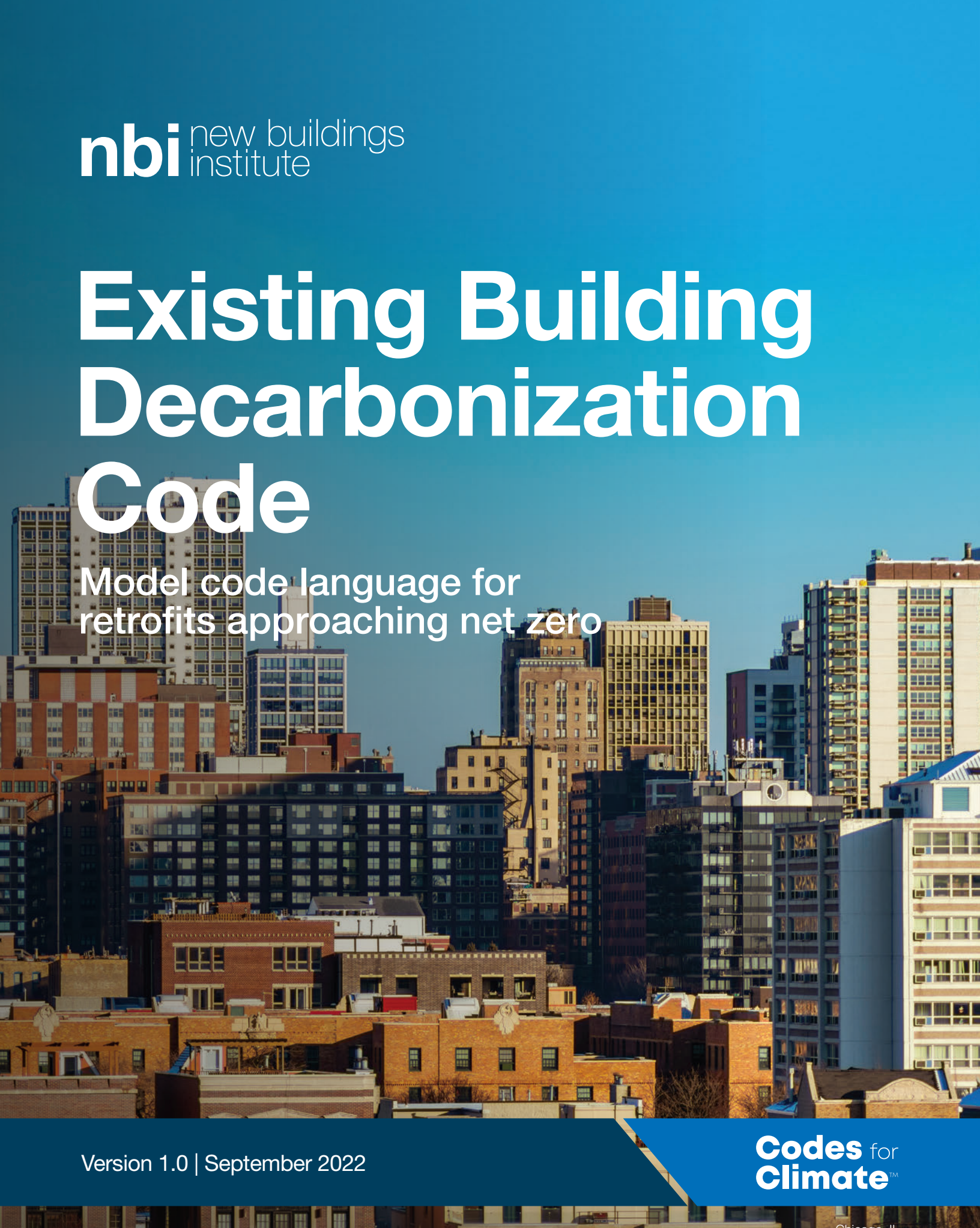
nbi new buildings institute

Existing Building Decarbonization Code

Model code language for retrofits approaching net zero



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Codes for Climate™

Chicago, IL

Table of Contents

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We gratefully acknowledge the following individuals for their contributions and insights into the development of the Existing Building Decarbonization Code.

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Introduction and Background

Jurisdictions across the United States have realized their building sector climate goals cannot be reasonably achieved by addressing new construction alone. As policymakers seek solutions to drive carbon emissions reductions in existing buildings, their current options are limited relying primarily on benchmarking and disclosure policies and building performance standards. Additional options for existing building decarbonization must be developed and presented rapidly to address the variety of physical and political realities jurisdictions face.

There are 5.9 million existing commercial buildings in the U.S. comprising 97 billion square feet.[1] New construction represents less than 2% of building activity in any given year, leaving a vast amount of outdated technologies in current building stock. By requiring existing buildings to be more energy efficient, cities could cut about 30% of all urban emissions by 2050.[2] Decarbonization retrofits will also aid jurisdictions in aligning climate goals with public health and equity goals. A growing number of studies are highlighting the impact of indoor fossil fuel combustion and health, raising calls for electrification of buildings. In addition to the operational energy- and carbon-saving benefits from retrofits of existing buildings, it's worth noting the high levels of embodied carbon in construction materials that could be saved (mainly in steel, concrete, and windows) by reusing and improving existing buildings rather than demolishing and rebuilding.[3]

New Buildings Institute's **Decarbonization Building Code**[4] provided the first off-the-shelf solution for jurisdictions to transform energy codes into decarbonization codes for new buildings. Expanding where that document left off, the **Existing Building Decarbonization Code** seeks to complement the original by adding provisions specifically for existing buildings. Utilizing a familiar structure provided by the existing buildings chapter (Chapter 5) in the **International Energy Conservation Code (IECC)** this overlay creates requirements that are specifically tailored to support decarbonization using the opportunities presented by common lifecycle events in existing buildings. It is meant to work in conjunction with the provisions in the **Building Decarbonization Code,** utilizing many of its definitions and requirements and adapting them to existing buildings.

New construction represents less than

2%

of building activity in any given year, leaving a vast amount of outdated technologies in current building stock

The **Building Decarbonization Code** was able to rely on the efficiency gains of the **IECC 2021** for new construction and did not include any efficiency provisions. For existing buildings, each construction event in the lifecycle provides an opportunity to lower a building's carbon footprint. The provisions presented here have been crafted to match reasonable and effective decarbonization strategies to these events, pairing these opportunities to decarbonize with additional efficiency to create buildings that see additional benefits from electrification. The overlay also incorporates trigger events and solutions for the inclusion of grid integration measures including renewable energy production, electric vehicles, and battery storage. Continuing to recognize that not every jurisdiction is looking to require mandatory electrification in all retrofits in their next code cycle, options for full electrification and electric-ready are presented here.

By requiring existing buildings to be more energy efficient, cities could cut about

30%

OF ALL URBAN EMISSIONS

by 2050.

1 https://www.eia.gov/consumption/commercial/

2 According to a September 2019 report by Coalition for Urban Transitions https://urbantransitions.global/en/publication/climate-emergency-urban-opportunity/

3 https://newbuildings.org/embodied-carbon-conundrum-solving-for-all-emission-sources-from-the-built-environment/

4 https://newbuildings.org/resource/building-decarbonization-code/

Key Strategies for Existing Buildings

EFFICIENCY

Existing buildings were built to a variety of previous codes, and many do not perform as well as new construction, even those that have been updated over time. Provisions that require strategic, opportunistic efficiency improvements are critical to get the existing building stock decarbonized. These range from improving the efficiency of equipment replacements to an application of the additional efficiency options in Sections C406 and R408 in existing buildings. Many jurisdictions will find it necessary to continue to allow for the installation of new combustion equipment in existing buildings, making it additionally important to adopt provisions to improve the performance of combustion equipment when it is allowed. These include requirements to improve efficiency, reduce emissions, and improve indoor air quality.

ELECTRIFICATION

Electrification in existing buildings follows several paths including provisions for full electrification of a whole building, addition, building system, or individual piece of equipment. When these provisions are targeted to an individual building system that system will be fully electrified even if other parts of the building may still include combustion equipment. Depending on the building type or piece of equipment, the path toward electrification may also result in "hybrid" building systems that use both electricity and fossil fuels. Where systems are not fully electrified, providing electric ready infrastructure will future-proof the next round of retrofits.

GRID INTEGRATION

Buildings that rely increasingly on electricity for their primary or sole source of energy also need to adopt technology that can support grid integration. Targeting key technologies like renewable energy, EV-charging, battery storage, and demand response will allow existing buildings to support a heathly grid. By selecting optimized lifecycle events for the mandatory installation of these technologies, buildings will benefit from the lowest cost retrofit solutions and obtain the benefits of the installations themselves: lower cost utility bills and increased resilience.

