



DENVER AMENDMENT PROPOSAL FORM FOR PROPOSALS TO THE 2019 DENVER BUILDING CODE AMENDMENTS AND THE 2021 INTERNATIONAL CODES

DENVER
THE MILE HIGH CITY

2021 CODE DEVELOPMENT CYCLE

1) **Name:** Courtney Anderson **Date:** 10/12/2021
Email: Courtney.Anderson@denvergov.org **Representing (organization or self):**
City Staff Proposal (check box):

2) One proposal per this document is to be provided with clear and concise information.

Is a separate graphic file provided ("X" to answer): Yes or No

3) Highlight the code and acronym that applies to the proposal

<u>Acronym</u>	<u>Code Name</u>	<u>Acronym</u>	<u>Code Name</u>
DBC-AP	Denver Building Code–Administrative Provisions	IPC	International Plumbing Code
IBC	International Building Code	IRC	International Residential Code
IECC	International Energy Conservation Code	IFGC	International Fuel Gas Code
IEBC	International Existing Building Code	IMC	International Mechanical Code
IFC	International Fire Code	DGC	Denver Green Code

AMENDMENT PROPOSAL

Please provide all the following items in your amendment proposal.

Code Sections/Tables/Figures Proposed for Revision:

Instructions: If the proposal is for a new section, indicate (new), otherwise enter applicable code section.

C401.2.1
Appendix SE (new)

Proposal:

Instructions: Show the proposal using ~~strikeout~~, underline format.

Place an "X" next to the choice that best defines your proposal: Revision New Text Delete/Substitute Deletion

Add the following sections and renumber the following equations:

Modify the section as follows:

C401.2.1 International Energy Conservation Code. Commercial buildings shall comply with one of the following:

1. Prescriptive Compliance. The Prescriptive Compliance Option requires compliance with Sections C402 through C406 and C408.
2. Total Building Performance. The Total Building Performance Option requires compliance with Section C407 or Appendix SE.

Add the following appendix:

Appendix SE
TOTAL BUILDING PERFORMANCE WITH SITE ENERGY

SE101 Scope. This section establishes criteria for demonstrating compliance using total building performance utilizing site energy in accordance with option c of section 4.2.1.1 of ANSI/ASHRAE/IESNA 90.1.

SE101.1 Relationship to Energize Denver. The requirements of this section are intended to support the *buildings'* future compliance with the requirements of the Energize Denver Building Energy Performance Requirements when the *building* is operated efficiently.

SE102 Mandatory requirements. *Buildings* complying with this appendix shall comply with section C407.2.

SE103 Compliance based on site energy. *Buildings* shall comply with option c: Normative Appendix G, "Performance Rating Method" of section 4.2.1.1 of ANSI/ASHRAE/IESNA 90.1 as modified by this section.

SE103.1 Terms. For the purposes of compliance with this appendix, terminology in ANSI/ASHRAE/IESNA 90.1 shall be modified as follows:

1. Replace references to energy cost with references to site energy in Sections G1.2.2, G1.3.2, G2.1, G2.5 and G2.4.2 section heading.
2. *baseline building performance* shall be defined as "the annual site *energy* for a *building* design intended for use as a baseline for rating above-standard design or when using the *Performance Rating Method* as an alternative path for minimum standard compliance in accordance with Section 4.2.1.1."
3. *proposed building performance* shall be defined as "the annual site *energy* calculated for a *proposed design*."

SE103.2 Section 4.2.1.1. Section 4.2.11 shall be replaced with the following:

Buildings shall comply with the provisions of Appendix G of ANSI/ASHRAE/IESNA 90.1, "Performance Rating Method." The Performance Site Energy Index (PSEI) shall be less than or equal to the Performance Site Energy Index Target (PSEI_t) when calculated in accordance with the following:

$$\text{PSEI}_t = \frac{[\text{BBUSE} + (\text{BPF} \times \text{BBRSE})]}{\text{BBP}}$$

where

PSEI = Performance Site Energy Index calculated in accordance with section G1.2.

