



# 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:** John Arent  
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**Date:** 5/30/2022  
**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 X 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	<b>DGC</b>	<b>Denver Green Code</b>

## 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.

**704.1.2**

**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

**Denver Green Code**

**704.1.2 (7.4.1.2) Battery Storage Systems (Elective).** All buildings that are required by the IECC section C405.13 to have a PV system shall also have a battery storage system meeting the minimum qualification requirements. The rated energy capacity and the rated power capacity shall be not less than the values determined by Table 7.4.1.2-A. Where the building includes more than one of the space types listed in Table 7.4.1.2-A, the total battery system capacity for the building shall be determined by applying Equations 7.4.1.2-B and 7.4.1.2-C to each of the listed space types and summing the capacities determined for each space type and equation.

**Exceptions:**

1. No battery storage system is required if the installed PV system size is less than 0.25 kW DC capacity per square foot of conditioned floor areas.

2. No battery storage system is required in buildings with battery storage system requirements with less than 10 kWh rated capacity.

3. For multi-tenant buildings, the energy capacity and power capacity of the battery storage system shall be based on the tenant spaces with a combined conditioned floor area exceeding 5,000 square feet . For single-tenant buildings with less than 5,000 square feet of conditioned floor area, no battery storage system is required.

**EQUATION 7.4.1.2-B - BATTERY STORAGE RATED ENERGY CAPACITY**

$$kWh_{batt} = kW_{PVdc} \times B / D^{0.5}$$

**WHERE:**

kWh<sub>batt</sub> = Rated Useable Energy Capacity of the battery storage system in kWh

kW<sub>PVdc</sub> = PV system capacity in kWdc

B = Battery energy capacity factor specified in Table 7.4.1.2 for the building type

D = Rated single charge-discharge cycle AC to AC (round-trip) efficiency of the battery storage system

**EQUATION 7.4.1.2-C - BATTERY STORAGE RATED POWER CAPACITY**

$$kW_{batt} = kW_{PVdc} \times C$$

**WHERE:**

kW<sub>batt</sub> = Power capacity of the battery storage system in kWdc

kW<sub>PVdc</sub> = PV system capacity required by section 701.4.1 in kWdc

C = Battery power capacity factor specified in Table 7.4.1.2 for the building type

**Table 7.4.1.2-A Battery Storage Capacity Factors (Storage to PV Ratio)**

	B - Energy Capacity (Wh / W PV)	C - Power Capacity (W / W PV)
Grocery	1.03	0.26
Highrise Multifamily	1.03	0.26
Office	1.68	0.42
Retail	1.03	0.26
School	1.87	0.46
Warehouse	0.93	0.23

**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.

- Purpose: What does your proposal achieve?

This proposal complements the requirement for onsite generation from photovoltaic (PV) panels by requiring an onsite battery storage system. This system benefits both the consumer and the utility by storing excess production from PV panels and allowing it to be used during periods of peak demand. The battery storage is primarily a load-shifting device that can also shave peak demand for some buildings. Moreover, it can provide a small degree of resilience if outages were to occur.

This proposal is a companion to the proposal for required onsite PV generation. The required battery storage system size is proportional to the required onsite PV system capacity. The size is designed to provide adequate opportunities for load shifting and demand reduction. Note that if an onsite PV system were NOT required, there can still be a requirement to install the batter storage system if a PV system is installed. This will ensure that the system provides for effective use of onsite generation over the life of the system.

- Reason: Why is your proposal necessary?

For the Denver Green Code, battery storage is an important complement to use of onsite photovoltaic systems for energy production. An electric battery storage system provides for load shifting and peak demand mitigation, and it can provide a small degree of resilience as well. The storage system addresses the fact that peak power consumption typically occurs late in the afternoon to early evening, hours removed from peak renewable power generation. Another complementary proposal has been submitted to support increased onsite storage.

The proposal is necessary to allow onsite distributed generation to continue to complement utility-scale renewable generation as the utilities generate an increasing share of power through renewables. Without energy storage, the value of energy produced at midday by distributed energy sources drops close to zero, as this coincides with peak power generation. Comparatively low energy is produced by renewables during peak periods, which are typically during the hours of 4pm and 8pm.

