



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

Acronym	Code Name	Acronym	Code Name
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.

R401.2.5

Add definitions as follows:

ALL-ELECTRIC PROPERTY. *A property that contains no permanently installed equipment or appliances that utilize combustion, plumbing for fuel gas or fuel oil or fuel gas utility connection, installed within the building(s) or site, except for emergency power systems and standby power systems.*

COMBUSTION. *In the context of this code, refers to the rapid oxidation of fuel accompanied by the production of heat or heat and light.*

DEMAND RESPONSE SIGNAL. *A signal that indicates a price or a request to modify electricity consumption for a limited time period.*

DEMAND RESPONSIVE CONTROL. *A control capable of receiving and automatically responding to a demand response signal.*

DEMAND RESPONSE PROGRAM. *An agreement between a building occupant or building owner and third party such as a utility to install and operate demand responsive controls in the building that automatically adjust building operations in response to a demand response signal from the third party.*

EMERGENCY POWER SYSTEM. *A source of automatic electric power of a required capacity and duration to operate required life safety, fire alarm, detection and ventilation systems in the event of a*

failure of the primary power. Emergency power systems are required for electrical loads where interruption of the primary power could result in loss of human life or serious injuries.

STANDBY POWER SYSTEM. A source of automatic electric power of a required capacity and duration to operate required building, hazardous materials or ventilation systems in the event of a failure of the primary power. Standby power systems are required for electrical loads where interruption of the primary power could create hazards or hamper rescue or fire-fighting operations.

Revise the section as follows:

R401.2 Application. Residential buildings shall comply with ~~Section R401.2.5~~ and either Sections R401.2.1, R401.2.2, or R401.2.3 ~~or R401.2.4~~.

R401.2.1 Prescriptive Compliance Option. The Prescriptive Compliance Option requires compliance with Sections R401 through R404, and Section R408.

~~**R401.2.4 Tropical Climate Region Option.** The Tropical Climate Region Option requires compliance with Section R407.~~

~~**R401.2.5 Additional energy efficiency.** This section establishes additional requirements applicable to all compliance approaches to achieve additional energy efficiency.~~

- ~~1. For buildings complying with Section R401.2.1, one of the additional efficiency package options shall be installed according to Section R408.1.~~
- ~~2. For buildings complying with Section R401.2.2, the building shall meet one of the following:
 - ~~2.1. One of the additional efficiency package options in Section R408 shall be installed without including such measures in the proposed design under Section R405; or~~
 - ~~2.2. The proposed design of the building under Section R405.3 shall have an annual energy cost that is less than or equal to 95 percent of the annual energy cost of the standard reference design.~~~~
- ~~3. For buildings complying with the Energy Rating Index alternative Section R401.2.3, the Energy Rating Index value shall be at least 5 percent less than the Energy Rating Index target specified in Table R406.5.~~

~~The option selected for compliance shall be identified in the Certificate required by Section R401.3.~~

R405.2 Performance-based compliance. Compliance based on total building performance requires that a *proposed design* meets all of the following:

1. The requirements of the sections indicated within Table R405.2.
2. The building thermal envelope shall be greater than or equal to levels of efficiency and solar heat gain coefficients in Table R402.1.1 or R402.1.3 of the 2009 *International Energy Conservation Code*.
3. An annual energy cost that is less than or equal to 95 percent of the annual energy cost of the *standard reference design* for all-electric properties and less than or equal to 82 percent of

the annual energy cost of the *standard reference design* for all other *buildings*. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration’s State Energy Data System Prices and Expenditures reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations.

Exception: The energy use based on source energy expressed in Btu or Btu per square foot of *conditioned floor area* shall be permitted to be substituted for the energy cost. The source energy multiplier for electricity shall be 3.16. The source energy multiplier for fuels other than electricity shall be 1.1.

Replace Section R408 with the following:

R408
ADDITIONAL ENERGY EFFICIENCY CREDITS

R408.1. Additional energy efficiency credit requirements. *New all-electric properties* shall comply with the following:

1. Section R408.8.2 or R408.8.3.
2. Section R408.10.2 or R408.10.3.
3. A total of 3 credits from Table R408.1 except sections R408.7, R408.8 and R408.10 and their subsections.

All other *buildings* shall achieve a total of 18 credits from Table R408.1. Credit calculations shall be as specified in relevant subsections of Section R408.

