Code Amendment Proposal Form
For public amendments proposed to the 2018 editions of the International Codes

**Instructions:** Upload this form and all accompanying documentation at [www.denvergov.org/BuildingCode](http://www.denvergov.org/BuildingCode). If you are submitting your proposal on a separate sheet, make sure it includes all information requested below.

All proposals must be received by **April 26, 2019**.

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**CONTACT INFORMATION**

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Organization: New Buildings Institute

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Signature: [Signature]

Co-proposed by: Amber Wood, Denver Department of Public Health and Environment  
Jim Meyers, Southwest Energy Efficiency Project

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**AMENDMENT PROPOSAL**

Please use a separate form for each proposal.

1) Code(s) associated with this proposal. Please use acronym: **IECC**

If you submitted a separate coordination change to another code, please indicate which code: __________________________________________

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Code Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>DBC-xxxx</td>
<td>Denver Building Code–xxxx (code) amendments (e.g., DBC-IBC, DBC-IEBC)</td>
</tr>
<tr>
<td>IBC</td>
<td>International Building Code</td>
</tr>
<tr>
<td>IEBC</td>
<td>International Existing Building Code</td>
</tr>
<tr>
<td>IECC</td>
<td>International Energy Conservation Code</td>
</tr>
</tbody>
</table>

2) Please check here if a separate graphic file is provided: ☐

*Graphics may also be embedded within your proposal below.*

3) Use this template to submit your proposal or attach a separate file, but please include all items requested below in your proposal. The only formatting needed is BOLDING, STRIKETHROUGH AND UNDERLINING. Please do not provide additional formatting such as tabs, columns, etc., as this will be done by CPD.

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**Code Sections/Tables/Figures Proposed for Revision:**

IECC C406

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**Proposal:**

Revise as follows:

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**SECTION C406**
Add new text as follows:

### Table C406.1

**Additional Energy Efficiency Credits**

<table>
<thead>
<tr>
<th>Climate Zone/Building Type</th>
<th>Group B</th>
<th>Groups R &amp; I</th>
<th>Group E</th>
<th>Group M</th>
<th>All Other&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>C406.2.1: 5% Heating</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>C406.2.2: 5% Cooling</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>C406.2.3: 10% Heating</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>C406.2.4: 10% Cooling</td>
<td>4</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>C406.3.1: 10% LPA</td>
<td>7</td>
<td>2</td>
<td>8</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>C406.4: Digital Lt Ctrl</td>
<td>2</td>
<td>NA</td>
<td>2</td>
<td>NA</td>
<td>2</td>
</tr>
<tr>
<td>C406.5: Renewable&lt;sup&gt;d&lt;/sup&gt;</td>
<td>9</td>
<td>7</td>
<td>6</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>C406.6: DOAS</td>
<td>5</td>
<td>8</td>
<td>NA</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>C406.7.1: SWH HR</td>
<td>NA</td>
<td>14</td>
<td>1&lt;sup&gt;c&lt;/sup&gt;</td>
<td>NA</td>
<td>14&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>C406.7.2: SWH NG eff</td>
<td>NA</td>
<td>9</td>
<td>2&lt;sup&gt;c&lt;/sup&gt;</td>
<td>NA</td>
<td>9&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>C406.7.3: SWH HP</td>
<td>NA</td>
<td>5</td>
<td>1&lt;sup&gt;c&lt;/sup&gt;</td>
<td>NA</td>
<td>5&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>C406.8: 85% UA</td>
<td>10</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>C406.9: Low Leak</td>
<td>11</td>
<td>9</td>
<td>1</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>C406.10: Plug Load Ctrl</td>
<td>L</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

a. for schools with full-service kitchens or showers  
b. Other occupancy groups include all Groups except for Groups B, R, I, E, and M  
c. for occupancy groups listed in C406.7.1  
d. Additional credits are available in accordance with C406.5.2

Revise as follows:

**C406.1 Requirements.** Additional energy efficiency requirements. Buildings shall comply. New buildings shall achieve a total of 10 credits from Tables C406.1(1) through C406.1(5) where the table is selected based on the use group of the building. Where a building contains multiple use groups, credits from each use group shall be weighted by floor area of each group to determine the weighted average building credit. Credits may also be as calculated in accordance with the relevant subsection of C406.1. Credits from the tables or calculation shall be achieved where a building complies with one or more of the following:

1. More efficient HVAC performance in accordance with Section C406.2.
2. Reduced lighting power in accordance with Section C406.3.
3. Enhanced lighting controls in accordance with Section C406.4.
4. On-site supply of renewable energy in accordance with Section C406.5.
5. Provision of a dedicated outdoor air system for certain HVAC equipment in accordance with Section C406.6.
6. High-efficiency service water heating in accordance with Section C406.7.
7. Enhanced envelope performance in accordance with Section C406.8.
8. Reduced air infiltration in accordance with Section C406.9.
9. Plug load control in accordance with Section C406.10.