BBUSE = baseline *building* unregulated site energy, the portion of the annual site energy of a baseline building design that is due to unregulated energy use.

BBRSE = baseline *building* regulated site energy, the portion of the annual site energy of a baseline building design that is due to regulated energy use.

BPF = *building* performance factor from table se103.2. for building area types not listed in table se103.2 use "all others." where a building has multiple building area types, the required bpf shall be equal to the area-weighted average of the building area types.

BBP = baseline *building* performance

$PBP = \frac{\text{proposed building performance, including the reduced, annual purchased site energy cost associated with all on-site renewable energy generation systems.}}{\text{proposed building performance without any credit for reduced annual energy from on-site renewable energy generation systems.}}$

$BBP_{nre} = \frac{\text{proposed building performance without any credit for reduced annual energy from on-site renewable energy generation systems.}}{\text{proposed building performance without any credit for reduced annual energy from on-site renewable energy generation systems.}}$

When $(PBP_{nre} - PBP)/BBP > 0.10$, new buildings, additions to existing buildings, and/or alterations to existing buildings shall comply with the following:

$$PSEI + [(PBP_{nre} - PBP)/BBP] - 0.010 < PSEI$$

SE103.3 Building performance factors. Table 4.2.1.1 Building Performance Factor (BPF) shall be replaced with Table SE103.3.

**TABLE SE103.3
BUILDING PERFORMANCE FACTOR (BPF)**

<u>Building Type</u>	<u>All-electric properties</u>	<u>All other buildings</u>
<u>Multifamily (R-2)</u>	<u>0.71</u>	<u>0.60</u>
<u>Hotel/Motel (R-1)</u>	<u>0.70</u>	<u>0.59</u>
<u>Healthcare/Hospital</u>	<u>0.73</u>	<u>0.62</u>
<u>Office (Group B)</u>	<u>0.59</u>	<u>0.51</u>
<u>Restaurant</u>	<u>0.75</u>	<u>0.63</u>
<u>Retail (Group M)</u>	<u>0.58</u>	<u>0.48</u>
<u>School (Group E)</u>	<u>0.69</u>	<u>0.58</u>
<u>Warehouse (Group S)</u>	<u>0.40</u>	<u>0.33</u>
<u>All Other</u>	<u>0.64</u>	<u>0.54</u>

SE103.4 Process load metering. *Process loads* that are categorized as *unregulated energy use* for the purposes of Normative Appendix G shall be metered separately from the rest of the *building* with meters or other measurement devices that comply with section C405.12.3.

SE103.5 Section G1.2.2. Section G1.2.2 shall be replaced with the following:

The performance of the *proposed design* is calculated in accordance with provisions of this appendix using the following formula:

$$\text{Performance Site Energy Index} = \frac{\text{Proposed building performance}}{\text{Baseline building performance}}$$

Both the *proposed building performance* and the *baseline building performance* shall include all end-use load components within and associated with the *building* when calculating the Performance Site Energy Index.

SE103.6 Section G1.3.2. Items a. and p. in Section G1.3.2 shall be replaced as follows:

- a. The following documentation shall be submitted to the rating authority: The simulation program used, the version of the simulation program, and the results of the energy analysis including the calculated values for the baseline building unregulated site energy (BBUSE), baseline building regulated site energy (BBRSE), Building Performance Factor

(BPF), baseline building performance, the proposed building performance, Performance Site Energy Index (PSEI), and Performance Site Energy Index Target (PSEIt).

- p. For any exceptional calculation methods employed, document the predicted energy savings by energy type, the site energy savings, a narrative explaining the exceptional calculation method performed, and theoretical or empirical information supporting the accuracy of the method.