BUILDING PERFORMANCE

Many jurisdictions have begun to consider and adopt policies, most commonly building performance standards (BPS), to address the actual performance of existing buildings in an effort meet their climate goals. Provisions for needed efficiency, system-by-system electrification, and onsite renewable energy generation will integrate with BPS to aid in overall building sector decarbonization and energy use reductions, the main objectives of currently adopted BPS. Where jurisdictions will not adopt a BPS, and for buildings that fall below size thresholds for regulation, the overlay will provide the opportunity to advance existing building decarbonization without performance regulations, closing an important gap created by most BPS policies.

How to Use This Document

The Existing Building Decarbonization Code is presented in two parallel electrification and mixed fuel paths, similar to the new construction version. Specific code language to be used in the amendment process is provided for each of the pathways.

1

ALL-ELECTRIC

The electrification path includes provisions to fully electrify buildings or building systems, while introducing increased efficiency.

2

MIXED-FUEL

The mixed-fuel path includes provisions to only partially electrify building systems, allowing hybrid systems that utilize both electricity and natural gas. The mixed-fuel path supports decarbonization in buildings with combustion equipment by including provisions for targeted electrification-readiness as well as provisions to improve the performance and air quality of combustion equipment.

The Existing Building Decarbonization Code includes provisions for:

efficiency

renewable energy

electric vehicle charging

energy storage

The code amendments are presented in strikethrough and underline formatting that is commonly used in the amendment process.

The ~~strikethrough~~ markup indicates the deletion of portions of code text.

The <u>underlined</u> markup indicates the addition of portions of code text.

Both paths restructure Chapter 5 of the IECC to improve usability generally and to make it easier to incorporate new measures for decarbonization provisions. The most noticeable change is the renumbering of sub-sections so building systems have consistent numbering in both the residential and commercial sections and in the additions (C502/R502) and alterations (C503/R503) sections: envelope is always 50x.2, mechanical systems are always 50x.3, water heating is always 50x.4, lighting and power is always 50x.5.

Amendments are followed by narrative text where needed to explain why a change was made, how the code relates to other I-Code language, and/or why certain exceptions were carved out in the new language. Narrative text should be removed for any formal adoption process or repurposed as background information or a reason statement.

Jurisdictions are not limited to using either the electrification or mixed-fuel paths in their entirety. If these full pathways do not support individual goals or political reality of a particular market, jurisdictions can select only a subset of the sections from one of the paths or even mix and match sections from both paths. The Existing Building Decarbonization Code is structured to be flexible and allow jurisdictions to find the solution that supports their climate goals while meeting the needs of their communities.

Application to Different Existing Building Retrofits

Retrofit work in existing buildings in the code is best captured through the classifications described in the International Existing Building Code (IEBC): repair, alteration, addition, and change of occupancy. Through a building's life, it is likely to experience most, if not all, of these types of work. This overlay relies on the relative cost, scale, and scoping implications of each of these interventions to present solutions for decarbonization.

To meet long-term climate goals, every replacement should be treated as an opportunity to reduce energy use and carbon emissions by optimizing systems and electrifying equipment. When assessing the opportunities to decarbonize assets, owners, managers, and operators should leverage large scale investments to move beyond aesthetic functions of a "face-lift" and plan inclusion of deep decarbonization strategies, such as efficiency, electrification, updating building controls, and grid-integration of systems and equipment. Taking these actions when it makes the most financial and structural sense will transform buildings into carbon mitigation assets instead of liabilities. Targeted provisions that opportunistically require onsite renewable energy systems, EV charging infrastructure, energy storage, and limited electrification readiness where it would be most cost-effective or more easily accommodated within a larger project aid in this transition and are presented in both the electrification and mixed-fuel paths.

Additions

Additions are generally treated as new construction within code application and enforcement. Key differences are that often the addition is smaller than the base building and an addition may not necessitate the addition of new space conditioning or water heating equipment. Because of the differences in scope, scale, and energy infrastructure being put into additions, the overlay presents specific options for new systems and system extensions as they relate to the key decarbonization strategies found in the new construction version.

Alterations

Alterations present the most variety in size and scale. The IEBC defines three types of alterations by these criteria as Level 1, Level 2, and Level 3.[5]

Combined with targeting replacements, reconfiguring of spaces, and remodeling scopes, this document introduces two key definitions based on the IEBC to further define points of intervention that are likely to be impactful of decarbonization policies:

- substantial improvement (based on cost of work),
- substantial energy alteration (based on potential energy impact of work)

With these in place, each scale of alteration is presented with the best opportunities to transition to electrification and add necessary supportive measures.

Change of Occupancy

Many changes of occupancy require at least some alterations to the space and building systems. The model energy code has specific provisions for upgrade requirements where a change of occupancy increases energy use. The change of occupancy requirements presented here are meant to work in conjunction with alteration requirements and add clarity and code usability for the specifics of a change of occupancy as a critical building lifecycle event to leverage where an alteration may not be planned.

5 ICC 2021. International Existing Building Code, accessed at https://codes.iccsafe.org/content/IEBC2021P1

Existing Building Decarbonization Code:

Commercial Overlay

All-Electric

Commercial Overlay (All-Electric)

Chapter 1 – Scope and Application

C101 SCOPE AND GENERAL REQUIREMENTS

Revise text as follows:

> **C101.3 Intent.** This code shall regulate the design, ~~and~~ construction, repair, alteration, change of occupancy, and additions of new and existing buildings for the ~~effective use and conservation~~ reduction of greenhouse gas emissions and for the efficient production, use and storage of energy over the useful life of each building. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. This code is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.

Intent has been modified to push beyond simply the inclusion of considerations of greenhouse gas emissions and production and storage of energy, to clearly emphasize the intent of the code to regulate existing buildings.

Chapter 2 – Definitions

C202 GENERAL DEFINITIONS

Add new definitions as follows:

> **ELECTRIC EQUIPMENT.** Any equipment or *appliance* used for space heating, *service water heating*, cooking, clothes drying, or lighting that uses electricity as its sole source of energy.

This new definition for electric equipment is a parallel of the definition of "combustion equipment" introduced in the Building Decarbonization Code.

> **ENERGY USE INTENSITY (EUI).** An expression of *building* energy use in terms of net energy divided by *gross floor area*.

EUI is an energy metric used in some performance-based energy policies, including many building performance standards (BPS). It is included here to allow provisions of the Existing Building Decarbonization Code integrate with BPSs. EUI is not currently defined in the suite of I-Codes, so it is added here. If a jurisdiction already has a formal definition of EUI, particularly in a building performance standard, then that definition should be integrated here as well.

> **SUBSTANTIAL ENERGY ALTERATION.** An *alteration* that includes replacement of two or more of the following:
>
> 1. 50% or more of the area of interior wall-covering material of the *building thermal envelope* or *fenestration.*
> 2. 50% or more of the area of the exterior wall-covering material of the *building thermal envelope* or *fenestration.*
> 3. Space-conditioning equipment constituting 50% or more of the total input capacity of the space heating or space cooling equipment serving the *building*.

4. Water-heating equipment constituting 50% of more of the total input capacity of all the water heating equipment serving the *building.*

5. 50% or more of the luminaires in the *building*

This new definition for substantial energy alteration is intended to capture projects that have the opportunity to greatly increase efficiency by nature of their scope and clarify when certain requirements related to the energy use of the building are triggered. By defining such scopes, confusion around generic terms like major renovations and applicability of work classifications in the IEBC can be removed. Other terms that define large-scale alterations such as Level III alteration or substantial improvement are not specific to the energy systems. An alteration could cross their thresholds without having a significant impact on the energy systems since they are based on metrics such as monetary value and reconfiguration of spaces. Similarly, an alteration that has significant impact on the energy systems of the building may not cross these other thresholds.

SUBSTANTIAL IMPROVEMENT. Any *repair*, reconstruction, rehabilitation, *alteration*, *addition* or other improvement of a building or structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the improvement or repair is started. If the structure has sustained *substantial damage*, any repairs are considered substantial improvement regardless of the actual *repair* work performed. The term does not, however, include either:

1. Any project for improvement of a *building* required to correct existing health, sanitary or safety code violations identified by the *building official* and that are the minimum necessary to assure safe living conditions.

2. Any *alteration* of a *historic structure* provided that the *alteration* will not preclude the structure's continued designation as a historic structure.

The definition of substantial improvement comes from the IBC and IEBC. The term generally aligns with vernacular use of "major renovation," which is not defined in code. It is used as a threshold for when certain flood protection requirements are triggered for existing building alterations. Since it is based on the monetary value of the alteration, it sets a useful threshold for introducing additional decarbonization requirements for large alterations.

In addition, the Existing Building Decarbonization Code leverages definitions from the Building Decarbonization Code including:

ALL-ELECTRIC BUILDING
APPLIANCE
COMBUSTION EQUIPMENT
COMMERCIAL COOKING APPLIANCES
ELECTRIC VEHICLE (EV)
EQUIPMENT
EV-CAPABLE SPACE
FUEL GAS

The use of these terms throughout assumes that adopting jurisdictions will adopt the Building Decarbonization Code alongside this existing building overlay.

