
5B	NWPP	4.1	5.0	5.0	5.7	7.3	5.8	6.6	6.8	6.2
5B	RMPA	4.1	5.0	5.0	5.7	6.1	5.2	6.2	6.3	5.5
5C	NWPP	5.4	6.7	6.4	7.3	9.6	7.5	8.4	8.5	8.1
6A	MROE	4.9	5.9	6.5	7.3	7.2	6.5	7.7	8.2	7.2
6A	MROW	4.9	5.9	6.5	7.3	8.6	7.4	8.3	9.0	8.4
6A	NEWE	4.9	5.9	6.5	7.3	7.1	6.5	7.7	8.2	7.2
6A	NYST	4.9	5.9	6.5	7.3	12.9	10.0	10.1	11.4	11.7
6A	RFCM	4.9	5.9	6.5	7.3	5.9	5.8	7.2	7.5	6.2
6A	RFCW	4.9	5.9	6.5	7.3	6.2	5.9	7.3	7.6	6.4
6A	RMPA	4.9	5.9	6.5	7.3	8.0	7.1	8.1	8.7	7.9

		HVAC-HP		HVAC-Elec Furn.		HVAC-Gas Furnace			HVAC Oil Furnace	
Climate Zone	**eGRID SR****	**SWH-HPHW**	**SWH-Elec Res**	**SWH-HPWH**	**SWH-Elec Res**	**SWH-Gas Storage**	**SWH-HPWH**	**SWH-Elec Res**	**SWH-Elec Res**	**SWH-HPWH**
6B	CAMX	4.6	5.6	5.9	6.7	15.5	10.9	10.3	11.1	12.2
6B	MROW	4.6	5.6	5.9	6.7	7.8	6.6	7.5	7.7	7.0
6B	NWPP	4.6	5.6	5.9	6.7	8.9	7.2	7.9	8.2	7.8
6B	RMPA	4.6	5.6	5.9	6.7	7.3	6.3	7.4	7.5	6.7
7	MROE	5.6	6.7	7.5	8.4	8.3	7.6	8.9	9.2	8.2
7	MROW	5.6	6.7	7.5	8.4	10.1	8.7	9.7	10.2	9.6
7	NEWE	5.6	6.7	7.5	8.4	8.3	7.6	8.9	9.2	8.1
7	NWPP	5.6	6.7	7.5	8.4	11.8	9.8	10.5	11.2	10.9
7	RMPA	5.6	6.7	7.5	8.4	9.4	8.3	9.4	9.8	9.0

* Prescriptive renewable energy requirements are based on crystalline silicon panels with a glass cover, 19.1% nominal efficiency and temperature coefficient of -0.47%/°C. Performance based on a reference temperature of 77°F (25°C) and irradiance of 317 Btu/ft^2-hr (1,000 W/m^2). Array type was a rack mounted with installed nominal operating cell temperature (INOCT) of 103°F (45°C). Total system losses were 11.3% with 0 tilt and azimuth of 180 degrees.

** The U.S. Environmental Protection Agency's (EPA's) maintains the Emissions and Generation Resource Integrated Database (eGRID), which provides environmental attributes of electric power systems for all U.S. electricity generating plans that provide power to the electric grid (https://www.epa.gov/egrid). The EPA data are aggregated by twenty-six eGRID subregions. The eGRID subregions referenced in the table refer to the National Renewable Energy Laboratory's (NREL's) Cambium data sets are simulated hourly emission, cost, and operational data for a range of modeled futures of the U.S. electric sector with metrics designed to be useful for long-term decision making. The Cambium eGRID regions are based on the EPA eGRID regions but they are not identical since they are based on balancing areas and not utility service territories.

3.2.3 CHANGES TO 2021 IECC APPENDIX RC ZERO OPERATIONAL EMISSIONS PERFORMANCE COMPLIANCE

Add following language to Appendix RC. The following changes describe the performance based zero operational emissions requirements.

RC102.2 Total Building Performance. Compliance based on total building performance requires that a proposed design meets the requirements of Sections RC102.2.1, RC102.2.2 and RC102.2.3.

RC102.2.1 Minimum Design Requirements.

