

2017

District of Columbia
**Energy Conservation Code
Appendix Z**

*** WE ARE WASHINGTON
GOVERNMENT OF THE DISTRICT OF COLUMBIA
DC MURIEL BOWSER, MAYOR



2017 District of Columbia Energy Conservation Code

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APPENDIX Z NET-ZERO ENERGY COMPLIANCE PATH

Z1. GENERAL. Appendix Z is intended to be an optional alternative compliance path for projects to comply with the energy conservation code-commercial provisions.

The design of a *net-zero energy building* shall be achieved through the use of three complementary approaches, to be employed to the maximum extent feasible, in the following order:

1. Reducing building energy demand for heating, cooling, lighting and ventilation through the use of passive design and improved envelope performance techniques.
2. Reducing total building energy demand through the installation of high-efficiency mechanical systems, hot water systems, power systems, lighting, and process equipment.
3. Supplying remaining building energy needs from renewable sources of energy.

Appendix Z draws on existing requirements outlined in the *Energy Conservation Code—Commercial Provisions*. Additional minimum performance requirements for building thermal energy performance and airtightness testing have been set to ensure new construction achieves a high degree of energy conservation.

Z1.1 Definitions. In addition to definitions contained in Chapter 2 of the *Building Code* and in Section 3.2 of the *Energy Conservation Code—Commercial Provisions*, the following definitions shall apply to projects opting to use Appendix Z:

Airtightness. The rate of air leakage through the building envelope, measured in cubic feet per minute per square foot of building envelope ($\text{cfm}/\text{ft}^2_{\text{env}}$), at 0.0109 psig (75 Pa) of pressure differential.

Annual cooling demand. The total amount of thermal energy required to cool a building over the course of a year, measured in thousands of British thermal units per square foot of interior conditioned floor area, per year ($\text{kBtu}/\text{ft}^2_{\text{iCFA}}/\text{yr}$).

Annual heating demand. The total amount of thermal energy required to heat a building over the course of a year, measured in thousands of British thermal units per square foot of interior conditioned floor area, per year ($\text{kBtu}/\text{sf}_{\text{iCFA}}/\text{yr}$).

Energy Use Intensity (EUI). The annual energy use of the building expressed in kBtu divided by square feet (kBtu/ft^2).

Low-carbon neighborhood thermal energy system. A district-scale energy system that uses acceptable sources of renewable energy per Section Z3.2 to produce steam, hot water, or chilled water for the purposes of providing

for building heating, cooling, and/or domestic hot water needs.

Net-zero energy building. A highly energy-efficient building that produces on-site, or procures through the construction of new renewable energy generation, enough energy to meet or exceed the annual energy consumption of its operations.

Renewable energy microgrid. (As defined by the U.S. Department of Energy) A group of interconnected loads and distributed renewable energy resources within clearly defined electrical boundaries that act as a single controllable entity with respect to the grid.

Zero Energy Performance Index (zEPI). A scale representing the ratio of the energy performance of a proposed design or an existing building compared to the mean energy performance of the building stock from the benchmark year of 2000 (Commercial Buildings Energy Consumption Survey, US Department of Energy, 2003 Average).

Z1.2 Scope and Intent. The provisions of Appendix Z regulate the design, construction, commissioning and operation of buildings and their associated building sites for compliance with the *Energy Conservation Code—Commercial Provisions*. The intent of this Appendix is the reduction of energy use to achieve net-zero performance.

Z1.3 Administration and Enforcement. Administration and enforcement of Appendix Z shall be governed by Chapter 1 of the *Building Code*, 12-A DCMR.

Z1.4 Application. The provisions of Appendix Z shall apply to each project that is new construction, or classified as a Level 3 alteration under the *Existing Building Code*, and for which this compliance path option has been chosen.

Z1.5 Compliance. Compliance with Appendix Z requires that the building and its site comply with the provisions of Sections Z2, Z3, Z4, and Z5.

