Showing Equivalency for Architecture 2030 Zero Energy Scenarios

Funding through the Inflation Reduction Act

Summary of Scenarios

Scenario	Action Required to Show Equivalency	Baseline Energy Savings
Scenario 1: The local jurisdiction has no authority to adopt an energy efficiency standard. This is the responsibility of the state but the state has shown its adopted energy efficiency standard is equivalent to one of the latest model codes (LMC). Your jurisdiction is seeking funding to adopt IECC-2021 Appendix CC.	The DOE EM (4.4.2) requires an energy efficiency backstop for ZEC. This would be provided by the state-adopted code that has been shown to be equivalent to one of the LMCs using Topic Area 2: Subtopics A and B of the EM. If the local jurisdiction is adopting the IECC-2021 Appendix CC with no changes, then equivalency need not be demonstrated according to Topic Area 1: Subtopic A and B of the EM. If the local jurisdiction is modifying the IECC-2021 Appendix CC, then equivalency is demonstrated according to Topic Area 2: Subtopic C and D and Section 4 of the EM.	Adoption of a LMC with optional Appendix CC from IECC 2021.
Scenario 2: Your jurisdiction has authority to adopt an energy efficiency standard and renewable energy standard. Your jurisdiction is seeking funding for: Streamlined adoption of IECC 2021 and Appendix CC (or possibly ASHRAE Standard 90.1-2022 instead of IECC 2021).	No equivalency calculation is required. Document any proposed strengthening and/or neutral amendments. Topic Area 1: Subtopics A and B	Equal to what is being adopted.
Scenario 3: Your jurisdiction is seeking local adoption of a Renewable Energy Standard (RES) which would apply to both new and existing buildings (Similar to San Francisco). New buildings would be designed to meet existing local or state energy efficiency standards.	Calculate the proposed code energy savings (PCES) and show that they are greater than the qualifying code energy savings (QCES). Equivalency must be demonstrated according to Topic Area 3: Subtopics A and B from the EM In this case, the PCES is adoption of the RES for existing and new buildings while the QCES is adoption of a LMC plus Appendix CC of the IECC-2021.	Adoption of 90.1-2019 or the IECC-2021 along with Appendix CC.

Acronyms that are used in this document

LMC. One of the Latest Model Codes, which are defined DOE to be either ASHRAE Standard 90.1-2019 or the IECC-2021.

EM. Equivalency Methodology Supporting Funding Eligibility for Section 50131 of the Inflation Reduction Act. Issued by DOE in February 2024.

RES. A Renewable Energy Standard that requires classes of buildings based on occupancy and/or size to be powered by onsite or offsite renewable energy.

QCES. Qualifying code energy savings; the energy savings that would result from adoption of one of the LMCs along with the ZEC for new buildings.

PCES. Proposed code energy savings. These are the savings that would result from adoption of a different code.

ZEC. Zero energy code, defined as Appendix CC from the IECC-2021 or equivalent.

BPS. Building Performance Standard, which applies to existing buildings and requires that they meet minimum levels of energy efficiency determined through utility bills.

GHG. Greenhouse gas

Scenario #1 Equivalency

For commercial buildings and **Scenario #1**: The local jurisdiction does not have authority to adopt an EE standard, but can adopt Appendix CC for new buildings. However, the state has adopted an energy efficiency standard with a stringency equal to or greater than a LMC.

- The EE backstop is minimum-compliance with either IECC-2021 or 90.1-2019 (the latest model code, LMC) with no consideration of renewables. This is satisfied because of mandatory compliance with the state's energy efficiency standard.
- The jurisdiction would then adopt IECC-2021 Appendix CC with no changes and the streamlined approval process should apply. [Topic Area 1: Subtopics A and B].
- If they make changes to IECC-2021 Appendix CC, then they would need to show that their version of CC is equivalent to the unchanged version of Appendix CC, Topic Area 2: Subtopics C and D would apply. In this case, streamlined approval would be unlikely.

Scenario #2 Equivalency

For commercial buildings and **Scenario #2**: The local jurisdiction has the authority to adopt both an EE standard and Appendix CC.

- They would adopt the IECC-2021 along with Appendix CC with no changes.
- No equivalency calculation is required, but any proposed strengthening and/or neutral amendments would need to be documented.

Scenario #3 Equivalency

For commercial buildings and **Scenario #3**: The local jurisdiction proposes to adopt a renewable energy standard (RES) that applies to a class of existing as well as new buildings. The RES would require that all electricity used by a complying building come from either on-site or off-site renewable energy. The RES recommended by Architecture 2030 in its App-in-a-Box program is modeled after the San Francisco program whereby large buildings must install or purchase renewable energy to offset electricity use.

- Carbon may be used instead of site energy to show equivalency (Section 5.3.1 of the EM) and this approach is recommended.
- Building classes to be addressed by the RES can be defined in terms of size and/or occupancy.
- Showing equivalency is a bit more complicated. For the classes of buildings covered, we would need to show that the proposed code energy savings (**PCES**) are equal to or greater than the qualifying code energy savings (**QCES**). The site energy savings (or GHG emissions) from existing buildings must be greater than (or within 1% of) the site energy savings from implementing a qualifying zero energy code for new construction. Both PCES and QCES represent the cumulative site energy savings over a 30-year time horizon. Future savings are not discounted, as is common in much economic analysis. The discount rate is zero. A unit of site energy saved 30 years in the future is counted the same as a unit saved the current year.