The building thermal envelope greater than or equal to levels of efficiency and solar heat gain coefficients in Table R402.1.1 or R402.1.3 of the 2021 International Energy Conservation Code.

RC102.2.2 Site Performance Energy Index

The Site Performance Energy Index (PEI_{site}), calculated in accordance with Equation RC-1, shall not be greater than the Site Performance Energy Index Target ($PEI_{site,t}$), from Table RC102.2.1.

$$PEI_{site} = \frac{PDEU_{site}}{SDEU_{site}} \leq PEI_{site,t} \quad \text{(Eq. RC-1)}$$

Where:

PEI_{site} = Site Performance Energy Index based on site energy determined for the *proposed design*.

$PDEU_{site}$ = *proposed design* total site energy use; the value excludes energy offsets associated with on-site or off-site renewable energy production.

$SDEU_{site}$ = *standard reference design* total site energy use. *Standard reference design* shall be configured and analyzed as specified by Table R405.4.2(1).

$PEI_{site,t}$ = Site Performance Energy Index target from Table RC102.2.1

TABLE RC102.2.1 SITE PERFORMANCE ENERGY INDEX TARGET BY CZ ($PEI_{site,t}$)

	Climate Zone															
	1A	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
Multifamily[3]	0.96	0.94	0.91	0.92	0.93	1.00	0.83	0.90	0.88	0.74	0.81	0.86	0.68	0.73	0.73	0.66
Single-Family[4]	0.89	0.82	0.74	0.76	0.78	0.88	0.64	0.72	0.68	0.52	0.62	0.66	0.46	0.51	0.47	0.42

1. R-2, R-3 and R-4 buildings three stories or less in height above grade plane
2. One and two family detached dwellings and townhouses

RC102.2.3 Greenhouse Gas Performance Emissions Index

The Greenhouse Gas Performance Emissions Index (PEI_{CO2e}), calculated in accordance with Equation RC-2, shall be less than or equal to the Greenhouse Gas Performance Emissions Index Target ($PEI_{CO2e,t}$), calculated in accordance with Equation 4-4. The greenhouse gas emissions associated with the building operation energy use shall be calculated using the factors provided in Table RC102.2.2. Other values for emissions, including hourly values for fossil fuels and electricity, shall be permitted by the authority having jurisdiction. Other values for emissions for distributed thermal energy shall be permitted by the authority having jurisdiction and shall account for efficiency of the heating or cooling plant, auxiliary equipment and distribution losses associated with delivery of thermal energy to the building.

$$PEI_{CO2e} = 1 - \frac{AE_{CO2e}}{PBEU_{nre,CO2e}} =< PEI_{CO2e,t} \quad \text{(Eq RC-2)}$$

Where:

PEI_{CO2e} = Greenhouse Gas Performance Emissions Index

$PBEU_{nre,CO2e}$ *proposed design* emissions associated with the *proposed design* total energy use, without renewable energy offsets, based on the greenhouse gas emissions conversion factors provided in Table RC102.2.2.

$PEI_{CO2e,t}$ = Greenhouse Gas Performance Emission Index Target for greenhouse gas emissions specified in Equation RC-4.

$$AE_{CO2e} = \sum_{i=1}^{n} RE_i * GHG_i \quad \text{(Eq RC-3)}$$

Where:

AE_{CO2e} = adjusted annual avoided emissions from on-site and off-site renewable energy generation specified in Equation RC-3 shall be credited against building energy use greenhouse gas emissions.

RE_i = annual energy production for the i^{th} on-site and off-site renewable energy system.

GHG_i = greenhouse gas emissions conversion factor from Table RC102.2.2 For renewable biofuel resources, select the fossil fuel equivalent. For renewable electricity resources for projects within the continental U.S., select the value corresponding to location eGRID subregion or use locally derived values.

and

$$PEI_{CO2e,t} = 0 \quad \text{(Eq RC-4)}$$

Informative Note

The target can be set to align with the authority having jurisdiction's timeline for achieving zero emissions with energy codes. For example, if the jurisdiction plans to achieve zero emissions in the current code cycle, the target value would be equal to zero. If the authority having jurisdiction plans to achieve zero emissions over two code cycles, the target equals 0.5 in the current code cycle and 0 in the second code cycle. If the goal is to achieve zero emissions over three code cycles, the target equals 0.67 in the current code cycle, 0.5 in the second code cycle and 0 in the third code cycle. Rating authorities may choose to adopt a different timeframe for achieving zero emissions for alterations.