Chapter 5 – Existing Buildings

C501 GENERAL

Add new text as follows:

C501.6 Requirements for combustion equipment. Where existing *combustion equipment* in *additions, alterations* and changes of occupancy is to remain, equipment shall comply with this section.

This section creates an additional set of requirements for combustion equipment when it is allowed to be installed in existing buildings. These requirements are intended to generally improve the emissions of the equipment and the interior and exterior air quality.

C501.6.1 Phase out documentation. Permit applications for projects retaining existing *combustion equipment* serving space heating and water heating shall include a plan for the future replacement of the *combustion equipment* with *electric equipment*. The documentation shall include the following:

1. Calculations of the electric load required by the replacement electric equipment and of the available electric capacity of the *building*.
2. Identification of any existing onsite electrical infrastructure, including but not limited to transformers, switchgear, electrical panels and conductors, that will need to be altered to accommodate the replacement electric equipment.
3. Floor plans identifying any spaces that will need to be reconfigured to accommodate the replacement electric equipment.

Where replacements are made with combustion equipment, building owners should understand the need for long term phase out and switch to electric equipment to avoid potential abandoned assets. Jurisdictions could also expand this section to include specifics related to other policies such as appliance emission standards or replacement policies targeting specific dates for combustion equipment phase out.

C501.6.2 Fuel gas pipe testing. All *fuel gas* piping serving *combustion equipment* shall be tested in accordance with Section 406 of the *International Fuel Gas Code*.

Exceptions:

1. For the purposes of demonstrating compliance with this section, unexposed pipe joints and welds shall not be required to be exposed for examination during the test.
2. Where it has been demonstrated to the code official that the *fuel gas* piping has met the requirements of this section within the previous five years.
3. Where compliance with this section would require interruption of *fuel gas* supply to *combustion equipment* that serves other tenant spaces or other *dwelling units,* provided all exposed pipe joints of the piping subject to the requirements of this section have been inspected for leaks by means of an *approved* gas detector, a noncorrosive leak detection fluid or other *approved* leak detection method once the equipment has been placed in operation.

Gas piping degrades over time, creating the possibility of natural gas leakage. Even though the natural gas is treated with mercaptan to give it that rotten egg smell, small leaks may go undetected, particularly in buildings where pipes are not exposed and older buildings that are likely to have envelopes that are less tight than newer construction. According to US DOE, building leakage accounts for nearly 27% of the natural gas leakage in the US natural gas distribution system.[6] Leaking natural gas represents a loss in energy, and even small leaks can add up over long periods of time. Additionally, natural gas is also a potent Green House Gas, with over 86 times the global warming potential of CO_2 on a short-term basis.

The installation of new gas equipment provides an ideal time to test gas pipe leakage. Contractors are already on site and the gas will often be partially or fully turned off for the new equipment installation. Additionally, new equipment installation can disturb and inflict additional stresses on existing piping, creating opportunities for the formation of new leaks where existing natural gas piping has weakened but not previously failed

This provision requires that existing fuel gas piping be tested like a new installation according the International Fuel Gas Code (IFGC). It includes targeted exceptions for elements of the IFGC testing methodology that is not appropriate for existing buildings. It also includes an exception for piping that has been tested in the last five years in order to prevent repeated testing. Finally, it includes an exception to ensure that testing requirements don't necessitate other tenants losing service, which could be a considerable in larger buildings with multiple tenant spaces. In those cases, it only requires visual inspection of the exposed joints with a testing fluid.

Add new text as follows:

C501.7 Heat pump supplementary combustion equipment. Heat pumps having *combustion equipment* and electric resistance equipment for supplementary space or water heating shall have controls that limit supplemental heat operation to only those times when one of the following applies:

1. The heat pump is operating in defrost mode.
2. The vapor compression cycle malfunctions.
3. For space heating systems, the thermostat malfunctions.
4. For space heating systems, the vapor compression cycle cannot provide the necessary heating energy to satisfy the thermostat setting.
5. For water heating, the heat pump water heater cannot maintain an output water temperature of at least 120°F (49°C)

New supplementary space and water heating systems for heat pump equipment shall not be permitted to have a heating input capacity greater than the heating input capacity of the heat pump equipment.

Supplementary heating systems are effectively back-up systems intended to provide heating if the primary heat pump system fails, if the operating conditions (heating demand, temperature around the heat pump compressor, etc.) exceed the ability of the heat pump to effectively, or cost-effectively, provide heating.

[6] "Natural Gas Infrastructure Modernization Programs at Local Distribution Companies: Key Issues and Considerations." US DOE, Office of Energy Policy and Systems Analysis. Washington DC, 2017.

Designers sometimes utilize "hybrid heat" systems where combustion equipment provides the supplementary heat to address these situations.

This new section creates a version of the supplementary heating equipment control requirements in Section C403 that is customized for existing buildings. It addresses both space and water heating applications and ensures that any combustion heating equipment used for supplementary heat is only used when the heat pump system is unable to fully meet the buildings heating needs (the language in C403 already addresses electric resistance supplementary heat).

C502 ADDITIONS

Revise text as follows:

> **C502.1 General.** *Additions* to an existing *building*, building system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portion of the existing *building* or *building* system to comply with this code. *Additions* shall not create an unsafe or hazardous condition or overload existing *building* systems. An addition shall be deemed to comply with this code if the *addition* alone complies or if the existing *building* and *addition* comply with this code as a single *building*. *Additions* shall comply with Sections C502.2 through C502.5.

These edits implement the restructuring discussed above in the introduction. The content of the sections is unaffected. The compliance language from the original Section C502.3 has been moved here.

The requirement in C502.1 for additions to meet the requirements for new construction mean that additions will be subject to the requirements in the Building Decarbonization Code for demand responsive thermostats and water heaters, onsite renewable energy, electrification readiness, energy storage infrastructure, etc.

Add new text as follows:

> **C502.1.1 Combustion equipment**. *Additions* shall not be permitted to contain *combustion equipment* and new equipment installed to serve *additions* shall not be *combustion equipment*. Where systems with *combustion equipment* are extended into an addition, the existing *building* and addition together shall use no more fossil fuel energy than the existing *building* alone.

This section requires additions to effectively be all-electric by prohibiting them from containing or being served by new combustion equipment additions combustion equipment. When additions are added to existing buildings, space and water heating systems are often extended into the new addition. This provision does allow the extension of systems that utilize combustion equipment into the addition. In order to ensure that the addition does not result in higher consumption of fossil fuels, the provision also requires that this extension doesn't result in an increase in combustion energy. In order to extend a system with combustion equipment into an addition, the efficiency of the existing building would need to be improved to offset the increased consumption from the addition.

Add new text as follows:

C502.1.2 Building Performance Standards. Where an addition to a *building* makes it subject to **[OFFICIAL NAME OF THE LOCAL BUILDING PERFORMANCE STANDARD]**, the permit application for the *addition* shall include a report that includes the following:

1. The current or last reported EUI of the *building*
2. The performance targets from **[NAME OF THE LOCAL BUILDING PERFORMANCE STANDARD]** that will be applicable to the *building* within five years from the date of the permit application

Where the current or last reported EUI exceeds the performance targets that will be applicable in the next five years, the report shall also include a plan describing how the *building* will be brought into compliance. The report shall include energy efficiency upgrades and operational improvements that will be made to the *building* before the applicable target goes into effect and the impact of the alteration under permit review.

Exceptions:

1. Where the total *building* performance of the *building* with the *alteration* determined in accordance with Section C407 demonstrates compliance with the performance targets identified in the report required by this section.
2. Additions that increase the *conditioned floor area* of the *building* by less than 10% and install no new space conditioning or water heating equipment.

In jurisdictions with a BPS it is important that all work on existing buildings support and reinforce the policy goals. Additions that either push a building into covered building status or are part of a building is already subject to the BPS that are undertaken without consideration of impending BPS performance targets represent a significant missed opportunity. This section requires that consideration by creating a requirement that permit applications include the building's current performance and any BPS performance targets that will be in effect in the next 5 years, the typical compliance cycle for US-based BPS. Where a building does not already meet those targets, it will be required to also submit what is effectively a plan for compliance with the BPS. This will ensure that project teams are thinking about a proposed alteration within the larger context of what will be required to meet up-coming BPS requirements.

The exceptions allow the compliance path to be avoided when the alteration is complying by performance modeling and that modeling shows that the alteration will bring the building into compliance with the BPS performance target, and for additions that will in and of themselves not create a major energy impact.

It may be necessary to modify the language in this provision to align with the terminology that is used in the official BPS regulation to maximize correlation and usability. For example, the provision can be modified to align with a carbon-based BPS by replacing "EUI" with "CUI" throughout and adding the following definition:

CARBON USE INTENSITY (CUI). An expression of *building* carbon emissions in terms of the equivalent carbon emissions of the net energy divided by *gross floor area*.

This definition defines a carbon use intensity that parallels the definition of EUI. It is a carbon metric where carbon emissions are divided by gross floor area in order to compare the emissions of different buildings or assess the performance a building's carbon emissions against a target.

