

Public Review Draft

Proposed Addendum k to Standard 189.1-2017

Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings

First Public Review (September 2018)
(Draft Shows Proposed Changes to Current Standard)

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(This foreword is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

Foreword

This is an update to Section 7.5 and Appendix C in response to WG7-DA89, the renewable energy proposal that is moving through Working Group 7. The addendum makes the performance approach and the prescriptive approach consistent with each other. It also addresses how to calculate the energy cost credit for the procurement of off-site renewable energy.

With the proposed modeling rules, it is not necessary to model renewable energy procured through self-owned or virtual PPAs. In these cases, the energy cost credit is calculated based on the virtual electric rate for the building project which is the annual electric bill divided by the annual consumption. This virtual rate includes demand charges, monthly service fees, TOU charges and other charges.

Community solar (or renewables) is different from the other off-site procurement options in that the building owner typically buys or leases a certain amount of renewable energy capacity and the production is credited to the building's utility bill on an hourly basis. For this reason, the modeling rules in Appendix C put community renewables in a separate category, e.g. production is accounted for on an hourly basis and the applicable net-metering or feed-in tariff is applied to calculate the credit to the building's energy cost.

Applying the proposed renewable energy requirements to CO₂e emissions and to zEPI is simpler than energy cost. Table C1.1, Section 15b addresses CO₂e emissions and Section 15c addresses zEPI. In the case on CO₂e emissions, an equation is added that makes it clear how to calculate the emissions for the proposed building. For zEPI, the language states that the adjusted renewable energy shall be credited using the source-site multiplier for electricity.

Table C1.1a.1 addresses on-site solar thermal systems. Table C1.1a.2 addresses on-site renewable energy electric generators. No changes are proposed to these sections.

Note: In this addendum, changes to the current standard and addenda approved for publication are indicated in the text by underlining (for additions) and ~~striketrough~~ (for deletions) unless the instructions specifically mention some other means of indicating the changes. Only these changes are open for review and comment at this time. Additional material is provided for context only and is not open for comment except as it relates to the proposed substantive changes.

Addendum k to 189.1-2017

Note to reviewers: Addendum AR adds section 7.5.3 and is not available in the published base standard. This addendum further modifies Section 7.5.3 as shown in track changes below:

7.5 Performance Option

7.5.1 Annual Energy Cost. The proposed building performance cost index (PCI) with consideration of renewables shall be calculated in accordance with ANSI/ASHRAE/IES Standard 90.1, Normative Appendix G, and be equal to or less than the Performance Cost Target, as determined from the following equation:

Note to reviewers: This new PCI_{target} equation is being added but is not shown as underlined

$$PCI_{target} = \frac{[BBUEC + (BBREC \times BPF)] \times (1 - RF)}{BBUEC + BBREC}$$

$$PCI_{target} = \frac{BBUEC + (BBREC \times BPF) - REC}{BBUEC + BBREC}$$

where

PCI_{target} = target PCI required for achieving compliance with the standard, unitless

BBUEC = the component of baseline building performance that is due to unregulated energy use, \$

BBREC = the component of baseline building performance that is due to regulated energy use, or baseline building performance minus BBUEC, \$

BPF = building performance factor taken from Table 7.5.2A1, unitless

~~RECRF = renewable energy production fraction from Table 7.5.1, unitless determined from Section 7.4.1.1.1 and converted to cost, \$~~

The proposed building PCI, without consideration of renewables, shall comply with the requirements of ASHRAE/IES Standard 90.1, Section 4.2.1.1.

On-site renewable energy systems in the proposed design shall be calculated using the procedures in Normative Appendix C. For mixed-use buildings, the building performance factor (BPF) shall be determined by weighting each building type by floor area.

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Table 7.5.1 Energy Cost and CO₂e-Building Performance Factors (BPF) and Renewable Fractions (RF)

<i>Building Type</i>	<i>Building Performance Factor (BPF)</i>	<i>Renewable Fraction (RF)</i>
Multifamily	0.71	<u>0.50</u>
Healthcare/hospital	0.56	<u>0.35</u>
Hotel/motel	0.58	<u>0.50</u>
Office	0.54	<u>0.50</u>
Restaurant	0.59	<u>0.10</u>
Retail	0.50	<u>0.50</u>
School	0.37	<u>0.50</u>
Semiheated warehouse	0.44	<u>0.50</u>
All others	0.54	<u>0.50</u>

a. Conditioned warehouses shall use the "All others" category

7.5.2 Annual Carbon Dioxide Equivalent (CO₂e). The proposed design shall have an annual CO₂e emissions equal to or less than the annual CO₂e emissions of the baseline building design multiplied by the building performance factor (BPF) target determined from Table 7.5.2A using the Performance Rating Method in ASHRAE/IES Standard 90.1, Normative Appendix G. To determine the annual CO₂e for each energy source in the baseline building design and proposed design, the energy consumption shall be multiplied by the CO₂e emission factors from Table 7.5.2B.