RC102.2.3.1 Off-site renewable energy

The proposed design shall be credited for the total amount of off-site renewable energy using one or more of the following:

5. A physical renewable energy purchase agreement.
6. A financial renewable energy purchase agreement.
7. A community renewable energy facility.
8. Off-site renewable energy system owned by the building property owner.

The renewable energy source shall be located where the energy can be delivered to the building site by any of the following:

4. Direct connection to the off-site renewable energy facility.
5. The local utility or distribution entity.
6. An interconnected electrical or pipeline network where energy delivery capacity between the generator and the building site is available.

RC102.2.3.2 Off-site renewable energy contract terms

The total off-site renewable energy shall be delivered or credited to the proposed design under an energy contract with a duration of not less than 15 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property.

RC102.2.3.3 Renewable energy certificate documentation

The property owner or owner's authorized agent shall demonstrate that for an on-site or off-site renewable energy system, no RECs or EACS are associated with the renewable energy system or the following provisions for RECS and EACS shall be met:

4. The RECS and EACS are retained and retired by or on behalf of the property owner or tenant for a period of not less than 15 years;
5. The RECS and EACS are created within a 12-month period of the use of the REC; and
6. The RECS and EACS are from an asset placed in service no more than 5 years before the issuance of the certificate of occupancy.

TABLE RC102.2.2 GREENHOUSE GAS EMISSIONS FACTORS*

Greenhouse gas emissions associated with site energy consumption	CO_2e Emissions	
	(lb/MWh)	(kg/MWh)
Fossil Fuels Delivered to Buildings		
Natural gas	611	277
LPG or propane	650	295
Fuel oil (residual)	737	334
Fuel oil (distillate)	714	324
Coal	842	382
Gasoline	742	337
Other fuels not specified in this table	842	382
Electricity Delivered to the Building		
eGRID Subregion	**(lb/MWh)**	**(kg/MWh)**
AZNMc	458	208
CAMXc	132	60
ERCTc	258	117
FRCCc	684	310
MROEc	639	290
MROWc	420	191
NEWEc	648	294
NWPPc	317	144
NYSTc	210	95
RFCEc	909	412

Electricity Delivered to the Building		
eGRID Subregion	**(lb/MWh)**	**(kg/MWh)**
RFCMc	1141	517
RFCWc	990	449
RMPAc	485	220
SPNOc	432	196
SPSOc	498	226
SRMVc	964	437
SRMWc	629	285
SRSOc	999	453
SRTVc	1151	522
SRVCc	548	248
Distributed Thermal Energy		
	(lb/MWh)	**(kg/MWh)**
Chilled Water	0.24*electricity emission factor for the appropriate eGRID subregion	0.24*electricity emission factor for the appropriate eGRID subregion
Steam	1028	466
Hot Water	971	440

*The total (combined combustion and pre-combustion) greenhouse gas emissions factors (referred to as CO_{2e} and associated with CO_2, CH_4, and N_20) are listed in Table RC102.2 for fossil fuels and for the production of electricity. The delivered fossil fuel factors are U.S. averages based on 2019 EIA and EPA data. The electricity conversion factors are 2022 Cambium long-run marginal emission rates (available at https://www.nrel.gov/analysis/cambium.html). The electricity data are site end-use values for the Cambium mid-case scenario, based on a 20-year levelized analysis period, zero discount rate, and a 20-year greenhouse gas global warming period. The Cambium eGRID subregions are based on balancing area and do not completely align with EPA eGRID subregion, which are based on utility service territory. Look up tables that indicate $eGRID_c$ subregions by zip code or county are included in the published Cambium 2022 LRMER workbooks available at https://data.nrel.gov/submissions/206 . More details on the Cambium input assumptions and methodology are described in the documentation report, available at https://www.nrel.gov/docs/fy23osti/84916.pdf.

3.2.4 CHANGES TO 2021 IECC APPENDIX RC ZERO OPERATIONAL EMISSIONS ENERGY RATING INDEX COMPLIANCE

Add following language to Appendix RC. The following changes describe the ERI and CO_2 Index zero operational emissions requirements.