Revise text and numbering as follows:

~~**C502.2 Change in space conditioning.** Any nonconditioned or low-energy space that is altered to become conditioned space shall be required to comply with Section C502.~~

~~**Exceptions:**~~

1. ~~Where the component performance alternative in Section C402.1.5 is used to comply with this section, the proposed UA shall be not greater than 110 percent of the target UA.~~
2. ~~Where the total building performance option in Section C407 is used to comply with this section, the annual energy cost of the proposed design shall be not greater than 110 percent of the annual energy cost otherwise permitted by Section C407.2.~~

This section is moved to C503, the alterations section. It is reasonable to make conversions of unconditioned space to conditioned space subject to the requirements for an addition, but they are technically alterations. Code users could naturally skip over the additions section, go straight to the alterations section, and miss this requirement. Moving the provision improves clarity and usability.

Revise text and numbering as follows:

~~**C502.3 Compliance** *Additions* shall comply with Sections C502.3.1 through C502.3.6.2.~~

C502.2 Building Envelope. New building envelope assemblies that are part of the *addition* shall comply with Sections C502.2.1 through C502.2.2.

~~**C502.3.1**~~ **C502.2.1 Vertical fenestration area.**

~~**C502.3.2**~~ **C502.2.2 Skylight area.**

~~**C502.3.3**~~ **C502.3 Building mechanical systems.**

These edits implement the restructuring discussed above in the introduction. The content of the subsections is unaffected. The compliance language from the original Section C502.3 has been moved to C503.1 and a new C502.2 has been introduced for the envelope subsections.

Add new text as follows:

C502.3.1 Space heating equipment. New space heating equipment in *additions* shall be electric heat pump equipment. Where existing systems with *combustion equipment* are extended to serve the addition, they shall comply with Section C501.7.

Exceptions:

1. Electric resistance supplementary heat in accordance with Section C403.4.1.1
2. Up to 5W of electric resistance heat per square foot of *conditioned floor area* in the *addition*

Requiring space heating installed during an addition to be electric will reduce carbon emissions and improve air quality in homes. Heat pumps have been shown to be technically effective in all climate zones, and cold-climate heat pump technology continues to improve, providing heating with a COP of more than 3 above 5°F.[7]

Exceptions are included for electric resistance supplementary heat and for up to 5W of electric resistance heat per square foot of conditioned floor area. The latter creates a budget for electric resistance heat that can be used for spot heating, small spaces, freeze protection and heat pump VAV systems with terminal electric resistance heat. 5W is a fairly low budget for these VAV systems that will require efficient design parameters such as delivering higher temperature air to the terminal boxes during heating that minimize the operation of the electric resistance coils. This section does not allow the installation of new combustion equipment, even as supplementary heat.

Revise text and numbering as follows:

~~C502.3.4~~ C502.4 Service water-heating systems.

~~C502.2.5~~ C502.4.1 Pools and inground permanently installed spas.

These edits implement the restructuring discussed above in the introduction. The content of the sections is unaffected.

Add new text as follows:

C502.4.2 Heat Pump Water Heating. New water heaters in *additions* shall be electric heat pump equipment.

Exceptions:

1. Electric storage water heaters with a rated storage volume of less than 20 gallons (75.7 liters) and a rated input of less than 5kW.
2. Instantaneous electric water heaters located within 10 feet of the point of use.
3. Electric resistance equipment where not less than 75 percent of the annual service water-heating requirement is provided by an on-site renewable energy system not used to meet any other provision of this code.
4. Water heaters that serve end-uses that require water temperature of 150°F (65.6°C) or hotter.

[7] "Achieve Comfort and Reliable Performance with Cold-Climate Heat Pumps." *Zero Energy Project*, 6 Feb. 2020, https://zeroenergyproject.org/2020/01/22/achieve-comfort-and-reliable-performance-with-cold-climate-heat-pumps/#:~:text=The%20Benefits%20of%20Heat%20Pumps%20in%20Cold%20Climates&text=Combustion%2Dbased%20heating%20systems%20such,3%20at%205%C2%B0F.

Heat pump water heaters can be 4-6 times more efficient than their electric resistance and combustion counterparts. This provision requires new water heaters in additions to be heat pump water heaters. It includes a few key exceptions:

1. *Small electric resistance storage water heaters. These will have small loads and there aren't HPWH alternatives for them, so it is reasonable to allow them as electric resistance water heaters.*
2. *Instantaneous resistance water heaters used in point-of-use applications. The loads from these will also generally be very low.*
3. *There is a blanket exemption for electric resistance water heating where 75% of the annual water heating load is served by onsite renewable energy (most likely solar thermal or PV). This provides flexibility and the pairing of dedicated renewable energy with electric resistance water heating creates a system with total efficiency similar to a HPWH.*
4. *High-temperature applications are exempted since high temperature HPWHs are just now coming on the market and don't have broad market penetration.*

If a jurisdiction finds that requiring central HPWHs is not a viable option, an additional exception for equipment with an input rating of more than 300,000 kbtu/h can be added.

Alternate add new text as follows:

5. Water heaters with an input rating of 300,000 Btu/h or greater.

This will exempt large central systems from this requirement, allowing them to be any kind of water heating system. This section can be also be replaced with an alternative that only requires electrification (below),but not heat pumps specifically, allowing electric resistance options.

Alternate add new text as follows:

C502.4.2 Service water heating equipment. Where service water heating equipment is added or replaced, new service hot water equipment shall not be *combustion equipment*.

Although such an approach would be more flexible, increasing large capacity electric resistance loads into buildings can have serious implications for carbon emissions and energy affordability. This approach should only be chosen in jurisdictions served by an electricity supply that has a carbon intensity comparable to onsite natural gas combustion. Additionally, the utility cost implications—particularly for equipment that serves residential occupancies—should be analyzed in order to ensure this requirement will not have an unacceptably adverse effect on utility bills. Replacement of combustion equipment with electric resistance equipment will also exacerbate the building electrical capacity issues for electrification.

Revise text and numbering as follows:

~~C502.2.6~~ C502.5 Lighting and power systems.

~~C502.2.6.1~~ C502.5.1 Interior lighting power.

~~C502.2.6.2~~ C502.5.2 Exterior lighting power.

These edits implement the restructuring discussed above in the introduction. The content of the subsections is unaffected. The compliance language from the original Section C502.3 has been moved to C503.1 and a new C502.2 has been introduced for the envelope subsections.

Add new text as follows:

C502.5.3 Renewable energy infrastructure. Additions with a new roof shall be provided with equipment for on-site renewable energy with a rated capacity of not less than 0.25 W/ft² (2.7 W/m²) multiplied by the sum of the gross conditioned floor area of the three largest floors of the *addition*.

Exceptions:

1. Additions that increase the *conditioned floor area* of the *building* by less than 10%.
2. Additions where an unshaded flat plate collector oriented towards the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 3.5 kWh/m²·day (1.1 kBtu/ft²·day).
3. Additions where more than 80 percent of the roof area is covered by any combination of equipment other than for on-site renewable energy systems, planters, vegetated space, skylights, or occupied roof deck.
4. Additions where more than 50 percent of roof area is shaded from direct beam sunlight by natural objects or by structures that are not part of the building for more than 2,500 annual hours between 8:00 AM and 4:00 PM.

Additions with roofs provide an opportunity to introduce renewable energy systems. The requirements in the Building Decarbonization Code for renewable energy systems reference buildings and so don't capture additions. This section uses the addition to trigger the requirements. The size of the system is based on the size of the addition, rather than the whole building. The new section includes exceptions that are paralleled from the new construction requirements. These exempt small additions, roofs without good solar access and roofs that are already utilized for other uses.

Add new text as follows:

C502.5.4 Electric vehicle charging infrastructure. New parking facilities and new parking spaces added to existing parking facilities shall comply with Section C405.14 based on the number of new parking spaces.

This section requires new parking facilities to meet the EV charging requirements in the new construction portion of the Building Decarbonization Code. While this is implicitly required by Section C501, the addition of this section makes it explicit for greater clarity and enforceability.

Add new text as follows:

C502.6 Additional energy efficiency credits. *Additions* shall achieve credits in accordance with Section C506. *All-electric buildings* shall be required to 10 credits and *mixed-fuel buildings* shall be required to select 15 credits. *Alterations* to the existing building that are not part of an *addition*, but permitted with an *addition*, may be used to achieve the required credits.

