The American Institute of Architects

Understanding Code Change Proposal CE264-19

Zero Code Renewable Energy Appendix

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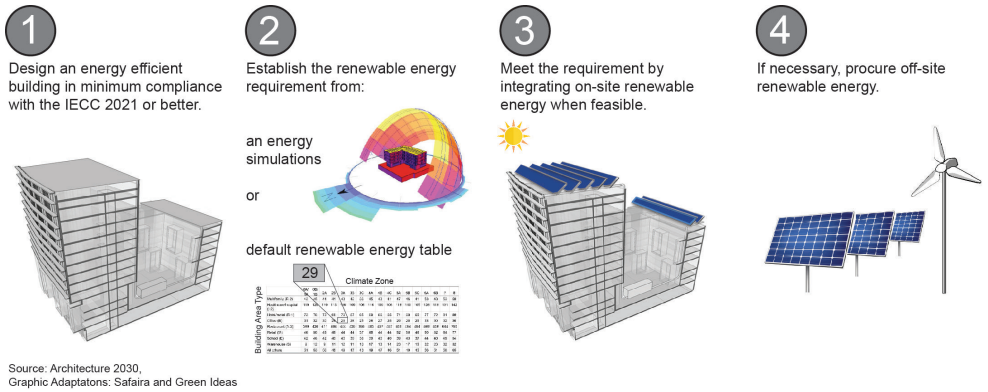
Description of proposal CE264-19: ZERO Code Renewable Energy Appendix

Code Change Proposal CE264-19; The American Institute of Architects Approved at the Committee Action Hearings, Albuquerque, New Mexico, 2019

This code addition is an appendix to the 2021 IECC to require that new commercial, institutional, and mid- to high-rise residential buildings install or procure enough renewable energy to achieve zero net carbon annually. The appendix encourages on-site renewable energy systems when feasible but also supports off-site procurement of renewable energy through a variety of methods. This appendix does not allow renewable energy to be traded off against the energy efficiency required by the 2021 IECC. The provisions contained in this appendix are mandatory when specified as such in the jurisdiction's adopting ordinance.

KEY POINTS

- Voluntary for jurisdictions to adopt
- Compliance with 2021 IECC is required
- Sets a minimum renewable energy requirement based on energy simulations or default values
- Provides an incentive for buildings to be designed to be more energy efficient than code requires
- Encourages on-site renewable energy when feasible
- Supports off-site renewable energy procurement when necessary
- 2021 IECC energy efficiency requirements cannot be traded with renewable energy
- Establishes a consistent framework that local governments can modify for their specific needs and conditions



Source: Architecture 2030,
Graphic Adaptatons: Safaira and Green Ideas

Buildings are required to comply with the 2021 IECC using either the prescriptive or performance approach. When the prescriptive approach is used, the renewable energy that must be installed or procured is specified based on building type and climate zone in Table AX104.1. For instance, an office building in climate zone 3A would need renewable energy production of 29 kBtu/ft²-y. When the performance approach is used, the renewable energy requirement is based on energy modeling, and the needed renewable energy can be reduced through energy efficiency measures that exceed code.

Why the ZCREA is important

We are already seeing the consequences of 1°C of global warming through more extreme weather, rising sea levels, rapid biodiversity decline, and diminishing Artic sea ice. In the 2015 Paris climate accord, 195 nations agreed to a goal of under 2°C (preferably 1.5°C) of temperature rise. A recent Intergovernmental Panel on Climate Change (IPCC) report warns that to achieve the 1.5°C goal, we must reduce CO^2 emissions by 45 percent by 2030.

Electricity generation is responsible for a large share of CO^2 emissions in the United States. About 75 percent of the electricity produced is used to power our buildings, so designing them to be energy efficient and then offsetting energy use with noncombustible renewable energy is the most cost-effective decarbonization strategy we can pursue.