RC102.3 Energy Rating Index. New residential buildings shall comply with Section RC102.3.1.

RC102.3.1 Energy Rating Index zero energy score. Compliance with this section requires that the rated design be shown to have a score less than or equal to the values in Table RC102.3.1 when compared to the Energy Rating Index (ERI) reference design determined in accordance with RESNET/ICC 301 for all of the following:

3. ERI value not including on-site power production (OPP) calculated in accordance with RESNET/ICC 301.

4. ERI value including on-site power production calculated in accordance with RESNET/ICC 301 with the OPP in Equation 4.1.2 of RESNET/ICC 301 adjusted in accordance with Equation RC-5.

5. Carbon Rating Index zero energy score (CO_{2e}) meeting the requirements of Table RC102.3.1 calculated in accordance with ANSI/RESNET 301-2022 Standard Addendum B.

$$Adjusted\ OPP = OPP + CREF + REPC \qquad \text{(Equation RC-5)}$$

CREF = Community Renewable Energy Facility power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from a community renewable energy facility that is qualified under applicable state and local utility statutes and rules, and that allocates bill credits to the rated home.

REPC = Renewable Energy Purchase Contract power production—the yearly energy, in kilowatt hour equivalent (kWheq), contracted from an energy facility that generates energy with photovoltaic, solar thermal, geothermal energy or wind systems, and that is demonstrated by an energy purchase contract or lease with a duration of not less than 15 years.

TABLE RC102.3.1 MAXIMUM ENERGY RATING INDEX[a]

Climate Zone	Energy Rating Index Not Including OPP	Energy Rating Index Including Adjusted OPP (as proposed)	Carbon Rating Index (CO_{2e})
1	55	0	0
2	54	0	0
3	45	0	0
4	47	0	0
5	48	0	0
6	37	0	0
7	39	0	0
8	35	0	0

a. The building shall meet the requirements of Table RC102.1.4, and the building thermal envelope shall not be less than the levels of efficiency and SHGC in Table R402.1.2 or R402.1.3.

3.3 Example Calculation of NZOEE Compliance Metrics

This section demonstrates the application of the plug-in NZOEE residential code language (Section 3.2) to calculate target and proposed design compliance metrics. The example highlights the impact of different eGRID subregion emission factors on the amount of solar PV electricity generation needed to achieve NZOEE. In Case 1, the example considers an eGRID subregion with emissions factors less than the national average. In Case 2, the example considers an eGRID subregion with emission factors greater than the national average. For each case, the calculations are completed for a mixed-fuel building (Cases 1a and 2a) and an all-electric building (Cases 1b and 2b). In the example, the gross energy use of the project mixed-fuel or all-electric building are equal and meet but do not exceed the site energy efficiency backstop (the Site Performance Energy Index Target). Therefore, in the example, the impact of electrification affects the proportion of energy supplied by electricity but not the building site energy use.

Step 1. Demonstrate the project meets the Site Performance Energy Index Target

1. Look up the BPF value associated with the project building type and climate zone provided in Table RC102.2.1.
2. Determine the baseline and proposed design total annual energy use (for example in kBtu/ft^2 year).
3. Calculate Site Performance Energy Index Target ($PEI_{site,t}$) using Equation RC102.2.2.
4. Calculate the Site Performance Energy Index for the proposed building using Equation RC102.2.2
5. Verify that the PEI_{site} is less than or equal to the $PEI_{site,t}$.

As indicated in Table 1, the site energy use values are based on a single family building located in climate zone 4A, and do not vary across cases. The example building performance meets the site energy use target.

Table 1. Example Calculation of the Site Performance Energy Index

NZOEE PEIsite Compliance	Case 1a Single Family 4A Mixed Fuel	Case 1b Single Family 4A All-Electric	Case 2a Single Family 4A Mixed Fuel	Case 2b Single Family 4A All-Electric
Baseline Building Energy Use Site (kBtu/ ft^2 yr)		33.3		
Baseline Building Regulated Energy Use (kBtu/ ft^2 yr)		21.3		
Baseline Building Unregulated Energy Use (kBtu/ ft^2 yr)		12.0		
Code Cycle 1 $PEI_{site,target}$ (kBtu/ ft^2 yr)		0.64		
Proposed Building Gross Energy Use (kBtu/ ft^2 yr)		21.3		
Proposed Building PEI_{site}		0.64		
PEI_{site} =< $PEI_{site,t}$		Yes		

Step 2. Calculate the greenhouse gas emissions associated with the gross energy use of the proposed single family building.