Where the entire building complies using credits from Section C406.5, C406.8 or C406.9, 5 credits shall be deemed to achieve a minimum number of 5 credits, where credits are selected from Section C406.2, C406.3, C406.4, C406.6 or C406.7.

Alternatively, Where the entire building complies using credits from Section C406.5, C406.8 or C406.9, additional credits are available in accordance with C406.5.2.

### Exception:
Previously occupied tenanted spaces that comply with this code in accordance with Section C501.

**C406.2 More efficient HVAC equipment performance.** Equipment shall exceed the minimum efficiency requirements listed in Table C406.3.2(1) through C406.3.2(7) by 10 percent, in addition to the requirements of Section C403. Where multiple performance requirements are provided, the equipment shall exceed all requirements by 10 percent. 9) and Variable refrigerant flow systems shall exceed the energy efficiency provisions of ANSI/ASHRAE/IESNA 90.1 by 10 percent, in accordance with Sections C406.2.1, C406.2.2, C406.2.3 or C406.4. Equipment shall also meet applicable requirements of Section C403. Energy efficiency credits for heating shall be selected from C406.2.1 or C406.2.3 and energy efficiency credits for cooling shall be selected from C406.2.2 or C406.2.4. Selected credits shall include a heating or cooling energy efficiency credit or both. Equipment not listed in Table C406.3.2(1) through C406.3.2(7) and Variable refrigerant flow systems not listed in the energy efficiency provisions of ANSI/ASHRAE/IESNA 90.1 shall be

Variable refrigerant flow systems

ADDITIONAL EFFICIENCY PACKAGE OPTIONS REQUIREMENTS
C406.2.2 More efficient HVAC cooling performance. Equipment shall exceed the minimum cooling and heat rejection efficiency requirements by 5 percent. Where multiple cooling performance requirements are provided, the equipment shall exceed the annual energy requirement, including IEER, SEER, and IPLV.

C406.2.3 High efficiency HVAC heating performance. Equipment shall exceed the minimum heating efficiency requirements by 10 percent.

C406.2.4 High efficiency HVAC cooling performance. Equipment shall exceed the minimum cooling and heat rejection efficiency requirements by 10 percent. Where multiple cooling performance requirements are provided, the equipment shall exceed the annual energy requirement, including IEER, SEER, and IPLV.

C406.3 Reduced lighting power. Buildings shall comply with Section C406.3.1 or C406.3.2.

C406.3.1 Reduced lighting power 10 percent. The total connected interior lighting power calculated in accordance with Section C405.3.1 shall be less than 90 percent of the total lighting power allowance calculated in accordance with Section C405.3.2.

C406.3.2 Reduced lighting power more than 15 percent. Where the total connected interior lighting power calculated in accordance with Section C405.3.1 is less than 85 percent of the total lighting power allowance calculated in accordance with Section C405.3.2, additional energy efficiency credits shall be determined based on Equation 4-12, rounded to the nearest whole number.

\[ \text{AEFC}_{\text{LPA}} = \text{AEFC}_{\omega} \times 10 \times \frac{(LPA - LPD)}{LPA} \quad \text{(Equation 4-12)} \]

Where:

\[ \text{AEFC}_{\omega} = C406.3.2 \text{ additional energy efficiency credits} \]

\[ LPD = \text{total connected interior lighting power calculated in accordance with Section C405.3.1} \]

\[ LPA = \text{total lighting power allowance calculated in accordance with Section C405.3.2} \]

\[ \text{AEFC}_{\omega} = C406.3.1 \text{ credits from Tables C406.1(1) through C406.1(5)} \]

No Changes to C406.4

C406.5 On-site renewable energy. Buildings shall comply with Section C406.5.1 or C406.5.2.

C406.5.1 Basic Renewable Credits. The total minimum ratings of on-site renewable energy systems shall be one of the following:

1. Not less than 1.74 0.85 Btu/h per square foot (5.4 2.7 W/m²) or 0.50 0.25 watts per square foot (5.4 2.7 W/m²) of conditioned floor area.
2. Not less than 3 percent of the annual energy used within the building for building mechanical and service water heating equipment and lighting regulated in Chapter 4.