Z2. MINIMUM PERFORMANCE REQUIREMENTS. Minimum performance requirements for building energy use intensity have been set to ensure maximum energy efficiency prior to adding renewable energy generation. The building and its site shall be designed and constructed to meet the mandatory prescriptive requirements in Sections Z2.1, Z.2, Z.3, Z.4, and Z.5.

Z2.1 Building Energy Use Intensity. Applicant shall submit, with the building permit application, *permit documents* with data and calculations sufficient to ascertain compliance with the net-zero energy performance target for buildings and their sites, using predictive modeling. Predictive modeling shall use a source energy unit of measurement, expressed in $\text{kBtu}/\text{ft}^2/\text{yr}$, based on the use of the *Zero Energy Performance Index (zEPI)* as outlined in section Z2.1.1. In a mixed-use building, all uses shall be included in demonstrating compli-

ance, and an area-weighted calculation method shall be used to account for each use.

Z2.1.1 Zero Energy Performance Index, zEPI. Building design shall demonstrate a zEPI of 30 or lower as determined in accordance with Equation 1.

$$zEPI = 50.4 \times (EUI_p/EUI) \quad (\text{Equation 1})$$

Where:

EUI_p = The annual energy use of the building in source kBtu/ft², for the proposed design of the building and its site, calculated in accordance with Section Z2.1.2, not taking into account any on-site or off-site renewable energy.

EUI = The annual energy use of the building in source kBtu/ft² for a baseline building and its site, calculated in accordance with Section Z2.1.2, not taking into account any on-site or off-site renewable energy.

Z2.1.2 Annual Energy Use Indices. The EUI_p of the building and building site, and the EUI, shall be calculated in accordance with Appendix G to ASHRAE 90.1-2016, as modified by Sections Z2.1.2.1 and Z2.1.2.2, and *approved* modeling guidelines published by the *Department in administrative bulletins*. The annual energy use shall include all energy used for the building systems and its anticipated occupancies.

Z2.1.2.1 Additional Modeling Rules and Procedures. Modeling inputs shall be in accordance with the *COMNet Rules and Procedures Manual*.

Z2.1.2.2 Electricity. In calculating the annual energy use indices, consistent units shall be used for electric energy use, converting the electric energy use, measured at the utility meter or metered point of delivery from kWh to kBtu. kWh shall be converted to kBtu by multiplying the annual electric energy use, in kWh, by 3.412 kBtu/kWh. and multiplying the result by the dimensionless conversion factor found in Table Z2.1.2.2.

TABLE Z2.1.2.2 ELECTRICITY GENERATION ENERGY CONVERSION FACTOR BASED ON EPA eGRID SUB-REGION

eGRID 2010 SUB-REGION ACRONYM	eGRID 2010 SUB-REGION NAME	CONVERSION FACTOR
RFCE	RF East	3.28

Z2.2 Building Thermal Energy Performance. Building thermal energy performance shall comply with Sections Z2.2.1 through Z2.2.2.

Z2.2.1 Annual Heating Demand. Building design shall demonstrate a maximum *annual heating demand* of 4.2 kBtu/ft²_{ICFA}/yr (4.8 × 10⁴ kJ/m²_{ICFA}/yr).

Z2.2.2 Annual Cooling Demand. Building design shall demonstrate a maximum *annual cooling demand* of 6.4 kBtu/ft²_{ICFA}/yr (7.3 × 10⁴ kJ/m²_{ICFA}/yr).

Z2.3 Multiple Buildings on a Site. Where there is more than one building on a site, each building shall comply with Sections Z2.2.1 and Z2.2.2 or the combined demands of all the buildings on the site shall comply with Sections Z2.2.1 and Z2.2.2.