Table 7.5.2B CO₂e Emission Factors

<i>Building Project Energy Source</i>	<i>CO₂e, lb/MWh</i>	<i>CO₂e, kg/MWh</i>
Grid-delivered electricity and other fuels not specified in this table	1348	612
LPG or propane	601	273
Fuel oil (residual)	685	311
Fuel oil (distillate)	663	301
Coal	820	372
Gasoline	681	309
Natural gas	509	231
District chilled water	323	146
District steam	855	388
District hot water	807	366

The values in this table represent national averages for the United States and include both direct and indirect emissions.

7.5.3 Zero Energy Performance Index. The zero energy performance index (zEPI₂₀₀₄) of the proposed design, including on-site renewable energy systems, shall be less than the target (zEPI_{2004,Target}). zEPI₂₀₀₄ and zEPI_{2004,Target} shall be calculated as described below.

Note to reviewers: This new zEPI2004 equation is being added but is not shown as underlined

$$zEPI_{2004} = \frac{\sum_i PDSE_i \times r_i - \sum_k RE_k \times REPF_k \times r_e}{\sum_i BBSE_i \times r_i}$$

$$zEPI_{2004} = \frac{\sum_t PDSE_t \times r_t}{\sum_t BBSE_t \times r_t}$$

where

zEPI₂₀₀₄ = Zero energy performance index relative to the Standard 90.1 baseline as defined in the performance rating method of Appendix G.

PDSE_i = Proposed design site energy use for energy type i.

BBSE_i = Baseline building site energy use for energy type i. The baseline building is created following the rules in Standard 90.1, Appendix G.

r_i = Source energy conversion factor for energy type i, value taken from Table 7.5.2.1 7.5.3.

RE_k = Annual renewable energy electricity production for renewable energy procurement method k (see Table 7.4.1.2)

REPF_k = Renewable energy factor from Table 7.4.1.2 for renewable energy procurement method k

r_e = Source energy conversion factor taken from Table 7.5.3 for electricity.

Informative Note: *On-site thermal energy and renewable energy contributions to district energy plants are accounted for in the PDE_i term through reductions in electricity and/or gas use. The RE_k term will always be electricity.*

Note to reviewers: This new zEPI2004 Target equation is being added but is not shown as underlined

$$zEPI_{2004\ Target} = \frac{[BBUSE + (BBRSE \times BPF)] \times (1 - RF)}{BBUSE + BBRSE}$$

$$zEPI_{2004\ Target} = \frac{BBUSE + (BBRSE \times BPF) - RECSE}{BBUSE + BBRSE}$$

where

zEPI_{2004 Target} = Zero energy performance index target (zEPI_{2004 Target}) required for achieving compliance with the standard, unitless.

BBUSE = Baseline building *unregulated energy use* expressed in source units.

BBRSE = Baseline building *regulated energy use* expressed in source units.

BPF = Building performance factor taken from Table 7.5.1, unitless.

RECSE = Renewable fraction from Table 7.5.1, unitless. ~~energy production determined from section 7.4.1.1.1 and converted to source energy.~~

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NORMATIVE APPENDIX C

PERFORMANCE OPTION FOR ENERGY EFFICIENCY

C1. GENERAL

Table C1.1 Modifications and Additions to ANSI/ASHRAE/IES Standard 90.1, Appendix G, Table G3.1

Proposed Building Performance	Baseline Building Performance
1. Design Model	
No modifications	No modifications
2. Additions and Alterations	
No modifications	No modifications
3. Space Use Classification	
No modifications	No modifications
4. Schedules	
No modifications	No modifications
5. Building Envelope	
No modifications	No modifications
6. Lighting	
No modifications	No modifications
7. Thermal Blocks—HVAC Zones Designed	
No modifications	No modifications
8. Thermal Blocks—HVAC Zones Not Designed	
No modifications	No modifications
9. Thermal Blocks—Multifamily Residential Buildings	
No modifications	No modifications
10. HVAC Systems	
No modifications	No modifications
11. Service Hot-Water Systems	
No modifications	No modifications