C406.5.2 Enhanced Renewable Credits. Where the total minimum ratings of on-site renewable energy systems exceeds the rating in C406.5.1(1), additional energy efficiency credits shall be determined based on Equation 4-13, rounded to the nearest whole number.

\[ \text{AEFC}_{\omega} = \text{AEFC}_{\omega} \times \frac{RRa}{RR} \quad \text{(Equation 4-13)} \]

Where:

\[ \text{AEFC}_{\omega} = C406.5.2 \text{ additional energy efficiency credits} \]

\[ RRa = \text{actual total minimum ratings of on-site renewable energy systems in Btu/h, watts per square foot or W/m²} \]

\[ RR = \text{minimum ratings of on-site renewable energy systems required by C406.5.1(1) in Btu/h, watts per square foot or W/m²} \]

\[ \text{AEFC}_{\omega} = C406.5.1 \text{ credits from Tables C406.1(1) through C406.1(5)} \]

No Changes to C406.4

C406.7 Reduced energy use in service water heating. Buildings shall comply with Sections C406.7.1 and either C406.7.2, C406.7.3 or C406.7.4.

C406.7.1 Building type. To qualify for this credit, the building shall contain one of the following use groups and the additional energy efficiency credit shall be prorated by conditioned floor area of the portion of the building comprised of the following use groups types to use this compliance method:

1. Group R-1: Boarding houses, hotels or motels.
2. Group I-2: Hospitals, psychiatric hospitals and nursing homes.
3. Group A-2: Restaurants and banquet halls or buildings containing food preparation areas.
5. Group R-2.
7. Group E: Schools with full-service kitchens or locker rooms with showers.
8. Buildings showing a service hot water load of 10 percent or more of total building energy loads, as shown with an energy analysis as described in Section C407.

C406.7.2 Load fraction - Recovered or renewable water heating. The building service water-heating system shall have one or more of the following that are sized to provide not less than 60% or 80% percent of the building's annual hot water requirements, or sized to provide 40% or 70% percent of the building's annual hot water requirements if the building shall otherwise be required to comply with Section C403.9.5:

1. Waste heat recovery from service hot water, heat-recovery chillers, building equipment, or process equipment.
2. On-site renewable energy water-heating systems.

C406.7.3 Efficient fossil fuel water heater. The combined input-capacity-weighted-average equipment rating of all fossil fuel water heating equipment in the building shall be not less than 95% Et or 0.95 EF. This option shall receive only half the listed credits for buildings required to comply with C404.2.1.

C406.7.4 Heat pump water heater. Where electric resistance water heaters are allowed, all service hot water system heating requirements shall be met using heat pump technology with a combined input-capacity-weighted-average EF of 3.0. Air-source heat pump water heaters shall not draw conditioned air from within the building, except exhaust air that would otherwise be exhausted to the exterior.

No Changes to C406.8-9

Supporting Information:

Purpose:

The purpose of this proposal is to allow the IECC to achieve performance levels consistent with Denver’s goals in a flexible way through converting Section C406 into a points-based system and by raising the amount of additional efficiency that is required to meet the code.

Reason:

The C406 Option Packages was introduced into the IECC in 2012 as part of the prescriptive method to achieve an additional 4% energy savings over the prescriptive requirements of the code. The original proposal included three additional options (reduced lighting power density, increased HVAC efficiency and renewables). The 2018 IECC now has eight options to select from. In 2018, PNNL performed an analysis to determine the energy savings potential for each of the eight options and found significant savings differences, as shown in Figure 1.

![Variation in Building Cost Savings for Options](image)

*Figure 1*
To address this issue PNNL developed a points-based option that provides equity across the efficiency measure options. The analysis is presented in their technical brief “Relative Credits for Extra Efficiency Measures” (http://www.pnnl.gov/main/publications/external/technical_reports/PNNL-28370.pdf). Prototype models are used in the analysis. Their development, and associated climate locations, are described in detail in the quantitative determination and are available for download (see bibliography). Four building prototypes were used to capture the difference between building types:

- Medium office
- Primary School
- Mid-rise Apartment
- Stand Alone Retail

EnergyPlus™ was used to evaluate each measure in the four prototypes in all U.S. climate zones, except in cases where there is not a strong interaction with building HVAC systems, where standard engineering calculations were used. This applies to service hot water and renewable energy. Dedicated outdoor air systems (DOAS) savings were estimated rather than modeled, as discussed in the “Relative Credits for Extra Efficiency Measures”.

- Using average annual commercial energy prices, cost savings for each measure are calculated as a percentage of building total annual energy cost.
- The cost percentages are converted to credit points, with the goal of not being exactly equivalent, but to provide approximate relative equivalency between measures. One point is assigned for each 0.25% of building energy cost savings.