States and cities across the country are pursuing policies to address climate change. More than 270 US cities and counties and 10 states are signatories to the "We Are Still In" commitment supporting climate action to meet the goals of the Paris climate accord. To date, 70 cities have committed to being powered by 100 percent renewable energy, and more are making this commitment all the time. The ZERO Code Renewable Energy Appendix (ZCREA) provides these communities with a powerful tool and a consistent policy option to accelerate the transition to a 100 percent clean electric grid. Standardization and consistency will speed the process of meeting their carbon reduction goals. Manufacturers, builders, designers, and others in the building industry will all be operating from the same playbook as opposed to a patchwork of divergent local approaches that might otherwise emerge.

In effect, the ZCREA accelerates progress toward a clean electric grid by requiring or encouraging new renewable energy generating capacity over and above what the electric utilities or electric distribution companies are already required to do through their renewable portfolio standards (RPS). In states that do not yet have RPS requirements, the ZCREA adds renewable energy generators to avoid the source energy and carbon emissions from conventional generators.

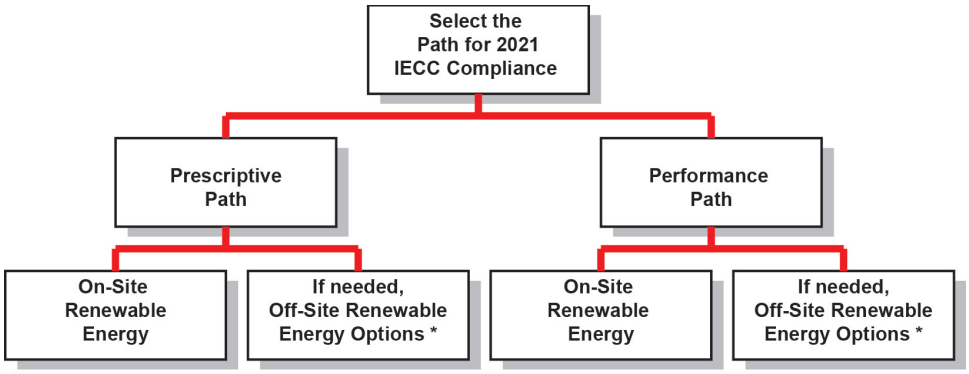
The ZERO Code Renewable Energy Appendix is unique because of its:

1. **incorporation into the 2021 IECC**, a highly efficient national building energy code;
2. **availability of sophisticated easy-to-use code compliance tools and software** such as COMcheck, EnergyPlus, and a multitude of private sector energy performance programs;

3. **a renewable energy default table and calculator** for all US locations that determines the renewable energy required and estimates the potential on-site renewable energy production and off-site renewable energy procurement needed to achieve zero net carbon; and
4. **recognition of off-site renewable energy options** that result in renewable energy generation that exceeds what utilities are already required to provide by their mandated RPS.

Enforcing & Complying with ZCREA

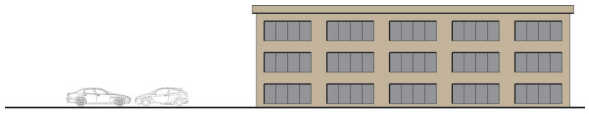
A strength of the ZCREA is that it accepts the multiple paths to achieve compliance with the 2021 IECC. The ZCREA allows the design professional and building owner to choose the path that best fits the climate zone, project needs, design goals and aspirations of the community. This document shows some of the ways to comply with ZCREA. There is no "extra work" for building officials. They simply (1) identify the compliance path selected, (2) verify that the appropriate information is in the design package for the building permit application, and (3) inspect during construction to confirm that the design features have been installed.



* A variety of off-site renewable energy options are recognized.

Implementation examples

The ZCREA is extremely flexible and accepts multiple paths to compliance. Following are six possible compliance paths for a simple three-story, 50,000 ft² office building in climate zone 3A. The compliance process is described in a series of decisions similar to those that a design/construction team makes as they design a building. The options that follow demonstrate how the building official may verify compliance (using documentation provided during the permit application and inspections during construction).



An example 50,000 ft², three-story office building in climate zone 3A is used to demonstrate some of the ways to comply with the ZCREA.

[1] report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf
[2] Energy Information Administration, Annual Energy Outlook, 2018.