TABLE R408.1
ADDITIONAL ENERGY EFFICIENCY CREDITS

<u>Measure Description</u>	<u>Credit Value</u>
R408.2: <u>Energy Star Appliances</u>	<u>4</u>
R408.3.1: <u>≥ 5% reduction in total UA</u>	<u>2</u>
R408.3.2: <u>≥ 7.5% reduction in total UA</u>	<u>3</u>
R408.3.3: <u>> 10% reduction in total UA</u>	<u>4</u>
R408.4.1: <u>≤ 2 ACH50 air leakage rate</u>	<u>2</u>
R408.4.2: <u>≤ 1 ACH50 air leakage rate</u>	<u>3</u>
R408.5: <u>≤ 2 CFM of total duct leakage</u>	<u>2</u>
R408.6: <u>Ducts in Conditioned Space</u>	<u>5</u>
R408.7.1: <u>High Performance Cooling</u>	<u>1</u>
R408.7.2: <u>Premium Performance Cooling</u>	<u>2</u>
R408.8.1: <u>High Performance Gas Space Heating</u>	<u>2</u>
R408.8.2: <u>High Performance Electric Space Heating</u>	<u>8</u>

R408.8.3: Premium Performance Electric Space Heating	<u>10</u>
R408.9.1: Heat Recovery Ventilation	<u>4</u>
R408.9.2: High Performance Heat Recovery Ventilation	<u>7</u>
R408.10.1: High Performance Gas Water Heating	<u>2</u>
R408.10.2: High Performance Electric Water Heating in conditioned space	<u>6</u>
R408.10.3: High Performance Electric Water Heating in unconditioned space	<u>4</u>
R408.10.4: Premium Performance Electric Water Heating in conditioned space	<u>8</u>
R408.10.5: Premium Performance Electric Water Heating in unconditioned space	<u>5</u>
R408.11.1: Waste Water Heat Recovery	<u>2</u>
R408.11.2: High Performance Waste Water Heat Recovery	<u>3</u>
R408.12: High Efficacy Lighting	<u>2</u>
R408.13: Demand Responsive Thermostats	<u>1</u>

R408.2. EnergyStar Appliances. The *building* shall be provided with an EnergyStar qualified refrigerator, dishwasher, clothes washer and clothes dryer.

Exception: Where an electrical outlet is not provided for an appliance.

R408.3. Reduced envelope UA. The *building thermal envelope* shall comply with either Section R408.3.1, R408.3.2 or R408.3.3.

R408.3.1. UA reduction of 5 percent. The total UA of the *building thermal envelope as designed* shall be not less than 5.0% below the total UA of the *building thermal envelope* in accordance with Section R402.1.5.

R408.3.2. UA reduction of 7.5 percent. The total UA of the *building thermal envelope as designed* shall be not less than 7.5% below the total UA of the *building thermal envelope* in accordance with Section R402.1.5.

R408.3.3. UA reduction of 10 percent. The total UA of the *building thermal envelope as designed* shall be not less than 10% below the total UA of the *building thermal envelope* in accordance with Section R402.1.5.

R408.4. Reduced air leakage. The air leakage rate of the *building* shall comply with R408.4.1 or R408.4.2 when calculated in accordance with Section R402.4.1.2:

R408.4.1. 2 ACH. The air leakage rate of the *building* shall be no greater than 2 air changes per hour.

R408.4.2. 1 ACH. The air leakage rate of the *building* shall be no greater than 1 air change per hour.

R408.5. Low duct leakage. All ducts shall have a postconstruction leakage rate no greater than 2 cubic feet per minute per 100 square feet of *conditioned floor area* served by the ducts when tested in accordance with Section R403.3.5.

R408.6. Duct location. All ducts shall be located within *conditioned space* in accordance with Section R403.3.2.

R408.7. Space cooling equipment efficiency. Space cooling equipment shall have efficiency rating in accordance with either R408.7.1 or R408.7.2.

R408.7.1. High performance space cooling. All space cooling equipment shall have a minimum SEER of 16.

R408.7.2. Premium performance space cooling. All space cooling equipment shall have a minimum SEER of 22.

R408.8. Space heating equipment efficiency. Space heating equipment shall have efficiency rating in accordance with either R408.8.1, R408.8.2 or R408.8.3.

R408.8.1. High performance gas space heating. All space heating equipment shall have a minimum AFUE of 95%.

R408.8.2. High performance electric space heating. All space heating equipment shall comply with the following:

1. Heat pumps shall have a rated COP of not less than 1.75 when operating at @5°F.
2. Non-Ducted heat pumps shall have an HSPF of not less than 10.
3. Ducted heat pumps shall have an HSPF of not less than 9.
4. The total electric resistance load shall not exceed 1.35W per square foot of conditioned floor area of the building.