Equivalency is shown using *site energy* as the metric, although the DOE methodology allows the use of GHG savings as a proxy for site energy.

$$PCES \geq QCES * 0.99$$

- The **PCES** would be equal to the site energy or carbon emission savings from meeting the electricity demand of **new and existing buildings** covered by the RES. A 30-year estimate projection is needed for the following:
    - Floor area of covered buildings both new and existing (Comstock is referenced as a data source and PNNL has projections of new construction activity)
    - Electricity use intensity of covered buildings (this would decline over the years as old buildings are replace by new buildings meeting newer codes)
    - Grid carbon emissions from electricity use (this would decline over the years as the grid becomes cleaner)
- The **QCES** would be the site energy or carbon emission savings from adopting both the LMC and the ZEC for **new buildings** of the same class. We would need to estimate a 30-year projection of the following:
    - Floor area of new construction for the classes of buildings covered
    - EUI's for buildings that comply with the LMC as well as the code that currently applies
    - Grid carbon emissions from electricity use (same as above)

With Scenario #3, the floor area of buildings covered by the PCES would be significantly greater than the floor area addressed by the QCES, but the carbon/site energy savings on a per square foot basis may be greater for the QCES.

Calculating the QCES for Scenario #3 for a Single Year

DOE provides a spreadsheet called “IRA_Codes_Equivalency_Methodology_Inputs.xlsx” that shows the weighted site energy EUIs for the current code adopted in the state, the EUI in the event that 90.1-2019 code (the QCES for new construction) were adopted, and the EUI for adoption of the zero-energy code (efficiency only). The following are example data for the state of Georgia.

Code	*Weighted Site EUI (kBtu/ft^2-y)*
Current code	46.2
Standard 90.1-2019	41.3
IECC Appendix CC (efficiency only)	39.0

The QCES for adoption of the LMC is then calculated by multiplying the expected new construction volume (for the jurisdiction in Georgia) by the reduction in the weighted site EUI between the current code and the qualifying code (90.1-2019). If the total construction volume in the jurisdiction for 2025 is expected to be 20,000 ft^2, then the QCES would be

$$QCES_{90.1-2019} = 20{,}000 \times (46.2 - 41.3) = 98{,}000\ kBtu/y$$

Detailed Question: Georgia is likely to update its code many times in the next thirty years. Do we just assume that the 2019 code will remain in effect for the whole period? The methodology paper provides no guidance on this. Can we expect that the 46.2 – 39.0 margin will remain for the 30-year period.

The energy efficiency portion of the QCES from adoption of both the 2021 IECC and Appendix CC, is shown below.

$$QCES_{Efficiency} = 20{,}000 \times (46.2 - 39.0) = 144{,}000\ kBtu/y$$

But, the ZEC also requires that onsite or offsite renewable energy be installed or procured so the total savings are equal to new building construction volume multiplied times the EUI for the current code.

$$QCES_{Efficiency+ZEC} = 20{,}000{,}000\ \times (46.2) = 974{,}000\ kBtu/y$$

Vince, can you verify that the above is correct? Appendix CC requires that renewable energy installed or acquired be equal to the energy use of the building.

There is another way to look at it. Adoption of the ZEC would result in 144,000 kBtu/y of efficiency savings and another 780,000 kBtu/y of savings from installing or acquiring renewable energy. See below.

$$QCES_{ZEC} = 20{,}000{,}000\ \times (39.0) = 780{,}000\ kBtu/y$$

$$QCES_{Efficiency+ZEC} = 144{,}000 + 780{,}000 = 924{,}000\ kBtu/y$$

Appendix CC (2021) requires that on-site renewable energy and/or adjusted off-site renewable energy be installed or procured with the capability of producing as much energy on an annual basis as the building uses. For mixed fuel buildings, renewable energy is required to offset natural gas use. With the procurement factors in Table CC103.3.3, even more renewable energy would be procured than needed to offset electricity use. If all the renewable energy were from the Class 1 procurement methods, 1,232,000 kBtu/y would be required to be installed or procured, but only 974,000 kBtu/y would count.

This calculation would be repeated for construction activity in each year stretching 30 years into the future. The QCES is the sum of these savings over the 30-year period.

Calculating the PCES for Scenario #3 for a Single Year

The RES affects existing buildings not just new construction. It requires that renewable energy be installed or procured in an equal amount to the electricity use, not the total energy use like Appendix CC. In this case, it's necessary to split the existing building site energy use between electricity and gas. For example, if the RES applies to 200,000 ft^2 of floor area in 2025 and the weighted average EUI for the 200,000 ft^2 of floor area is 50 kBtu/ft^2-y (30 kBtu/ft^2-y for electricity and 20 kBtu/ft^2-y for gas), then the PCES for year 2025 would be calculated as follows:

$$PCES = 30 \times 200{,}000 = 6\ million\ kBtu/y$$

This calculation would be repeated and summed for each class of building covered and for each year. In this example for a single year, 6 million kBtu/y is greater than 924,000 kBtu/y so the RES for existing buildings saves more energy than adoption of the LMC and ZEC for new buildings.

Note: The methodology paper references the Comstock database maintained by NREL. This database would be used to determine the ft2 of existing building stock covered by the RES and the EUI of existing buildings in the jurisdictions. I've looked at this and someone with some serious data processing skills will be needed to ferret out the data needed. The database consists of 350,000 EnergyPlus computer runs, each with a breakdown of end uses calculated at 15 minute time intervals over typical or representative years.