Option 1. Prescriptive path renewable energy requirement

The ZCREA builds on the 2021 IECC and adds requirements for renewable energy systems. When adopted by a jurisdiction, designers and builders can comply with the IECC's energy efficiency requirements using any of the available compliance paths. If the designers choose to comply with the prescriptive energy efficiency requirements of Section C401.2 of the IECC, then the renewable energy requirement is determined from Table AX104.1, according to the building area type and climate zone. In this example, the renewable energy requirement is 29 kBtu/ft²-y. This is multiplied by the building's 50,000 ft² conditioned floor area, resulting in the example building needing 1.45 million kBtu/y or 425 MWh/y of renewable energy production to comply with the ZCREA. This renewable energy production can be satisfied by installing an on-site photovoltaic (PV) system or by procuring off-site renewable energy.

Enforcement and compliance notes: When the appendix is adopted by local jurisdictions, the building design must meet the energy efficiency requirements of the 2021 IECC according to Section C401.2. The ZCREA adds no additional burden. The code official verifies the following:

- The building meets the prescriptive energy efficiency requirements of the 2021 IECC as outlined in Section C401.2.
- The plans and specifications include the necessary energy efficiency features.
- These features are installed at the time of construction.

AX104 Minimum Renewable Energy Prescriptive Path Selected
Table AX104.1 is used to determine the renewable energy requirement.
50,000 ft² * 29 kBtu/ft²-y = 1.45 million kBtu/y
1.45 million kBtu/y / 3,412 kBtu/MWh = 425 MWh/y

Option 1A. Compliance with on-site renewable energy

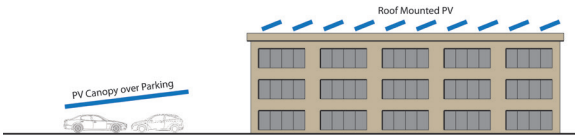
After using the prescriptive path to comply with the 2021 IECC, the designers could comply with the ZCREA using on-site renewable energy systems.
A number of free tools and software applications can help design on-site PV systems. Tools are also embedded in commercial CADD software commonly used in the building design and construction industry. PVWatts is a popular and free software application that is available on the National Renewable Energy Laboratory's (NREL) website.

For the example building, the designers determined that 800 collectors could be located on the roof, each with a rated output of 300 W at standard test conditions (STC). This results in 240 kW^{DC} of solar collector capacity. The collectors would be mounted on racks facing south and tilted 30 degrees from the horizon. When this information is entered in to the PVWatts software, the annual production is estimated to be 354 MWh/y. This is not quite enough energy (425 MWh/y is needed), so the designer used canopies over some of the parking spots to add another 200 collectors (60 kW^{DC}). These have a different azimuth and tilt from the ones on the roof and are estimated to produce another 81 MWh/y. The total estimated renewable energy production is **435 MWh/y, which is greater than the requirement**, so this is an acceptable compliance option.

Enforcement and compliance notes: The on-site PV system would be shown on the plans and specifications like HVAC systems, lighting systems, and other details of construction. Calculations using PVWatts or other acceptable software would be submitted with the permit application and checked in a manner similar to structural, heating/cooling, and other calculations. The code official verifies the following:

- The Prescriptive Compliance Path of Section C401.2 of the 2021 IECC is selected.
- Table AX104.1 of the ZCREA is used to determine the renewable energy requirement and that a total of 425 MWh/y of production is needed.
- Calculations are submitted showing that the on-site PV system produces enough electricity on an annual basis to meet the 425 MWh/y requirement.
- The approved plans and specifications include the PV system.
- The PV system is installed at the time of construction in compliance with the plans and specifications.