R408.8.3. Premium performance electric space heating. All space heating equipment shall comply with R408.8.2 and shall have a minimum HSPF of 11.2.

R408.9. Heat/Energy Recovery Ventilation. All *ventilation air* shall be provided by a *whole house mechanical ventilation system* that complies with R408.9.1 or R408.9.2:

R408.9.1 High performance heat/energy recovery ventilation. All *ventilation air* shall be provided by a heat or energy recovery ventilation system with a Sensible Recovery Efficiency (SRE) of no less than 75%.

R408.9.2 Premium performance heat/energy recovery ventilation. All *ventilation air* shall be provided by a heat or energy recovery ventilation system with a Sensible Recovery Efficiency (SRE) of no less than 90%.

R408.10. Water heating equipment efficiency. Water heating shall comply with either R408.10.1, R408.10.2, R408.10.3, R408.10.4, R408.10.5 or R408.10.6.

R408.10.1 High efficiency gas water heating. All gas water heating equipment shall have a Uniform Efficiency Factor UEF of no less than 0.82.

R408.10.2 High efficiency electric water heating in conditioned space. All electric water heating equipment shall have a UEF of no less than 2.0 and shall be located in *conditioned space*.

R408.10.3 High efficiency electric water heating in unconditioned space. All electric water heating equipment shall have a UEF of no less than 2.0 and be located outside of *conditioned space*.

R408.10.4 Premium efficiency electric water heating in conditioned space. All electric water heating equipment shall have a UEF of no less than 3.1 and shall be located in *conditioned space*.

R408.10.5 Premium efficiency electric water heating in unconditioned space. All electric water heating equipment shall have a UEF of no less than 3.1 and shall be located outside of *conditioned space*.

R408.11. Drain water heat recovery. The *building* shall be provided with drain water heat recovery units in accordance with R403.5.3 and R408.11.1 or R408.11.2.

R408.11.1. Drain water heat recovery units. All shower, bath tub, laundry and sink drains shall be provided with drain water heat recovery units with Heat Recovery Efficiency of no less than 50%.

R408.11.2. High performance drain water heat recovery units. All shower, bath tub, laundry and sink drains shall be provided with drain water heat recovery units with Heat Recovery Efficiency of no less than 65%.

R408.12. High efficacy lighting. All rooms shall be provided with hard wired lighting with a lamp efficacy of 90 lm/W or a luminaire efficacy of 55 lm/W.

R408.12. Demand responsive controls. All thermostats serving the *building* shall be provided with *demand responsive controls* listed for participation in a *demand response program* that serves the *building site*

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?

The 2019 Denver Code and 2021 edition of the IECC both adopted an additional package efficiency option for residential buildings. This proposal goes a step further by converting the package options into a points-based system similar to the “Additional Efficiency Credits”

system in C406 of the commercial section of the energy code. The proposal requires projects to select additional efficiency options equal to achieve a credits target. There are several options provided, covering all aspects of building performance.

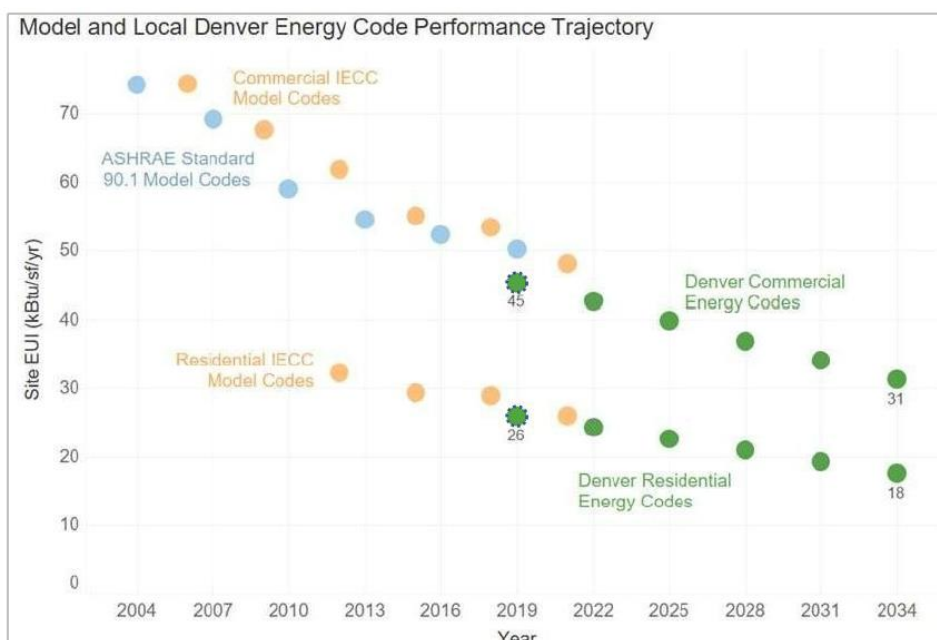
Reason for Working Group Revisions:

The Residential Working Group met over a series of 4 meetings and one additional special session with a subset of the working group. The WG recommended several modifications to the original proposal, including:

- **Definition of All-Electric Property.** The definition of “all-electric property” was modified to explicitly allow combustion for emergency and standby power. The WG wanted explicit clarity about how these systems fit into all-electric buildings. This was done in the definition since it was seen as useful for all building types, even residential occupancies, and because it was seen as the place that would provide the most clarity for users.
- **Removal of partial electrification options.** The credit values for the efficient electric water and space heating options included credit for both electrification and efficiency. The standalone credit options for partial electrification were removed since they overlapped with the efficient electric credit options and the additional credit incentivized partial electrification over full electrification.
- **Clarification of the implementation of R408.** IECC-2021 uses Section R401.2.5 to implement the additional efficiency in Section R408. The WG found that this structure was confusing since it mixed the prescriptive path and the performance paths of R405 and R406. Therefore, Section R401.2.5 was eliminated and replaced with clearer language in each compliance path. R408 was added to the requirements for the prescriptive path in R401.2.1 and the commensurate efficiency improvements were added to Section R405.2 #3 for the modeling path. (The equivalent ERI path target was set in combined proposal 19/31.)
- **Demand Responsive controls:** The demand responsive controls requirements were moved out of the proposed mandatory section of the code and made options in R408. The Supplemental Meeting group was concerned about the alignment between the requirements and DR program offerings that would be available to newly constructed buildings. The requirements for DR thermostats were modified so that they require controls that are currently approved for a local DR program instead of the original set of functional requirements. A definition for DR program was introduced to support this language.

Original Reason Statement: Why is your proposal necessary?

“Denver’s Net Zero Energy (NZE) New Buildings & Homes Implementation Plan” sets a goal for all new Denver homes to achieve zero energy by the 2024 code cycle. Achieving this goal will require that the 2021 Denver Energy Code achieve 15% savings compared to the 2021 IECC. There are multiple energy efficiency measures that could be added to the Denver Energy Code that can deliver the significant savings required to meet this goal. However, some of these measures may not be cost effective for, or compatible with, all home designs. This issue was addressed in the commercial section of the code with the conversion of the additional efficiency options in Section C406 to a credit-based system. The credit-based system allows projects to select the most effective and appropriate measures to achieve the performance goal of the code. This maximizes flexibility while still allowing the code to achieve higher levels of performance.



Adopting this same approach in the residential section of the code to replace the less capable and less flexible package options currently in Section R408 allows Denver to achieve its ambitious goals for new homes. This structure has several advantages for Denver's effort to increase the stringency of the energy code to meet the City's climate goals:

- It allows the stringency of the prescriptive compliance path to be quickly and easily calibrated to Denver's goals by simply changing the number of credits required. Without a credit-based approach, the only way to achieve Denver's goals would be to add many of these credit options to the mandatory measures in the main body of the code.
- It provides the maximum flexibility possible for projects using the prescriptive path since project teams will be able to choose which credit options are the most effective and cost effective for their particular project.
- It allows the custom elements of Denver's code to be confined to Section R408, which offers related benefits:
 - It keeps Denver's code requirements more aligned with those of neighboring jurisdictions since the efficiency requirements in the main body of the code remain the same. This will make compliance easier for the market, which will make enforcement easier for the City.
 - It requires little to no change to standard code compliance tools like ResCheck.

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

The proposal replaces Section R408 in its entirety. It sets a target of 18 credits for mixed fuel buildings, which corresponds to 15% improvement over IECC-2021 (accounting for the approximate 3% of savings delivered by the package version of R408). Each credit corresponds to 1% savings. Table R408.1 includes 26 different credit options and the credit value for each option. The 18-credit target can be met by implementing multiple options, but there are two options based on high-performance heating equipment that can meet the target by themselves.