Exceptions:

1. *Buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H
2. *Additions* less than 1,000 ft^2 (92.9 m^2) and less than 50% of existing floor area.
3. *Additions* that do not include the addition or replacement of equipment covered by Section C403.3 or C404.2 that achieve a total of 5 credits.
4. *Additions* that do not contain *conditioned space* that achieve a total of 5 credits.
5. *Buildings* in Residential Group R and Institutional Groups I in climate zones 3C, 4B, 4C, 5C that achieve a total of 5 credits
6. Where the *addition* alone or the existing building and *addition* together comply with Section C407

This section works with the new Section C506 (see below for more) to bring additional energy efficiency to additions through implementing the additional efficiency credits in Section C406 in "substantial" additions. The section requires 10 credits in additions to all-electric buildings, just like new buildings, and greater efficiency of 15 credits for additions to mixed-fuel buildings. It also includes a series of important exceptions for occupancy types with low building loads, small additions and buildings that comply with Section C407. It also requires only 5 credits in additions to certain building types in certain climate zones that have fewer credit options available, additions that don't include new HVAC or water heating equipment and additions that do not include conditioned space.

C503 ALTERATIONS

Add new text as follows:

C503.1.1 Change in space conditioning. Any nonconditioned or low-energy space that is altered to become conditioned space shall be required to comply with Section C502.

Exceptions:

1. Where the component performance alternative by Section C402.1.5 is used to comply with this section, the proposed UA shall be not greater than 110 percent of the target UA.
2. Where the total building performance option by Section C407 is used to comply with this section, the annual energy cost of the proposed design shall be not greater than 110 percent of the annual energy cost otherwise permitted by Section C407.2.

This content is located in the additions section in the model code (Section C502.2). As part of the restructuring needed for this overlay, it has been relocated here since it describes an alteration project. The requirements have not been changed, but the relocation will improve the usability and enforceability of the code.

Add new text as follows:

C503.1.2 Substantial improvement. Buildings undergoing *substantial improvements* shall be *all-electric buildings*, comply with C402.5 and meet a site EUI by building type in accordance with ASHRAE Standard 100 Table 7-2a.

Exception: Compliance with Standard 100 shall not be required where Group R-occupancies achieve an ERI score of 80 or below without on-site renewable energy included in accordance with RESNET/ICC 301, for each dwelling unit.

Substantial improvements are extensive alterations that have significant scope, large project budgets relative to the value of the building and are more likely to already include major systems that could include combustion equipment. The larger scopes and budgets of substantial improvements are likely to occur infrequently within a building lifecycle and create the best opportunity to significantly increase efficiency and electrify the full building. In jurisdictions where requiring substantial improvements to be all-electric is not feasible, substantial alterations can be require to be electric ready. See Mixed Fuel Section C503.1.3.

Add new text as follows:

C503.1.3 Combustion equipment. New *combustion equipment* and plumbing for *combustion equipment* shall not be permitted to be installed in *alterations*.

This requirement prohibits the installation of new combustion equipment in alterations but does not require the full removal of existing combustion equipment.

Add new text as follows:

C503.1.4 Building Performance Standards. Where the *building* is subject to **[OFFICIAL NAME OF THE LOCAL BUILDING PERFORMANCE STANDARD]**, the permit application for the *alteration* shall include a report that includes the following:

1. The current or last reported EUI of the *building*
2. The performance targets from **[NAME OF THE LOCAL BUILDING PERFORMANCE STANDARD]** that will be applicable to the *building* within five years from the date of the permit application

Where the current or last reported EUI exceeds the performance targets that will be applicable in the next five years, the report shall also include a plan describing how the *building* will be brought into compliance. The report shall include energy efficiency

upgrades and operational improvements that will be made to the *building* before the applicable target goes into effect and the impact of the alteration under permit review.

Exception: Where the total *building* performance of the *building* with the *alteration* determined in accordance with Section C407 demonstrates compliance with the performance targets identified in the report required by this section.

In jurisdictions with a Building Performance Standard (BPS), it is important that all alterations support and reinforce the BPS. Alterations that are undertaken without consideration of impending BPS performance targets represent a significant missed opportunity. This section requires that consideration by creating a requirement that permit applications include the building's current performance and any BPS performance targets that will be in effect in the next 5 years, the typical compliance cycle for US-based BPS. Where a building does not already meet those targets, it will be required to also submit what is effectively a plan for compliance with the BPS. This will ensure that project teams are thinking about a proposed alteration within the larger context of what will be required to meet up-coming BPS requirements.

The exception allows the compliance path to be avoided when the alteration is complying by performance modeling and that modeling shows that the alteration will bring the building into compliance with the BPS performance target.

It may be necessary to modify the language in this provision to align with the terminology that is used in the official BPS regulation to maximize correlation and usability. For example, the provision can be modified to align with a carbon-based BPS by replacing "EUI" with "CUI" throughout and adding the following definition:

CARBON USE INTENSITY (CUI). An expression of *building* carbon emissions in terms of the equivalent carbon emissions of the net energy divided by *gross floor area*.

This definition defines a carbon use intensity that parallels the definition of EUI. It is a carbon metric where carbon emissions are divided by gross floor area in order to compare the emissions of different buildings or assess the performance a building's carbon emissions against a target.

Add new text as follows:

C503.3.2 System sizing. New heating and cooling equipment that is part of an *alteration* shall be sized in accordance with Section C403.3.1 based on the existing *building* features as modified by the *alteration.*

Exception: Where is has been demonstrated to the *code official* that compliance with this section would result in heating or cooling equipment that is incompatible with the rest of the heating or cooling system.

Space conditioning equipment is routinely oversized for its application. Even when equipment was sized appropriately when it was installed, many buildings have undergone alterations, particularly energy efficiency retrofits, that have changed the heating and cooling characteristics of the building. It is reasonable to assume that the existing equipment sizing is more likely to be wrong than right, yet many equipment replacements use existing system sizing to size new equipment. Oversized equipment is less efficient, costs more to operate, costs more to install, provides lower levels of comfort and is less effective at de-humidification.

This measure explicitly requires that new equipment installed as part of an alteration be sized based on current building characteristics and loads, using current sizing standards. It provides an exception for situations where right-sizing equipment may create an incompatibility with the rest of the system (as can be the case with steam systems where boilers are sized to the radiators/convectors and not the building).

Add new text as follows:

C503.3.3 Controls. New heating and cooling equipment that are part of the *alteration* shall be provided with controls that comply with Section C403.4.

Exception: Systems with direct digital control of individual zones reporting to a central control panel

The IECC's requirements for HVAC controls only apply to new controls. As a result, new equipment is permitted to be controlled by existing controls that can fall far short of current code requirements. This section requires new equipment to have code-compliant requirements. The exception ensures that this section won't trigger the replacement of an entire central control system when only one portion of a central HVAC system is replaced.

Add new text as follows:

C503.3.4 Mechanical system acceptance testing. Where an *alteration* requires compliance with Section C403 or any of its subsections, mechanical systems that serve the *alteration* shall comply with Sections C408.2.2, C408.2.3 and C408.2.5.

Exceptions:

1. Mechanical systems and service water heater systems in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h (140.7 kW) cooling capacity and 600,000 Btu/h (175.8 kW) combined service water-heating and space-heating capacity.
2. Systems included in Section C403.5 that serve individual *dwelling units* and *sleeping units*.

Retro-commissioning and building re-tuning is generally accepted as one of the most cost-effecting energy efficiency measures for existing buildings. Average savings for building re-tuning is 12%, and studies have found savings as high as 52%. However, the IECC only requires acceptance testing of new portions of altered systems. This section requires an altered system to meet the relevant Sections of C408 for acceptance testing to ensure that the altered system is operating as intended.

Jurisdictions with Building Performance Standards (BPS) could replace the system capacity threshold with the BPS application threshold to align the BPS and the energy code more fully. Most BPS are triggered based on building size. Where this is the case, exception #1 would be replaced with the following:

1. *Buildings* with a *gross floor area* less than **[SQUARE FOOTAGE THRESHOLD OF THE BPS]**.

Where BPS or other policies have other triggers that may be important, exceptions can be further tailored.

Add new text as follows:

> **C503.3.5 Furnace replacement.** Where an existing furnace is replaced with new equipment to provide space heating, that new equipment shall be an electric heat pump system.

This section requires electrification of space heating at equipment replacement, but only for furnaces. Furnaces are generally one of the easier kinds of combustion space heating equipment to electrify since they can generally be replaced with a heat pump connected to the same air distribution system. This section requires electrification of space heating at equipment replacement, but only for furnaces.

Add new text as follows:

> **C503.3.6 Cooling equipment.** New and replacement unitary air conditioners shall be electric heat pump equipment sized and configured to provide both space cooling and space heating. Any existing space heating systems that serve the same zone as the new equipment shall be configured as supplementary heat in accordance with Section C501.7.

Unitary air conditioners are essentially cooling-only heat pumps. AC replacement therefore provides a valuable opportunity to electrify or partially electrify space heating. This section requires that when AC equipment is replaced that it gets replaced with a heat pump that is configured to also provide heating. It also requires that any existing heating system be reconfigured as supplementary heating (see Section C501.7). This allows existing heating equipment to remain as a backup heating system, which is particularly important in buildings that are required to have emergency backup power for space heating and to ease the transition of some jurisdictions policies to all-electric renovations.