AX104 Minimum Renewable Energy Prescriptive Path Selected
Table AX104.1 is used to determine the renewable energy requirement.
50,000 ft² * 29 kBtu/ft²-y = 1.45 million kBtu/y
1.45 million kBtu/y / 3,412 kBtu/MWh = 425 MWh/y



A 240 kW^{DC} PV system (354 MWh/y) installed on the roof and a 60 kW^{DC} PV system (81 MWh/y) installed on some of the parking produce a total of 435 MWh/y.
In Compliance: 435 MWh/y >= 425 MWh/y

Option 2. Performance path renewable energy requirement

The performance approach referenced in Section C401.2 of the IECC provides another option for the designers if they believe they have designed a building that exceeds the energy efficiency requirements of 2021 IECC. The team models the building to take advantage of more efficient lighting loads, smartly sized and oriented windows, external shading, and advanced HVAC systems. The results of the energy simulations indicate that the building requires only 18 kBtu/ft²-y of renewable energy production or a total of 264 MWh/y for the 50,000 ft² building. Compliance with the energy efficiency requirements of the IECC is achieved according to the energy performance modeling rules referenced in Section C401.2 of the IECC. With the more energy efficient building, a considerably smaller PV system can be installed to meet the requirements of the ZCREA. In most cases, it will be more cost effective to increase energy efficiency and reduce the size of the renewable energy system. Enforcement and compliance notes: When the appendix is adopted by local jurisdictions, the building design must meet the energy efficiency requirements of the 2021 IECC. In this case, the performance approach would be used to comply with the energy efficiency requirements of the IECC 2021. The ZCREA adds no additional burden. The code official verifies the following:

- The building meets the performance requirements of Section C401.2 of the 2021 IECC via energy modeling software results.
- The plans and specifications include the necessary energy efficiency features.
- These features are installed at the time of construction.

AX104 Minimum Renewable Energy Performance Path Selected
Renewable energy requirement is determined from energy simulations and significantly reduced.
50,000 ft² * 18 kBtu/ft²-y = 0.90 million kBtu/y
0.90 million kBtu/y / 3,412 kBtu/MWh = 264 MWh/y

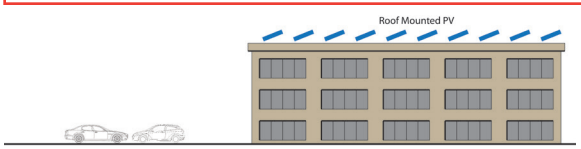
Option 2A. Compliance with on-site renewable energy

After using the performance path to comply with the 2021 IECC, the designers could comply with the ZCREA using on-site renewable energy systems.
In this example, the PVWatts software is used to evaluate the potential for on-site renewable energy. In this case, 600 collectors with a total rated capacity of 180 kW^{DC} can produce the 264 MWh/y needed to comply with the ZCREA. The same collector performance, azimuth, and tilt are assumed as before. These collectors can be easily located on the roof of the building, and the collectors over the parking can be eliminated from the construction plans.

Enforcement and compliance notes: The energy modeling results would be referenced to verify the reduced renewable energy needed for compliance. The on-site PV system would be shown on the plans and specifications like HVAC systems, lighting systems, and other details of construction. Calculations using PVWatts or other acceptable software would be submitted with the permit application and checked in a manner similar to structural, heating/cooling, and other calculations. The code official verifies the following:

- The Performance Path of Section C401.2 of the 2021 IECC is selected.
- The results of the energy simulations are used to determine the renewable energy requirement and that a total of 264 MWh/y of production is needed.
- Calculations are submitted showing that the on-site PV system produces at least 264 MWh/y.
- The approved plans and specifications include the PV system.
- The PV system is installed at the time of construction in compliance with the plans and specifications.

AX104 Minimum Renewable Energy Performance Path Selected
Renewable energy requirement is determined from energy simulations and significantly reduced.
50,000 ft² * 18 kBtu/ft²-y = 0.90 million kBtu/y
0.90 million kBtu/y / 3,412 kBtu/MWh = 264 MWh/y



The energy efficient building complies with a 180 kW^{DC} PV system (264MWh/y) on the roof.
In Compliance: 264MWh/y >= 264MWh/y

Option 2B. Compliance with on-site and off-site renewable energy through a self-owned system

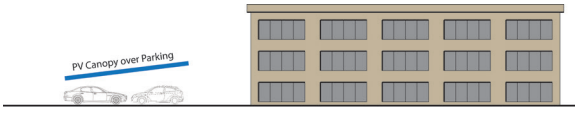
After using the performance path to comply with the 2021 IECC, designers could also choose to comply with the ZCREA using a combination of on-site and off-site renewable energy systems.