All-electric buildings only need to achieve 3 credits, corresponding roughly to the value of one additional efficiency package option in IECC-2021. This is due to the significant lifetime carbon emissions savings from all-electric buildings. Due to the decarbonization requirements of XCEL's electrical supply by 2050, building electrification has a greater carbon benefit for Denver homes over a 50-year service life than the increased efficiency in "Denver's Net Zero Energy (NZE) New Buildings & Homes Implementation Plan" would deliver over the same period. Therefore, the credit targets have been maintained at IECC-2021 levels for all-electric buildings.

The credit options provide different levels of performance for the same measure. For example, there are three levels of improved envelope performance, there are two levels of improved envelope leakage, two levels of performance for heating and cooling equipment and water heating equipment, etc. The "premium" equipment options for space conditioning represent close to the best-in-class equipment available on the market today. The "premium" water heating measure is based on Tier 3 performance from Northwest Energy Efficiency Alliance's (NEEA) Advanced Water Heating Specification. Since heat pump water heaters (HPWH) scavenge heat from their surrounding areas, they can increase the heating load of a home when located within conditioned space; however, they do not operate as efficiently when located in unconditioned spaces in cold climates like Denver's. Therefore, there are separate credit values for water heaters located in conditioned versus un-conditioned space.

The following sections each detail the requirements that must be met in order to achieve the corresponding credits. Each section (R408.2, R408.3, etc) contains a different energy efficiency measure. Where multiple options represent different levels of the same energy efficiency measure, the requirements for each option are in their own subsection (eg. R408.3.1, R408.3.2, R408.3.3). In order to provide the greatest level of consistency with the existing package options version of Section R408, the existing package options were included as credit options in the new Section R408. The table also includes options for the electrification of space or water heating alone.

Calculating the Credits:

The credits were calculated by modeling prototype homes in the Denver climate zone using the REMRate modeling platform.

Prototypes: The prototypes are based on the single-family home prototypes developed by the Pacific Northwest National Laboratory to determine the saving for each edition of the IECC. Based on feedback from the Denver building department about typical building practices in Denver, two different prototypes were utilized: one with a conditioned basement and one with a crawlspace. Based on that same feedback, the prototypes utilize a forced air natural gas furnace for heating, a split-system AC unit for cooling and a natural gas water heater.

Savings Baseline: When multiple energy efficiency measures are implemented together, the interactive effects of the measures mean that each measure delivers less savings than it would if it were being implemented alone. This means that calculating the credit for each measure in isolation would over-estimate the savings when multiple options are implemented together. To account for these interactive effects, the credits were calculated from a modified baseline. That baseline is not a 2021-IECC compliance home. The baseline includes high performance gas furnaces and water heaters as these were considered to be the most likely measures to be implemented in multi-measure projects. This effectively derates the credits for each individual credit option.

The credit values represent an average of the savings crawlspace and conditioned basement for each measure. Again, according to typical building practices as reported by the Denver building department, the distribution of the two approaches in new Denver homes is about an even 50/50 split.

The value of the partial electrification options was calculated separately from the modeling. The credits were calculated by calculating the carbon emission savings that would result over the lifecycle of a building (assumed to be 50 years and an average COP of 1.25 to represent the impact of low-temperature heat pump operation and resistance heating equipment), calculating the efficiency improvement that would be required from a standard mixed fuel-building to generate the same carbon emissions savings, and assigning the credit value that amount of efficiency gains. The calculations were based on the EUI target for homes identified in “Denver’s Net Zero Energy (NZE) New Buildings & Homes Implementation Plan.” (If the Denver Energy Code does not meet the EUI targets set in the plan, the value of electrification would actually be even higher, so these numbers are conservative.) The gas/electric distribution and the breakdown of gas loads for space heating and water heating was based on analysis of the Denver building stock conducted by the City of Denver. The 50-year carbon savings from electrification were calculated along with the efficiency savings that would be necessary to generate an equivalent carbon emissions savings. These efficiency savings were then converted at the percentage savings-to-credits ratio used for the rest of the R408 approach (1 credit per 1 percentage point of efficiency).

The definition of “all-electric building” focuses on prohibiting combustion and the plumbing for fuel gas/oil within the building. The definition for “combustion” comes from the IMC.

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 has two separate impacts on cost. It will reduce the cost of construction since the credit approach is more flexible than the package approach in the IECC-2021 model code. However, it will also increase the cost of construction by requiring more efficiency from Denver homes.

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.