SE103.7 Section G2.4.2. Section G2.4.2 shall be renamed “Annual Site Energy.” The informative note for sections G2.4.2 and G2.4.2.2 shall be removed. The first sentence in section G2.4.2. shall be replaced with the following:

Site energy shall be calculated in accordance with the following:

1. 3,412 BTU per kWh of electricity
2. 100,000 BTU per therm of natural gas

SE103.8 Section G2.5. Section G2.5, item e shall be replaced with the following:

The Performance Site Energy Index calculated with and without the exceptional calculation method.

Supporting Information (Required):

All proposals must include a written explanation and justification as to how they address physical, environmental, and/or customary characteristics that are specific to the City and County of Denver. The following questions must be answered for a proposal to be considered.

Reason for Revisions:

The Energy Modeling Working Group met over a series of 4 meetings and recommended several modifications to the original proposal, including:

- **Move to an Appendix.** The WG identified the inclusion of site energy and energy cost provisions together in C407 as a source of potential confusion. Therefore, the site energy approach was moved to an appendix to allow C407 to stand as a “standard” modeling approach that is as close to Appendix G and to remove the potential for users to confuse which code sections applied to energy cost and which applied to site energy. The appendix includes a reference to the mandatory requirements in C407 to ensure consistency between the modeling paths.
- **Alignment with Addendum CH.** ASHRAE is finalizing a new Addendum CH for 90.1 that allows the utilization of alternate energy metrics in Appendix G. This addendum is very similar to the site energy approach already in the proposal. The proposal was modified to fully align with Addendum CH to both benefit from the additional refinements in that addendum and to align Denver’s site energy approach with how site energy metrics will be integrated into future editions of 90.1 and Appendix G.
- **Move site energy to an Appendix.** The WG identified the inclusion of site energy and energy cost provisions together in C407 as a source of potential confusion. Therefore, the site energy approach was moved to an appendix to allow C407 to stand as a “standard” modeling approach that is as close to Appendix G and to remove the potential for users to confuse which code sections applied to energy cost and which applied to site energy. The appendix includes a reference to the mandatory requirements in C407 to ensure consistency between the modeling paths.
- **Renewable energy cap.** The WG felt that the cap on renewable energy that could be counted toward compliance was too restrictive given Denver’s goals. The cap was therefore raised to 10% in order to allow for more flexibility without allowing too much tradeoff between renewable energy and fundamental efficiency. This also aligns the modeling path with changes made to C406 by the commercial prescriptive WG.
- **BPFs.** For the 2022 version of 90.1, a new methodology is being utilized to generate the BPFs. This methodology is more accurate and generally results in less stringent BPFs. PNNL utilized this new methodology to generate revised site energy BPFs for Denver specifically for 90.1-2019 levels of performance.

Target Setting

The stringency levels in this proposal are based on the performance goals set for the 2022 DEC by *Denver’s Net Zero Energy (NZE) New Buildings & Homes Implementation Plan*. That performance target was set by plotting a trajectory from the 2019 DEC to NZE levels of performance. The NZE end target was set by surveying multiple published datasets of modeled and measured NZE potential.¹ The existing IECC delivers different levels of performance for different building types, with some building types closer to Denver’s NZE goal than others. This results in different performance improvement trajectories for those building types and different performance improvement targets for each code cycle for those building types. The DEC -2019 is about 7% more efficient than the IECC-2021 and about 9% more efficient than the 90.1-2019. This relationship between the DEC-2019 and IECC-2021 or 90.1-2019 and the performance improvements in the *Implementation Plan* for the DEC-2021 can be combined to calculate the improvement that is required beyond the IECC-2021 and 90.1-2019 for each building type. These percent improvements were then converted to the credit requirements for C406 and the BPF improvement for modeling.