![Figure 2](image)

The points resulting from averaging four typical C406 measures (10% HVAC, 10% LPA, Renewable and 85% UA) are shown as the last item on the right side of Figure 2. These average around 10 points across climate zones, while lighting power allowance—a popular option selection—averages around 8 points across climate zones. Selecting 10 points or 2.5% savings of building energy cost as the target of a point-based system makes sense as being slightly ahead or roughly equal to the approach followed in the 2018 IECC.

To achieve savings from a combination of multiple measures under the 2018 IECC, the only recourse is to follow the performance path that requires a building model. Having a simple table of points for measures in different building types and climate zones bypasses the need for full performance modeling, which can be expensive relative to savings for smaller buildings. The end result is a performance-based approach that can be applied with the simplicity of a prescriptive approach.

The outlined approach is based on the structure currently employed in the IECC for commercial buildings. It just shifts from a “pick one” approach to one that selects adequate measures from the options to meet a required point level. It is also similar to packages of measures that have been utilized in both residential and commercial energy codes, particularly in the Pacific Northwest. The Washington code has successfully used such a structure to balance energy performance, design flexibility, and evolving technologies.
The existing measures were modified to better fit within the points option and to provide more flexibility.

More efficient HVAC heating performance (C406.2) There has been industry feedback that it is difficult to comply with the 10% increase in efficiency for the More Efficient HVAC Option because both the heating and cooling equipment must comply. The points option allows either heating or cooling or both to comply. This measure would be modified to provide separate credits for the following:

- Medium efficiency HVAC heating performance (C406.2.1) is a 5% improvement in efficiency over the existing minimum requirement.
- Medium efficiency HVAC cooling performance (C406.2.2) is a 5% improvement in efficiency over the existing minimum requirement.
- High Efficiency HVAC heating performance (C406.2.3) is a 10% improvement in efficiency over the existing minimum requirement.
- High Efficiency HVAC cooling performance (C406.2.4) is a 10% improvement in efficiency over the existing minimum requirement.

Note: If equipment efficiency tables for VRF or other items are added by another proposal, then remove the reference to the ASHRAE 90.1 tables and adjust the table number reference range to include all HVAC equipment tables.

C406.3 Reduced lighting power. The proposal keeps the 10% reduced lighting power allowance threshold and adds a threshold of 15%. Lighting designers that want to design to lower LPD levels can also use the calculation (Equation 4-12) to achieve more points giving them more flexibility.

C406.5 On-sit e renewable energy. The onsite renewable energy credit has been modified to allow for additional credit from increased system size over the base level requirement for this credit.

C406.7.1 Reduced energy use in service water heating. The water heating option allows for credit for high efficiency gas and electric water heaters in addition to heat recovery.

This proposal includes a requirement of 10 credits. This is the number of credits that are being proposed for the 2021 IECC to maintain parity with the existing stringency of Section C406. However, this requirement can be increased in order to ensure that the prescriptive path meets the goals that Denver has set for the next version of the energy code (below).

In order for the next version of the energy code to stay “on the line” to make Denver’s 2035 goal, it will need to be 22% more efficient than the IECC-2018. All of the City of Denver’s sponsored code proposals will deliver approximately 15% savings over IECC-2018. That leaves an additional 7% (or more if some of those proposals are not adopted) that will need to come from proposals from stakeholders or from changing the points requirement in this proposal. Each point in this proposal is worth ¼%, so the additional savings can be obtained by adding 4 credits per additional percentage point needed to the existing points requirement.
### Bibliography:


http://buildingconnections.seattle.gov/2012/03/01/air-barriers-and-pressure-testing/

### Referenced Standards:

NA

### Impact:

The effect of the proposal on the cost of construction: ☒ Increase ☐ Reduce ☐ No Effect
- This proposal could increase the cost of construction, especially for projects that will need to implement more than one option. However, the flexibility allows this proposal to provide a far more cost-effective path to meeting Denver’s ambitious goals prescriptively.

The effect of the proposal on the cost of design: ☒ Increase ☐ Reduce ☒ No Effect
- The proposal may require greater attention to the design process, especially in evaluating the options.

Is the proposal more or less restrictive than the I-codes: ☒ More ☐ Less ☐ Same

### Departmental Impact: (To be filled out by CPD staff)

Note: CITY STAFF ONLY. Discuss the impact of this proposal in this section AND indicate the impact of this amendment proposal for each of the following:
- The effect of the proposal on the cost of review: ☐ Increase ☐ Reduce ☐ No Effect
- The effect of the proposal on the cost of enforcement/inspection: ☐ Increase ☐ Reduce ☐ No Effect