Add new text as follows:

> **C503.3.7 Cooking equipment.** *Combustion equipment* used for cooking shall not be permitted in spaces undergoing an *alteration.*

This provision leverages an alteration to a space to require the electrification of any combustion cooking equipment in that space. In commercial buildings, this would apply to domestic cooking equipment in multifamily and other dwelling units, commercial kitchens, and cooking equipment in other spaces like kitchenettes and community rooms. In the case of multifamily dwelling units and commercial kitchens, this could be a substantial project. This provision can be limited by adding targeted exceptions for R-2 occupancies (multifamily units) or commercial cooking appliances (commercial kitchens). While these exceptions would reduce market resistance, they would also remove most of the impact of the provision.

Add new text as follows:

> **C503.4.1 Service hot water system acceptance testing.** Where an *alteration* requires compliance with Section C404 or any of its subsections, service hot water systems that serve the *alteration* shall comply with Sections C408.2.3 and C408.2.5.

Exceptions:

1. Service water heater systems in buildings where the total mechanical equipment capacity is less than 600,000 Btu/h (175.8 kW) combined service water-heating and space-heating capacity.
2. Systems included in Section C403.5 that serve individual dwelling units and sleeping units.

Retro-commissioning and building re-tuning is generally accepted as one of the most cost-effecting energy efficiency measures for existing buildings. Average savings for building re-tuning is 12%, and studies have found savings as high as 52%. However, the IECC only requires acceptance testing of new portions of altered systems. This section requires an altered system to meet the relevant Sections of C408 for acceptance testing to ensure that the altered system is operating as intended.

Jurisdictions with Building Performance Standards (BPS) could replace the system capacity threshold with the BPS application threshold instead to align the BPS and the energy code more fully. Most BPS are triggered based on building size. Where this is the case, exception #1 would be replaced with the following:

1. *Buildings* with a *gross floor area* less than **[SQUARE FOOTAGE THRESHOLD OF THE BPS]**.

Where BPS or other policies have other triggers that may be important, exceptions can be further tailored.

Add new text as follows:

C503.4.2 Service water heating equipment. Where service water heating equipment is added or replaced, new service hot water equipment shall be electric heat pump equipment.

Exceptions:

1. Equipment with an input rating greater than 300,000 Btu/h.
2. Electric storage water heaters with a rated storage volume of less than 20 gallons (75.7 liters) and a rated input of less than 5kW.
3. Instantaneous electric water heaters located within 10 feet of the point of use.
4. Electric resistance equipment where not less than 75 percent of the annual service water-heating requirement is provided by an on-site renewable energy system not used to meet any other provision of this code.
5. Water heaters that serve end-uses that require water temperature of 150°F (65.6°C) or hotter.
6. Water heaters located on the exterior of the building.
7. Where it has been demonstrated to the *code official* that the dimensions or structural capacity of the space in which the water heater is located cannot accommodate a heat pump water heater sized to meet the service hot water load.

This provision requires a heat pump water heater to be installed whenever combustion water heater equipment is replaced. HPWHs can be more difficult to incorporate into existing buildings; therefore, the section has some important exemptions:

1. *Equipment with an input rating greater than 300,000 BTU/h is exempted. The technical and cost obstacles for water heating electrification are different for different kinds of water heating equipment. Large central boilers will often pose some of the greatest technical and cost challenges for electrification, so they are exempted. 300,000 BTU/h corresponds to the size division used for electrification readiness in the Building Decarbonization Code and will generally only apply to storage water heaters, instantaneous water heaters and small boilers.*
2. *Small electric resistance storage water heaters. These will have small loads and there aren't HPWH alternatives for them, so it is reasonable to allow them as electric resistance water heaters.*
3. *Instantaneous resistance water heaters used in point-of-use applications. The loads from these will also generally be very low.*
4. *There is a blanket exemption for electric resistance water heating where 75% of the annual water heating load is served by onsite renewable energy (most likely solar thermal or PV). This provides flexibility and the pairing of dedicated renewable energy with electric resistance water heating creates a system with total efficiency similar to a HPWH.*
5. *High-temperature applications are exempted since high temperature HPWHs are just now coming on the market and don't have broad market penetration.*
6. *Some instantaneous gas water heaters are rated for exterior locations and are located outside the building. There are currently not good HPWH options for these installations, so they've been exempted.*
7. *Buildings with space configuration constraints that prohibit a HPWH retrofit in existing space configurations. This will require substantiating the limitation with the code official, effectively requiring code official approval.*

If a jurisdiction finds that requiring HPWHs is not a viable option, this section can be replaced with an alternative that only requires electrification (below), which would allow electric resistance options.

Alternate add new text as follows:

C503.4.2 Service water heating equipment. Where service water heating equipment is added or replaced, new service hot water equipment shall not be *combustion equipment*.

Exception: Equipment with an input rating greater than 300,000 Btu/h .

Although such an approach would be more flexible, it also allows for electric resistance equipment, which can have serious implications for carbon emissions and energy affordability. This approach should only be chosen in jurisdictions served by an electricity supply that has a carbon intensity comparable to onsite natural gas combustion. Additionally, the utility cost implications—particularly for equipment that serves residential occupancies—should be analyzed in order to ensure this requirement will not have an unacceptably adverse effect on utility bills. Replacement of combustion equipment with electric resistance equipment will also exacerbate the building electrical capacity issues for electrification.

Revise text as follows:

C503.5 Lighting and power systems. New lighting and power systems that are part of the *alteration* shall comply with Sections C405 and C408.

This minor change adds "power" to the title and scope of C503.5 so that decarbonization requirements related to electrical power can be added to the section.

Add new text as follows:

C503.5.1 Interior Lighting and Controls. New and existing lighting in the *alteration* shall be provided with *controls* that comply with Section C405.2.

Exceptions:

1. Where the size or configuration of an interior spaces is not altered
2. Where less than 50 percent of the luminaires in the space are replaced

The IECC's requirements for lighting controls only apply to new controls, even when substantial changes are made to a lighting system. In some older buildings, lighting may not have any controls at all. Lighting alterations therefore provide a valuable opportunity to introduce or upgrade lighting controls. This section requires lighting controls to meet current control requirements in certain, more substantial lighting retrofits.

Add new text as follows:

C503.5.2 Lighting acceptance testing. Where an *alteration* requires compliance with Section C405 or any of its subsections, the *registered design professional* or *approved agency* shall provide a report in accordance with section C408.3.2.3 demonstrating that the new and existing lighting control systems that serve the *alteration* have been tested in accordance with the following:

1. Verify that manual controls function.
2. Verify that occupancy and vacancy sensors automatically turn off the lights when spaces are unoccupied.
3. Verify that time switch controls are functioning, set to the correct day and time, programmed with scheduled off times, and provided with new backup batteries (where applicable).

While best practices for any lighting project include ensuring that lighting controls are operating properly, the code is only required new controls. New luminaires do not trigger control testing. This provision ensures that lighting controls will be receive basic functional testing whenever a lighting system is altered. This section is based on the acceptance testing requirements for lighting in Section C408 but has tailored for existing controls since some of those requirements are only appropriate for new buildings or new controls.

Add new text as follows:

C503.5.3 Combustion lighting. New and replacement gas lighting shall not be permitted as part of an *alteration*.

Gas lighting is not common but is still used for decorative purposes. This provision prohibits the installation of new or replacement gas lighting. There is a very limited application of historic gas lighting to establish historically accurate lighting that would still be allowed under the accommodations for historic buildings in C501.6.

Add new text as follows:

C503.5.4 Electrical Service replacement. Where a *building* electrical service is replaced, the new electrical service shall include additional electrical capacity for the following as applicable:

1. Replacement of c*ombustion equipment* used for space heating with electric heat pump equipment or reverse-cycle chiller sized for the heating load of the *building* in accordance with C403.3.1 based on the existing *building* features
2. Replacement of c*ombustion equipment* used for water heating with electric heat pump equipment sized for the service hot water load of the *building*
3. Replacement of c*ombustion equipment* used for cooking with electric cooking equipment
4. Replacement of *combustion equipment* used for clothes drying with electric equipment
5. Renewable energy infrastructure in accordance with Section C405.13
6. Sufficient electric capacity for all parking facilities served by the electrical service to comply with Section C405.14 as a new parking facility. For the purposes of compliance with this section, sizing shall be permitted to be based on the capacity requirements of *EVSE spaces* served by an *ALMS.*
7. Energy storage infrastructure in accordance with Section C405.15.1

One potential significant cost in electrification retrofit projects is electrical service replacement. This section ensures that if a building service is being replaced that it must be sized for the full electrification of combustion equipment in the building—space heating, water heating, cooking and clothes drying—and for the addition of the onsite renewable systems, EVCI and energy storage in the future. "Electrification-sizing" the electrical service at the time of normal replacement is the most cost-effective approach to providing sufficient capacity for individual electrification retrofits. This will remove that barrier for future electrification retrofits.