Suppose the designers would like to keep the 60 kW^{DC} PV system over the parking that produces 81 MWh/y (see Option 1A), but they would like to replace the rooftop-mounted PV panels by installing panels on an existing warehouse that is owned by the same parties. The owners decide to build a 170 kW^{DC} PV system on the warehouse designed through PVWatts or another acceptable software. The calculations show that the system is estimated to produce 251 MWh/y. This option also meets the requirements of the ZCREA. Table AX104.2 provides a default procurement factor of 0.75 for self-owned off-site renewable energy so 75 percent of the 251 MWh or 188 MWh/y can be counted toward compliance. The total adjusted renewable energy is 81 MWh/y + 188 MWh/y = 269 MWh/y, which is greater than the requirement of 264 MWh/y.

Enforcement and compliance notes: The energy modeling results would be referenced to verify the reduced renewable energy needed for compliance. In this case, the code official would need to verify two PV systems, the on-site system over the parking and the off-site system on the warehouse. The process and steps for each would be the same as Option 2A. The code official verifies the following:

- The Performance Path of Section C401.2 of the 2021 IECC is selected.
- The results of the energy simulations are used to determine the renewable energy requirement and that a total of 264 MWh/y of production is needed.
- Calculations are submitted showing that the on-site PV system produces at least 81 MWh/y, and the off-site system produces at least 251 MWh/y considering the procurement factors from Table AX104.2.
- Documentation is provided that transfers renewable energy certificates (RECs) from the warehouse to the subject building for a period of at least 15 years, per the minimum requirements of AX104.2.2.
- The approved plans and specifications include the PV systems.
- The PV system is installed at the time of construction in compliance with the plans and specifications.

AX104 Minimum Renewable Energy Performance Path Selected
Renewable energy requirement is determined from energy simulations and significantly reduced.
50,000 ft^2 * 18 kBtu/ft^2-y = 0.90 million kBtu/y
0.90 million kBtu/y / 3,412 kBtu/MWh = 264 MWh/y



Option 2C. Compliance with on-site and off-site renewable energy through a virtual power purchase agreement

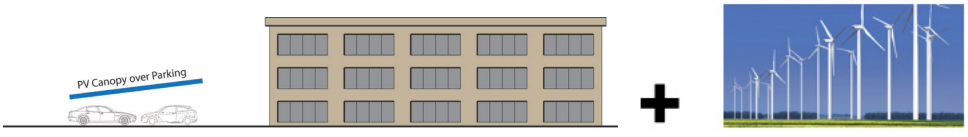
After using the performance path to comply with the 2021 IECC, designers could also choose to comply with the ZCREA using a combination of on-site renewable energy systems and the purchase of a virtual power purchase agreement (vPPA). Suppose the designers would like to keep the 60 kW^{DC} PV system over the parking that produces 81 MWh/y, but they would like to replace the rooftop-mounted PV panels by purchasing a vPPA.

The procurement factor from Table AX104.2 for a vPPA is the same as for self-owned, off-site systems (0.75), so the owner would need to buy and assign at least 264 MWh/y – 81 MWh/y = 183 MWh/y to the complying building. A minimum of 244 MWh would need to be assigned to the building (244 MWh/y * 0.75 = 183 MWh/y). If the buyer of the vPPA manages and operates multiple buildings, a larger vPPA could be purchased so that the energy use of the entire portfolio is offset by renewable energy.

Enforcement and compliance notes: The energy modeling results would be referenced to verify the reduced renewable energy needed for compliance. For the on-site PV system over the parking, the process and steps would be the same as Option 2A. For the off-site renewable energy portion, evidence would need to be provided that a vPPA contract has been signed meeting the minimum requirements specified in AX104.2.2 (e.g., RECs assigned to the building for at least 15 years). The Rocky Mountain Institute Business Renewables Center and other organizations have model contracts for vPPAs. The code official verifies the following:

- The Performance Path of Section C401.2 of the 2021 IECC is selected.
- The results of the energy simulations are used to determine the renewable energy requirement and that a total of 264 MWh/y of production is needed.
- Calculations are submitted showing that the on-site PV system produces at least 81 MWh/y.
- Evidence is provided that at least 244 MWh/y will be acquired through a vPPA, per the minimum requirements of AX104.2.2 and the procurement factor from Table AX104.2.
- The approved plans and specifications include the on-site PV systems.
- The on-site PV system is installed at the time of construction in compliance with the plans and specifications.