Z2.3.1 Assignment of Energy to Multiple Buildings on a Site. For building sites employing district energy systems and with multiple buildings, the energy use associated with the building site shall be assigned to each building proportionally to the gross floor area of each building as a fraction of the total gross floor area of all buildings on the building site. Where energy is derived from either renewable or waste energy, or both sources, either located on the building site, within individual buildings, or on individual buildings and delivered to multiple buildings, the energy so derived shall be assigned on a proportional basis to the buildings served, based on each served building gross floor area. Energy delivered from renewable or waste energy sources located on or within a building shall be assigned to that building.

Exception: Where it can be shown that energy to be used at the building site is associated with a specific building, that energy use shall be assigned to that specific building.

Z2.4 Registered Design Professional in Responsible Charge of Building Energy Simulation. Where the *applicant* chooses to utilize Appendix Z as the path of compliance with the *Energy Conservation Code—Commercial Provisions*, the owner shall engage the services of, and designate on the building permit application, a registered design professional who shall act as the registered design professional in responsible charge of building energy simulation. Building energy simulation services engaged by the registered design professional shall be certified by an *approved* accrediting entity as determined by the *code official*. As authorized by the *code official*, the owner is allowed to designate a substitute registered design professional who shall perform the duties required of the original registered design professional in responsible charge of building energy simulation. The owner shall notify the *code official*, in writing, whenever the registered design professional in responsible charge of building energy simulation is changed or is unable to continue to perform his or her duties.

Z2.5 Building Commissioning. All systems shall be commissioned in accordance with this section and the *Energy Conservation Code—Commercial Provisions*. Energy systems commissioning and completion shall be performed for the following systems and their associated controls:

- Building envelope;
- HVAC (both mechanical and passive systems as well as HVAC controls);
- Lighting, daylighting, and lighting control systems;

- Domestic hot water systems; and
- Renewable energy systems.

Z2.6 Airtightness Testing. A whole building pressurization testing shall be conducted in accordance with Section 11.3.1.2.4(a) of the *Energy Conservation Code – Commercial Provisions* to measure the airtightness of the building envelope. The owner shall verify that the airtightness specified in the final approved predictive energy model is achieved in the field by providing the *code official* with a copy of the test results before the final *Certificate of Occupancy* is issued.

Z3. RENEWABLE ENERGY. The building and building site shall be provided with renewable energy equal to the EUI_p on an annual basis and calculated in accordance with Section Z2.1.1. Sources of renewable energy shall comply with Sections Z3.1 through Z3.3.

Z3.1 On-site Combustion. On-site combustion of fossil fuels shall not be permitted for the provision of thermal energy to the building except as specified by the *code official*.

Z3.2 Acceptable Sources of Renewable Energy. Acceptable sources of on-site renewable energy to be used on the building site include:

- Photovoltaic panels.
- Solar thermal systems.
- Wind turbines.
- Biogas.

No other source of on-site renewable energy is acceptable for building design, unless the rationale for its selection is approved by the *code official*.

Z3.3 On-site Renewable Energy. Renewable energy shall be generated on-site wherever feasible. Before procuring off-site renewable energy, a project must demonstrate one of the following:

1. A minimum of 5% of the total building energy consumption shall first be met by an acceptable source of renewable energy installed on the building roof or site.
2. For projects generating onsite renewable energy through solar photovoltaic systems, a minimum of 25% of total site area, including building footprint, shall be allocated for photovoltaic array and energy production.

Exception: Where there is not adequate solar access as determined by Chapter 13 of the *Energy Conservation Code—Commercial Provisions*.

Z3.4 Procurement of Off-site Renewable Energy. The procurement of off-site renewable energy is acceptable only where the energy is procured from a qualified electricity supplier providing energy from Tier 1 renewable sources meeting the minimum percentages of the District of Columbia Renewable Portfolio Standard. Acceptable methods for the procurement of off-site renewable energy include any of the following or as approved by the *code official*:

- Owner shall provide the *code official* with documentation of a signed, legally-binding contract to procure off-site renewable energy through a power purchase agreement for a minimum period of 5 years for electricity generation from, solar or wind-generation facilities that are located within the District of Columbia, Maryland, or Virginia. The owner remains subject to, and must comply with, the District of Columbia’s Renewable Portfolio Standard.
- Connection to a *renewable energy microgrid*.
- Connection to a *low-carbon neighborhood thermal energy system*.