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

Commercial battery storage systems are available for residential buildings and commercial buildings, and their costs have dropped precipitously over the last five years. Capacity-weighted average costs per-unit of energy capacity have decreased by 61% between 2015 and 2017, from \$2,153/kWh to \$834/kWh (EIA 2020). A study developed for the California Energy Commission has shown (CITE) that PV systems combined with battery storage are cost-effective over the life of the equipment. The battery systems have an expected life of 10 years

The California Energy Commission applied the results of an independent evaluation (Athalye 2021) to serve as the justification for requiring PV panels and battery storage to be installed on some building types for new construction, beginning in January 2023.

**IECC for reference:**

**TABLE C405.13.1(1)  
MINIMUM ONSITE RENEWABLE ENERGY REQUIREMENTS**

<b><u>Building Type</u></b>	<b><u>Onsite Renewable Energy Production Requirement (kBtu/sf/yr)<sup>a</sup></u></b>	<b><u>Onsite Renewable Energy Production Requirement (kWh/sf/yr)</u></b>
<u>Mid-Rise Apartment (R-2) 4-7 stories</u>	<u>7.0</u>	<u>2.0</u>
<u>High-Rise Apartment (R-2) 8 or more stories</u>	<u>7.6</u>	<u>2.2</u>
<u>Small Hotel (R-1) 0-100,000</u>	<u>9.4</u>	<u>2.7</u>
<u>Large Hotel (R-1) 100,000 sf and larger</u>	<u>13.6</u>	<u>3.9</u>
<u>Medium Office (Group B) 40,000-100,000 sf</u>	<u>5.2</u>	<u>1.5</u>
<u>Large Office (Group B) 100,000 sf and larger</u>	<u>10.8</u>	<u>3.1</u>
<u>Standalone Retail (Group M)</u>	<u>7.8</u>	<u>2.3</u>
<u>Warehouse (Group S)</u>	<u>2.6</u>	<u>0.8</u>
<u>All Other</u>	<u>5.6</u>	<u>1.6</u>

a. Or 20% of the annual energy use as calculated in accordance with Section C407.

**TABLE C405.13.1(2)**  
**MINIMUM OFF-SITE RENEWABLE ENERGY REQUIREMENTS**

<b><u>Building Type</u></b>	<b><u>Off-site Renewable Energy Production Requirement (kBtu/sf/yr)<sup>a</sup></u></b>	<b><u>Off-site Renewable Energy Production Requirement (kWh/sf/yr)</u></b>
<u>Mid-Rise Apartment (R-2)</u> <u>4-7 stories</u>	<u>35</u>	<u>10.0</u>
<u>High-Rise Apartment (R-2)</u> <u>8 or more stories</u>	<u>38</u>	<u>11.0</u>
<u>Small Hotel (R-1)</u> <u>0-100,000</u>	<u>47</u>	<u>13.5</u>
<u>Large Hotel (R-1)</u> <u>100,000 sf and larger</u>	<u>68</u>	<u>19.5</u>
<u>Medium Office (Group B)</u> <u>40,000-100,000 sf</u>	<u>26</u>	<u>7.5</u>
<u>Large Office (Group B)</u> <u>100,000 sf and larger</u>	<u>54</u>	<u>15.5</u>
<u>Standalone Retail (Group M)</u>	<u>39</u>	<u>11.5</u>
<u>Warehouse (Group S)</u>	<u>13</u>	<u>4.0</u>
<u>All Other</u>	<u>28</u>	<u>8.0</u>

a. Or 100% of the annual energy use as calculated in accordance with Section C407.

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

EIA 2020. Battery Storage in the United States: An Update on Market Trends, July 2020 by the Energy Information Administration

Athalye, et. al. Nonresidential PV and Battery Storage. Building Energy Efficiency Measure Proposal to the California Energy Commission for the 2022 Update to the California Energy Code. NORESO and Energy and Environmental Economics, January 2021,

**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 increase the cost of construction. However, by providing multiple options for compliance, project teams will be able to choose the option that is the most cost effective for that particular project.

Cost of construction:     Increase    \_\_\_ Decrease    \_\_\_ No Impact

Cost of design:         Increase    \_\_\_ Decrease    \_\_\_ No Impact

Restrictiveness:       Increase    \_\_\_ 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.