1. Determine the break down in annual site energy use by source energy type (e.g., natural gas, electricity, etc.) for the proposed design building based on the building simulation results.
2. Look up the greenhouse house gas emission factors provided in Table RC102.2.2.
3. Apply the greenhouse house gas emission factors and determine the proposed design gross annual greenhouse gas emissions.

As indicated in Table 2, the electricity emission factors differ between Case 1 and Case 2. The percent electricity also differs between subcases *a* and *b*. But the total annual site energy use is stipulated to be the same for each case and subcase. The annual greenhouse gas operational energy use emissions do vary. For Case 1, a grid with lower than average emissions, the total annual emissions are lower for the all-electric case. For Case 2, a grid with higher than average emissions, the total annual emissions are not lower for the all-electric case. This results from the electricity CO_{2e} emissions factor being higher than that for natural gas, which is the fuel type displaced by electrification.

Table 2. Example calculation of the greenhouse gas emissions associated with the proposed design gross annual energy use

NZOEE Greenhouse Gas Emissions Calculation	Case 1a Single Family Mixed Fuel	Case 1b Single Family All- Electric	Case 2a Single Family Mixed Fuel	Case 2b Single Family All-Electric
Natural Gas CO_{2e} Emissions Factor (lb/MWH)	611			
Electricity CO_{2e} Emissions Factor (lb/MWH)	210		990	
Proposed Building Electricity	65%	100%	65%	100%
Proposed Building Natural Gas Proportion	35%	0%	35%	0%
Proposed Building Gross Annual Energy Use (kBtu/ft^2 year)	21.3	21.3	21.3	21.3
Proposed Building Gross Annual Greenhouse Gas Emissions (lbs/ft^2 year)	1.8	1.3	5.7	6.2

Step 3. Determine the annual energy production needed from renewable energy resources to comply with the greenhouse gas performance emissions index target ($PEI_{CO2e,t}$)

1. Identify the target compliance value for the greenhouse gas performance emissions index established by the jurisdiction. The value is specified in Section RC102.2.3.
2. Determine the net annual emissions to be avoided by renewable energy sources based on the target value and the proposed building gross annual emissions.
3. Determine the annual energy generation produced by the renewable energy resource that provides the needed avoided emissions.

For the example, the avoided emissions will be provided by an on-site PV electric system. For renewable electricity energy production, the associated avoided emissions are based on the property's eGRID subregion emissions factor. Table 3 shows the needed amount of annual energy produced by the renewable energy system required to achieve compliance. To determine the value, the avoided emissions are divided by the eGRID emissions factor and multiplied by the appropriate energy conversion factor (e.g., 3412 kBtu/MWh or 1000 kWh/MWh). Due to the one-for-one tradeoff for electricity use and production, the two all-electric building cases need the same level of PV electric production regardless of their eGRID subregion. For electric grids with emissions lower than natural gas, the required PV electric production needed for NZOEE compliance is lower for the all-electric building than the mixed-fuel building.

Table 3. Example calculation of the greenhouse gas emissions associated with the proposed design gross annual energy use

NZOEE PEI_{CO2e} Compliance	**Case 1a Single Family Mixed Fuel**	**Case 1b Single Family All-Electric**	**Case 2a Single Family Mixed Fuel**	**Case 2b Single Family All-Electric**
$PEI_{CO2e,\ target}$ (Net/Gross)		0		
Proposed building gross annual emissions rate (lbs/ft^2 year)	1.8	1.3	5.7	6.2
Avoided emissions needing to be produced from renewables (lbs/ft^2 year)	1.8	1.3	5.7	6.2
eGRID CO2e emissions factor (lb/MWH)	210		990	
PV electric production needed for compliance (kBtu/ft^2 year)	29.4	21.3	19.7	21.3
PV electric production needed for compliance (kWh/ft^2 year)	8.6	6.2	5.8	6.2

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