12. Receptacle and Other Loads

No modifications

No modifications

13. Modeling Limitations to the Simulation Program

No modifications

No modifications

14. Exterior Conditions

No modifications

No modifications

15. On-Site Renewable Energy Systems

The reduction in the proposed building performance annual energy cost, and annual-CO₂e emissions and source energy of the proposed design due to energy generated by on-site renewable energy systems shall be calculated as follows:

a. **Annual Energy Cost.** The annual energy cost of the proposed design with an on-site renewable energy system shall be adjusted to account for renewable energy systems calculated on an hourly basis and adjusted as follows.

1. **On-Site Thermal Energy Performance Calculation.** The hourly thermal loads of the proposed design shall be reduced by the hourly thermal energy production of the on-site renewable energy system (but thermal loads shall not be reduced to less than zero). When the on-site renewable thermal energy production exceeds the applicable thermal demands of the building for any hour, the excess generated energy may be used to displace thermal loads at other times, provided the system has the storage capability and storage losses are included in the calculation. The approved energy rate structure shall be applied to the reduced energy consumption.

2. **On-Site Electric Renewable Energy Performance Calculation Systems.** The production of the on-site renewable electricity energy systems shall be calculated on an hourly basis, and the energy cost of the proposed building performance shall be calculated by applying the approved electrical rate structure to each hour's electrical usage, including any reduction from hourly electrical energy production of the on-site renewable energy system.

Exception to (a) a.2.: For building projects with no net metering agreement, feed-in tariff, or other electrical rate structure for net generated electricity, the cost of imported electricity from the grid is calculated by applying the approved electrical rate structure to each hour's electrical loads minus the hourly electrical energy production of the on-site renewable energy system, but the cost of imported electricity shall not be less than zero on a monthly basis.

Electricity production of the on-site renewable energy system that has a retail value in excess of the retail cost of electricity consumption on a monthly basis shall be credited as a reduction in energy costs to the building performance at the wholesale rate as follows:

$$Credit = \frac{ExRR - ImRR}{ExRR} \times ExkWh \times WR$$

where

Credit_k = cost reduction credit for month where retail value of exported electricity is greater than retail value of imported electricity

ExRR = month's value of exported electricity at retail rate

ImRR = month's value of imported electricity at retail rate

ExkWh = total kilowatt-hours exported in month

WR = average monthly wholesale rate for the region where the building located

Informative Note: *Thermal renewable energy is accounted for in a.1 above so the renewable energy addressed in a.2 will always be on-site electricity. There is no need to apply the renewable energy procurement factors from Table 7.4.1.2 since the multiplier will always be one.*

3. Electricity Generation from Community Renewable Energy Systems.

Community renewable energy systems that credit the building project electricity account on an hourly basis shall be calculated according to a.2, except that the renewable energy procurement factor from Table 7.4.2.1 shall be applied to each hour of electricity production from the community renewable energy system. The energy cost credit for other community renewable energy systems shall be calculated according to a.4.

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4. Electricity Generation from Self-Owned Off-Site Systems or Virtual

Power Purchase Agreements. The adjusted renewable energy is the actual renewable energy for each procurement source of renewable energy delivered to or credited to the *building project* multiplied by the renewable energy procurement factors in Table 7.4.1.2. The annual energy cost reduction of the proposed design shall be the adjusted renewable energy from self-owned off-site systems or virtual power purchase agreements credited to the project at the virtual electric rate paid by the building. The virtual electric rate is the total retail cost for electricity for the year divided by the net consumption for the year, in dollars per kWh (\$/kWh).

- b. **Annual CO₂e.** The annual CO₂e emissions of the proposed building that includes an on-site renewable energy system shall be equal to the annual CO₂e associated with all of the imported energy to serve the proposed building energy use (with reduced loads due to the on-site renewable energy system) minus the *annual adjusted renewable energy* exported electricity produced by the onsite renewable energy system multiplied by the electrical CO₂e emission factor from Table 7.5.2. Each procurement source of renewable energy delivered to or credited to the *building project* shall be multiplied by the renewable energy procurement factors in Table 7.4.1.2.

$$PD-CO_2e = \sum_i PDSE_i \times e_i - \sum_k RE_k \times RPEF_k \times e_k$$

where

PD-CO₂e = CO₂e emissions for the proposed design.