Where jurisdictions are concerned with increased costs for these upgrades before the service may be put to full use, several options are available to modify the language. First, the addition of new construction quantities of EV charging capacity can be significant. Item 6 could be altered to only require electrical capacity for a smaller percentage of EV charging spaces. Second, exceptions can be specifically crafted to address the cost implications of such an upgrade.

Alternate add new text as follows:

> **Exception:** Where it has been demonstrated to the code official that compliance with this section will result in increased costs for electrical utility service be charged to the *building* owner that create a substantial burden, the electrical service size shall be permitted to be reduced to a size that will not increase utility infrastructure costs charged to the *building* owner.

This exception has been crafted to provide discretion to the code official that the cost is not simply increased but will show a substantial burden on the building owner. While this phrasing may be widely interpreted, it is suggested that jurisdictions adopting this exception work to tailor this language to be more prescriptive and appropriate to their local considerations.

Add new text as follows:

> **C503.5.5 Onsite renewable energy.** *Substantial improvements* and *alterations* that include *roof replacements* of more than 75 percent of the total roof area of the *building*, the *building* or *building* site shall comply with Section C405.13.
>
> **Exception:** Where *roof replacements* do not alter the existing structure and it has been demonstrated to the *code official* that the existing structure cannot support the addition of solar panels.

This provision requires roof replacement projects to be paired with the installation of an onsite renewable energy system. There are different kinds of re-roofing projects. A roof recover only involves putting a new layer of roofing material on top of existing roofing. A roof replacement includes the removal of old roofing material, repair of exposed sheathing and installation of a new roof. Roof replacements provide an advantageous opportunity to install an onsite renewable energy system like a photovoltaic array. It exposes the roof structure under the roof cover, providing a clearer picture of the condition and configuration of the roof structure. It also presents a more cost-effective time to make structural improvements. It synchronizes the service life of the roof and the renewable energy system, eliminating concerns about the need to repair a roof under the system. Synchronizing roof replacement and rooftop renewable energy systems also reduces costs as both projects can often utilize the same onsite construction and safety equipment.

If there is pushback to using roof replacement as a code trigger for the onsite renewable energy system, substantial improvement could be used as a standalone trigger instead.

Alternate add new text as follows:

> **C503.5.5 Onsite renewable energy.** *Substantial improvements* shall comply with Section C405.13.

This would only require the renewable system when the building is undergoing a major renovation, as substantial improvement is defined, giving the opportunity for reinforcing structure to be added to accommodate future solar installations.

Add new text as follows:

> **C503.5.6 Electric vehicle charging infrastructure.** Parking facilities serving *substantial improvements* shall comply with Section C405.14 as a new parking facility. All other *alterations* shall be provided with *electric vehicle* parking infrastructure in accordance with this section.

There are several building lifecycle events that support the addition of EV charging to existing sites or the addition of electrical infrastructure to support future EV charging retrofits. This top section requires that parking facilities that serve substantial improvements be retrofit to fully comply with the EV charging requirements for new construction. All other alterations are directed to the subsections that include targeted opportunistic electrical infrastructure upgrades during certain kinds of alterations.

> **C503.5.6.1 New parking facilities.** New parking facilities and new parking spaces added to existing parking facilities shall comply with Section C405.14 based on the number of new parking spaces.

This section makes explicitly clear that new parking facilities are subject to the EVCI requirements of C405.14. This section may not be strictly necessary, but it ensures that there is no ambiguity in the code.

> **C503.5.6.2 Alterations to parking lots.** Where more than 25% of the paving of a parking lot is removed, the affected parking spaces shall be *EV-capable spaces*, up to the total number of *EV-capable spaces* indicated in Table C405.14 based on the total number of parking spaces in the parking lot. Where the parking lot serves more than one occupancy type, the number of required *EV-capable spaces* shall be based on a weighted average of the different occupancies. *EV-capable spaces* shall be provided with raceway in accordance with the following:
>
> 1. Continuous between a junction box or outlet located within 3 feet (914 mm) of the parking space and an electrical panel serving the area of the parking space or a space containing an electrical panel serving the area of the parking space.
> 2. The raceway shall be sized and rated to accommodate a 40-amp, 208/240-volt branch circuit and have a minimum nominal trade size of 1 inch.
> 3. Both ends of the raceway shall have labels stating "For future electric vehicle charging"

Parking lot repaving is a cost effective time to undertake the retrenching of a parking lot that EVCI retrofits often require. The paving material is already being removed and replaced, which limits the cost of retrofitting a parking lot to only the cost of the retrenching. This section leverages these parking lot repaving projects to introduce raceways for EV-Capable spaces. It sets a minimum threshold for paving of 25% to ensure that the requirement is not triggered by simple repair projects. It also only includes requirements for the raceway component of EV-Capable spaces, and not other components such as panel capacity or physical space since those are not generally part of the scope of a re-paving project. As such, it only requires the raceways to get into proximity of the panel and not connect as is required in new construction. The section also sets a cap for the number of spaces that need to be provided with this raceway, so that a retrofit project would not need to provide more EV-Capable spaces than are required of new construction in C405.14.

C503.5.6.3 Alterations to parking structure electrical service. Where the electrical service serving a parking garage is replaced, the electrical service shall be sized to provide capacity for the parking garage to meet the requirements of Section C405.14 as a new parking facility. For the purposes of compliance with this section, sizing shall be permitted to be based on the capacity requirements of *EVSE spaces* served by an *ALMS*.

Parking garages sometimes have independent electrical service connections and may not be captured by the service upgrade requirements in Section C403.5.4 above. This ensures that parking garage electrical service replacements are sized to accommodate an EV charging retrofit.

Add new text as follows:

C503.6 Additional energy efficiency credits. *Substantial energy alterations* shall comply with Sections C506 in accordance with this section. *All-electric buildings* shall achieve a total of 5 credits and *mixed-fuel buildings* shall achieve a total of 10 credits.

Exceptions:

1. *Alterations* that are part of an *addition* complying with section C502.
2. *Alterations* that comply with Section C407.
3. Alterations that comply with Section C503.1.2.

This section works with the new section C506 (see below for more) to bring additional energy efficiency through implementing the additional efficiency credits in C406 in substantial energy alterations. Substantial energy alterations are defined in a way that they are projects that impact multiple building energy systems, which creates multiple opportunities for acquiring credits from C406. The section requires 5 credits in alterations to all-electric buildings—half of the credit target for new construction—and 10 credits for mixed-fuel buildings. It includes a series of important exceptions:

1. *An exception that reflects the allowance for alterations and additions to comply together under Section C502 when they are part of the same project (see Section C502.6 above).*
2. *An exception for buildings that model using Section C407.*
3. *An exception for substantial improvements that comply with the EUI requirements of C503.1.2.*

C505 CHANGE OF OCCUPANCY

Add new text as follows:

C505.1.1 Combustion equipment. Spaces undergoing a change in occupancy shall not be permitted to be served by *combustion equipment.*

Exception: Where a central heating or water heating system serving other dwelling or sleeping units in the same building is extended to serve spaces converted to a dwelling or sleeping unit.

This provision prohibits changes of occupancy from being served by combustion equipment. This would effectively require changes of occupancy to result in an all-electric space or all-electric building. Jurisdictions should bear in mind that this could discourage changes of occupancy and the efficiency gains that would otherwise have been gained through a standard change of occupancy. Where these

changes are likely to require substantial alterations, this type of trigger may be already sufficiently captured in the alterations section of this code and this section could be removed by an adopting jurisdiction. The exception presented allows for areas of multifamily buildings to extend existing systems to areas that have undergone a change of occupancy to provide more dwelling or sleeping units. This exception mirrors residential provisions.

C506 ADDITIONAL EFFICIENCY

Add new text as follows:

SECTION C506
ADDITIONAL EFFICIENCY CREDITS

C506.1 General. Where required by Section C502 or C503, credits shall be achieved from Tables C406.1(1) through C406.1 (5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. 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 from the tables of 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 space-conditioning 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. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
11. Efficient kitchen equipment in accordance with Section C406.12.

This new section C506 creates a framework to use the additional efficiency credits from Section C406 in alterations and additions been leveraged to achieve additional energy savings in the IECC in a very flexible way. Over the last several code cycles, Section C406 has b C506.1 serves the same role as C406.1, directing projects how to achieve credits from the various credit options in sections C406.2-12.

Unlike Section C406, the credit target is not set in this section. Those targets are set in the companion Sections C502.6 for additions and C503.6 for alterations. It makes sense to apply Section C406 to all new buildings, but not all alterations and additions. Less substantial additions and alterations and certain

other existing projects with limited scopes are less likely to be able to accommodate a reasonable number of credit options to meet a credit target. By setting the targets in Sections C502 and C503, the credit targets can be selectively applied to only those projects where it is reasonable to incorporate Section C406 credit options as a requirement. It also allows for a clear distinction between the unique exceptions for additions and alterations.