AX104 Minimum Renewable Energy Performance Path Selected
Renewable energy requirement is determined from energy simulations and significantly reduced.
50,000 ft^2 * 18 kBtu/ft^2-y = 0.90 million kBtu/y
0.90 million kBtu/y / 3,412 kBtu/MWh = 264 MWh/y



The 60 kW^{DC} PV system (81 MWh/y) is retained on some of the parking, and this is supplemented with off-site 244 MWh/y vPPA.

AX104.2.3 Adjusted Off-Site Renewable Energy
Table AX104.2 is used to determine the procurement factor.
Adjusted Off-site Renewable Energy from vPPA
244 MWh/y * 0.75 = 183 MWh/y
Total = 81 MWh/y (onsite) + 183 MWh/y = 264 MWh/y

In Compliance: 269 MWh/y >= 264 MWh/y

Option 2D. Compliance with on-site and off-site renewable energy through the purchase of RECs

After using the performance path to comply with the 2021 IECC, designers could also choose to comply with the ZCREA by purchasing RECs.

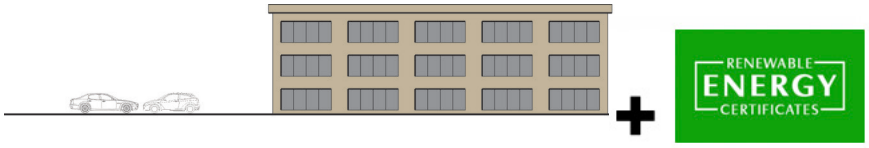
If the owner does not want to install any on-site renewable energy, another option would be to sign a contract to purchase RECs for a period of 15 years. If the example 50,000 ft² building is designed at 18 kBtu/ft²-y as discussed in the performance path requirements (Option 2), then the adjusted renewable energy that would need to be purchased each year is 264 MWh/y or 264 RECs. A REC is defined as one MWh of renewable energy production. The procurement factor from Table AX104.2 for unbundled RECs is 0.20, so a total of 1,320 MWh/y of RECs (1,320 * 0.20 = 264) would need to be purchased each year for a period of 15 years as required in AX104.2.2.

Enforcement and compliance notes: The energy modeling results would be referenced to verify the reduced renewable energy needed for compliance. For the off-site renewable energy, the permit applicant would provide evidence to the code official that a contract has been signed to purchase the required number of RECs for a 15-year period. Evidence or a copy of this contract would be provided to the code official with the permit application and filed with the other construction documents. The code official verifies the following:

- The Performance Path of Section C401.2 of the 2021 IECC is selected.
- The results of the energy simulations are used to determine the renewable energy requirement and that a total of 264 MWh/y of production is needed.
- Documentation is provided for the purchase of 1,320 MWh/y of unbundled RECs, per the minimum requirements of AX104.2.2 and the procurement factor from Table AX104.2.

Note: All of the ZCREA compliance pathways outlined in "Option 2. Performance path renewable energy requirement" are also applicable to ZCREA compliance in "Option 1. Prescriptive path renewable energy requirement."

AX104 Minimum Renewable Energy Performance Path Selected
Renewable energy requirement is determined from energy simulations and significantly reduced.
50,000 ft² * 18 kBtu/ft²-y = 0.90 million kBtu/y
0.90 million kBtu/y / 3,412 kBtu/MWh = 264 MWh/y



1,320 MWh/y of RECs are procured.

AX104.2.3 Adjusted Off-Site Renewable Energy
Table AX104.2 is used to determine the procurement factor.
Adjusted Off-site Renewable Energy from Unbundled RECs = 1,320 MWh/y * 0.20 = 264 MWh/y

In Compliance: 264 MWh/y >= 264 MWh/y

Notes