PDSE_i = Proposed design site energy use for energy type i.

e_i = CO₂e emission factor for energy type i, taken from Table 7.5.2.

RE_k = Annual renewable energy production for renewable energy type k

RPEF_k = Renewable procurement factor from Table 7.4.1.2 for renewable energy type k

e_k = CO₂e emission factor for electricity taken from Table 7.5.2.

- c. **Zero Energy Performance Index.** The *adjusted renewable energy* of the proposed building shall be credited using the source-site multiplier for electricity from Table 7.5.3. On-site thermal energy from solar shall be directly modeled according to Table C1.1, 15a.1 and accounted for through the displacement of on-site fossil fuel or electricity.

Documentation: The documentation required in ANSI/ASHRAE/ IES Standard 90.1, Section G2.5 (a), (b), and (e), shall be made available to the AHJ, upon request, for all on-site renewable energy systems in the proposed design.

Note to Reviewer: The underlines and strikethroughs in this addendum are shown relative to 189.1-2017 and addenda AR, which has been approved for publication, but not yet available to the public. Section 7.5.2 is also modified by addendum e which is not yet published. The informative material below is provided for the convenience of the reviewer. These changes are not open for public comment.

Note to Reviewer: Section 7.5.3 is also modified by addendum ar which is approved for publication, but is not yet available to the public. The relevant portions of addendum ar that are modified by addendum XX are shown below for the convenience of the reviewer.

7.5.3 Zero Energy Performance Index. The zero energy performance index (zEPI₂₀₀₄) of the proposed design, including on-site renewable energy systems, shall be less than the target (zEPI_{2004,Target}). zEPI₂₀₀₄ and zEPI_{2004,Target} shall be calculated as described below.

$$zEPI_{2004} = \frac{\sum_i PDSE_i \times r_i}{\sum_i BBSE_i \times r_i}$$

where

zEPI₂₀₀₄ = Zero energy performance index relative to the Standard 90.1 baseline as defined in the performance rating method of Appendix G.

PDSE_i = Proposed design site energy use for energy type i.

BBSE_i = Baseline building site energy use for energy type i. The baseline building is created following the rules in Standard 90.1, Appendix G.

r_i = Source energy conversion factor for energy type I, taken from Table 7.5.2.1.

$$zEPI_{2004\ Target} = \frac{BBUSE + (BBRSE \times BPF) - RECSE}{BBUSE + BBRSE}$$

where

zEPI_{2004 Target} = Zero energy performance index target (zEPI_{2004 Target}) required for achieving compliance with the standard, unitless.

BBUSE = Baseline building *unregulated energy use* expressed in source units.

BBRSE = Baseline building *regulated energy use* expressed in source units.

BPF = Building performance factor taken from Table 7.5.2.1, unitless.

RECSE = Renewable energy production determined from Section 7.4.1.1.1 and converted to source energy.

Informative Note: zEPI₂₀₀₄ uses Standard 90.1 Appendix G to define the baseline building. The traditional definition of zEPI uses the median energy of the existing building stock at the turn of the millennium as the baseline. The traditional zEPI definition is used by the Architecture 2030 program and for other programs. Informative Appendix I has a methodology for converting zEPI₂₀₀₄ to zEPI.

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TABLE 7.5.4 – National Average Source Energy Conversion Factors

<u>Energy Type</u>	<u>Conversion Factor (r)</u>
Electricity, Imported	3.15
Electricity, Exported Renewable	3.15
Natural Gas	1.09
Fuel Oil (1,2,4,5,6,Diesel, Kerosene)	1.19
Propane & Liquid Propane	1.15
Steam	1.45
Hot Water	1.35
Chilled Water	1.04
Coal or Other	1.05

Note: The values in this table represent national averages for the United States.

Note to Reviewer: Section 7.5.2 is also modified by addendum e which is not yet published. The relevant portions of addendum e that are modified by addendum XX are shown below for the convenience of the reviewer.

7.5.2 Annual Carbon Dioxide Equivalent (CO₂e). The proposed design shall have an annual CO₂e equal to or less than the annual CO₂e of the baseline building design multiplied by the performance cost index target determined from 7.5.1 building performance factor (BPF) target determined from Table 7.5.2A using the Performance Rating Method in ANSI/ASHRAE/IES Standard 90.1, Normative Appendix G. To determine the annual CO₂e for each energy source in the baseline building design and proposed design, the energy consumption shall be multiplied by the CO₂e emission factors from Table 7.5.2B.