Z4. ENERGY METERING, MONITORING AND REPORTING.

Z4.1 Scope. The provisions of this Section Z4 shall apply to all projects that opted for Appendix Z as a path of code compliance.

Z4.2 Purpose. The purpose of Section Z4 is to provide requirements that will ensure that buildings are constructed or altered in a way that will provide the capability for their energy use, production and reclamation to be measured, monitored and reported. This includes the design of energy distribution systems so as to isolate load types, the installation of meters, devices and a data acquisition system, and the installation of energy displays and other appropriate reporting mechanisms.

Z4.3 Energy Metering. All forms of energy delivered to the building and building site or produced on the building site or in the building, shall be metered and all energy load types measured.

Z4.4 Ventilation Flow Rate. In addition to requirements outlined in the *Energy Conservation Code—Commercial Provisions*, all centrally ventilated building systems shall be designed to enable the collection of real-time and historical ventilation flow rate data.

Z4.5 Grid Integration. In places where equipment constraints in the distribution network render net metering impossible, onsite storage options shall be considered.

Z5. ENERGY REPORTING. Owners of buildings that used Appendix Z as a path for code compliance shall comply with this section.

Z5.1 Post Occupancy Measurement and Reporting.

Z5.1.1 Owners of buildings that use Appendix Z as a path for code compliance shall annually benchmark and report their energy and water performance using the Energy Star® Portfolio Manager tool, including renewable energy generation and green power usage, pursuant to rules in *20 DCMR 3513*, regardless of square footage.

Z5.1.2 Energy Star Portfolio Manager Account. The *owner* of a *building* that used Appendix Z as a path for compliance with the *Energy Conservation Code—Commercial*

Provisions shall create an Energy Star® Portfolio Manager account and property record on the U.S. Environmental Protection Agency’s benchmarking website, and share the property with the District of Columbia’s Department of Energy and Environment. The *code official* is authorized to require proof of compliance with Section Z5.3.1 and proof that all utilities have been linked to the account.

Z5.2 Performance Verification. Within 24 months of occupancy, the owner or owner’s representative shall submit documentation to the *code official* demonstrating 12 continuous months of operation with no less than 90% occupancy where the energy consumed by the building and building site as measured in accordance with Section Z4 are equal to or less than the renewable energy associated with the building and building site in accordance with Section Z3. Documentation shall be in a form acceptable to the *code official*.

Z5.2.1 Normalization for abnormal conditions. At the discretion of the *code official*, the owner or owner’s representative may submit documentation demonstrating that abnormal weather or occupancy conditions during the compliance period are responsible for the variance between the energy consumed by the energy and energy site and the renewable energy associated with the building and building site and that the building would comply with Z5.2 under normal conditions.

Z6. NORMATIVE REFERENCES

Section numbers indicate where the reference occurs in Appendix Z.

Standard Reference number	Title	Referenced in code section number
U.S. Army Corps of Engineers 441 G Street NW, Washington, DC 20314-1000		
Version 3: 2012-05-11	Air Leakage Test Protocol for Building Envelopes	Appendix Z, Z2.6
Passive House Institute US (PHIUS) 116 W Illinois Street, #5e, Chicago, IL 60654		
Version 1.03 July 27 2016	Passive Building Standard for North America	Appendix Z, Z.1
RESNET P.O Box 4561, Oceanside, CA 92052 www.resnet.us		
August 16, 2010	<i>COMNET Rules and Procedures Manual</i>	Appendix Z, Z2.1.2.1