Table 1: 2022 Code improvement targets

<u>Building Type</u>	<u>Improvement over DEC-2019</u>	<u>Improvement over IECC-2021</u>	<u>Improvement over 90.1-2019</u>
Multifamily (R-2)	7%	14%	16%
Healthcare/Hospital	7%	14%	16%
Hotel/Motel (R-1)	6%	13%	15%
Office (Group B)	5%	12%	14%
Retail (Group M)	8%	15%	17%
School (Group E)	7%	14%	16%
Warehouse (Group S)	9%	16%	18%

¹ Resources included the NBI Getting to Zero Database, the ASHRAE Advanced Energy Design Guides, The City of Toronto Zero Emissions Buildings Framework, GARD’s “Development of Maximum Technically Achievable Energy Targets for Commercial Buildings,” ARUP’s “Technical Feasibility of Zero Net Energy Buildings in California,” and “Built to Perform: An industry led pathway to a zero carbon ready building code.”

Purpose: What does your proposal achieve?

This proposal adds an option to use site energy as the energy metric in the modeling compliance path of ASHRAE 90.1 Appendix G to support the electrification of projects.

Reason: Why is your proposal necessary?

“Denver’s Net Zero Energy (NZE) New Buildings & Homes Implementation Plan” includes a goal to transition new Denver buildings to all-electric design. However, ASHRAE 90.1 Appendix G uses energy cost as the energy metric for modeling. Due to very inexpensive costs for natural gas in Denver, this creates a significant barrier to electrification for Denver projects that pursue modeled performance-based code compliance. The inexpensive gas disadvantages electric equipment, effectively making it harder to comply with the code with electric equipment, even when that equipment is significantly more efficient than their gas counterparts.

The 2019 Denver Energy Code partially addressed this issue by including a source energy-based option for modeling developed by the Pacific Northwest National Lab. This limited the advantage of natural gas but did not eliminate it. At the time, site energy options were not available because there was not a site energy approach for the new modeling method in 90.1-2016. For the 2021 DEC, PNNL has been able to develop a set of site energy-based building performance factors (BPFs) that can be used with Appendix G. Utilizing site energy eliminates the substantial advantage inexpensive gas gives gas equipment in Denver projects.

Substantiation: Why is your proposal valid? (i.e. technical justification)

This proposal adds an additional option for using site energy in Appendix G. It is an option, so the energy cost metric is still available. The equations and BPFs are added to the new Section C407 that is being proposed for the DEC to modify 90.1 Appendix G for use in Denver.

In order to minimize the changes required to Appendix G to convert energy cost terminology to site energy terminology, the proposal uses a terminology management method already used in Appendix G. Appendix G has a provision that states that when Appendix G is used for code compliance, all instances of “rating authority” shall be replaced with code official. This proposal does a similar thing by stating that all references to “proposed building performance” shall be replaced with “proposed design site energy” and all references to “baseline building performance” shall be replaced with “baseline building design site energy.”

The Performance Cost Index (PCI) calculation utilized for Appendix G assumes energy cost in the terminology. Therefore, this proposal also creates a new equation and set of equations for calculating a performance target that is based on site energy terminology.

Bibliography and Access to Materials (as needed when substantiating material is associated with the amendment proposal):

None

Other Regulations Proposed to be Affected

***For proposals to delete content from the 2019 Denver Green Code in conjunction with adding it to other mandatory Denver codes and/or regulations, only.**

Please identify which other mandatory codes or regulations are suggested to be updated (if any) to accept relocated content.

None

Referenced Standards:

List any new referenced standards that are proposed to be referenced in the code.

None

Impact:

How will this proposal impact cost and restrictiveness of code? (“X” answer for each item below)

The proposal will decrease the cost of design and construction by providing greater flexibility. The proposal will specifically reduce the cost of compliance for all-electric buildings by removing the advantage given in the standard energy cost method.

Cost of construction:	Increase	X Decrease	No Impact
Cost of design:	Increase	Decrease	X No Impact
Restrictiveness:	Increase	X Decrease	No Impact

Departmental Impact (City use only):

This amendment proposal increases/decreases/is neutral to the cost of plans review.

This amendment increases/decreases/is neutral to the cost of inspections.