Chapter 6 – Referenced Standards

Add new standard as follows:

ASHRAE

100---2018: Energy Efficiency in Existing Buildings

C503.1.2

Existing Building Decarbonization Code:

Commercial Overlay

Mixed-Fuel

Commercial Overlay (Mixed-Fuel)

Chapter 1 – Scope and Application

C101 SCOPE AND GENERAL REQUIREMENTS

Revise text as follows:

> **C101.3 Intent.** This code shall regulate the design, ~~and~~ construction, repair, alteration, change of occupancy, and additions of new and existing buildings for the ~~effective use and conservation~~ reduction of greenhouse gas emissions and for the efficient production, use and storage of energy over the useful life of each building. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. This code is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.

Intent has been modified to push beyond simply the inclusion of considerations of greenhouse gas emissions and production and storage of energy, to clearly emphasize the intent of the code to regulate existing buildings.

Chapter 2 – Definitions

C202 GENERAL DEFINITIONS

Add new definitions as follows:

> **ELECTRIC EQUIPMENT.** Any equipment or *appliance* used for space heating, *service water heating*, cooking, clothes drying, or lighting that uses electricity as its sole source of energy.

This new definition for electric equipment is a parallel of the definition of "combustion equipment" introduced in the Building Decarbonization Code.

> **ENERGY USE INTENSITY (EUI).** An expression of *building* energy use in terms of net energy divided by *gross floor area*.

EUI is an energy metric used in some performance-based energy policies, including many building performance standards (BPS). It is included here to allow provisions of the Existing Building Decarbonization Code integrate with BPSs. EUI is not currently defined in the suite of I-Codes, so it is added here. If a jurisdiction already has a formal definition of EUI, particularly in a building performance standard, then that definition should be integrated here as well.

> **SUBSTANTIAL ENERGY ALTERATION.** An *alteration* that replacement of two or more of the following:
>
> 1. 50% or more of the area of interior wall-covering material of the *building thermal envelope* or *fenestration.*
> 2. 50% or more of the area of the exterior wall-covering material of the *building thermal envelope* or *fenestration.*
> 3. Space-conditioning equipment constituting 50% or more of the total input capacity of the space heating or space cooling equipment serving the *building*.

4. Water-heating equipment constituting 50% of more of the total input capacity of all the water heating equipment serving the *building.*

5. 50% or more of the luminaires in the *building*

This new definition for substantial energy alteration is intended to capture projects that have the opportunity to greatly increase efficiency by nature of their scope and clarify when certain requirements related to the energy use of the building are triggered. By defining such scopes, confusion around generic terms like major renovations and applicability of work classifications in the IEBC can be removed. Other terms that define large-scale alterations such as Level III alteration or substantial improvement are not specific to the energy systems. An alteration could cross their thresholds without having a significant impact on the energy systems since they are based on metrics such as monetary value and reconfiguration of spaces. Similarly, an alteration that has significant impact on the energy systems of the building may not cross these other thresholds.

SUBSTANTIAL IMPROVEMENT. Any *repair*, reconstruction, rehabilitation, *alteration*, *addition* or other improvement of a building or structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the improvement or repair is started. If the structure has sustained *substantial damage*, any repairs are considered substantial improvement regardless of the actual *repair* work performed. The term does not, however, include either:

1. Any project for improvement of a *building* required to correct existing health, sanitary or safety code violations identified by the *building official* and that are the minimum necessary to assure safe living conditions.

2. Any *alteration* of a *historic structure* provided that the *alteration* will not preclude the structure's continued designation as a historic structure.

The definition of substantial improvement comes from the IBC and IEBC. The term generally aligns with vernacular use of "major renovation," which is not defined in code. It is used as a threshold for when certain flood protection requirements are triggered for existing building alterations. Since it is based on the monetary value of the alteration, it sets a useful threshold for introducing additional decarbonization requirements for large alterations.

In addition, the Existing Building Decarbonization Code leverages definitions from the Building Decarbonization Code including:

ALL-ELECTRIC BUILDING
APPLIANCE
COMBUSTION EQUIPMENT
COMMERCIAL COOKING APPLIANCES
ELECTRIC VEHICLE (EV)
EQUIPMENT
EV-CAPABLE SPACE
FUEL GAS

The use of these terms throughout assumes that adopting jurisdictions will adopt the Building Decarbonization Code alongside this existing building overlay.

Chapter 5 – Existing Buildings

C501 GENERAL

Add new text as follows:

C501.6 Requirements for combustion equipment. New and replacement *combustion equipment* in *additions*, *alterations* and changes of occupancy shall comply with this section.

This section creates an additional set of requirements for combustion equipment when it is allowed to be installed in existing buildings. These requirements are intended to generally improve the emissions of the equipment and the interior and exterior air quality.

C501.6.1 Replacement of electric equipment. C*ombustion equipment* shall not be permitted to be installed to replace electric equipment.

The largest cost for existing buildings to electrify is to install the infrastructure to swap the equipment. Where electric appliances and equipment already exist, it is critical to maintain the electric energy source and not install new fossil fuel infrastructure.

C5061.6.2 Phase out documentation. Permit applications for projects installing new and replacement *combustion equipment* or retaining existing *combustion equipment* serving space heating and water heating shall include a plan for the future replacement of the *combustion equipment* with *electric equipment*. The documentation shall include the following:

1. Calculations of the electric load required by the replacement electric equipment and of the available electric capacity of the *building*.
2. Identification of any existing onsite electrical infrastructure, including but not limited to transformers, switchgear, electrical panels and conductors, that will need to be altered to accommodate the replacement electric equipment.
3. Floor plans identifying any spaces that will need to be reconfigured to accommodate the replacement electric equipment.

Where replacements are made with combustion equipment, building owners should understand the need for long term phase out and switch to electric equipment to avoid potential abandoned assets. Jurisdictions could also expand this section to include specifics related to other policies such as appliance emission standards or replacement policies targeting specific dates for combustion equipment phase out.

C501.6.3 Sealed combustion and direct venting. *Combustion equipment* used for space and water heating shall be direct vent or sealed combustion.

Space and water heating equipment that utilize direct venting or sealed combustion techniques improve the efficiency of the equipment and the indoor air quality of a home by ensuring that hazardous byproducts of the combustion process are vented outside of the living space.

C501.6.4 Low NOx furnaces. Warm-air furnaces shall have no more than 14 nanograms of nitrogen dioxide emissions per joule of useful heat delivered to the heated space.

Exception: Equipment with an AFUE of not less than 90 percent.

This requirement also limits the nitrogen dioxide emissions from these appliances. Appliances in buildings emit twice the amount of NOx as power plants, a major pollutant which causes asthma. The air quality limit is based on NOx emission limits imposed by California's South Coast Air Quality Management District and the San Joaquin Valley Air Pollution Control District. An exception is given to equipment that exhibit an AFUE of 90 percent or more because those systems use direct vent or sealed combustion technology and comply with the NOx limit.

C501.6.5 Fuel gas pipe testing. All *fuel gas* piping that serves new or replacement *combustion equipment* shall be tested as a new installation in accordance with Section 406 of the *International Fuel Gas Code*.

Exceptions:

1. For the purposes of demonstrating compliance with this section, unexposed pipe joints and welds shall not be required to be exposed for examination during the test.
2. For the purposes of demonstrating compliance with this section, where it has been demonstrated to the code official that the *fuel gas* piping has met the requirements of this section within the previous five years.
3. Where compliance with this section would require interruption of *fuel gas* supply to *combustion equipment* that serves other tenant spaces or other *dwelling units,* provided all exposed pipe joints of the piping subject to the requirements of this section have been inspected for leaks by means of an *approved* gas detector, a noncorrosive leak detection fluid or other *approved* leak detection method once the equipment has been placed in operation.

Gas piping degrades over time, creating the possibility of natural gas leakage. Even though the natural gas is treated with mercaptan to give it that rotten egg smell, small leaks may go undetected, particularly in buildings where pipes are not exposed and older buildings that are likely to have envelopes that are less tight than newer construction. According to US DOE, building leakage accounts for nearly 27% of the natural gas leakage in the US natural gas distribution system.[8] Leaking natural gas represents a loss in energy, and even small leaks can add up over long periods of time. Additionally, natural gas is also a potent Green House Gas, with over 86 times the global warming potential of CO_2 on a short-term basis.

The installation of new gas equipment provides an ideal time to test gas pipe leakage. Contractors are already on site and the gas will often be partially or fully turned off for the new equipment installation. Additionally, new equipment installation can disturb and inflict additional stresses on existing piping, creating opportunities for the formation of new leaks where existing natural gas piping has weakened but not previously failed

This provision requires that existing fuel gas piping be tested like a new installation according the International Fuel Gas Code (IFGC). It includes targeted exceptions for elements of the IFGC testing methodology that is not appropriate for existing buildings. It also includes an exception for piping that has been tested in the last five years in order to prevent repeated testing. Finally, it includes an exception to ensure that testing requirements don't necessitate other tenants losing service, which could be a considerable in larger buildings with multiple tenant spaces. In those cases, it only requires visual inspection of the exposed joints with a testing fluid.

[8] "Natural Gas Infrastructure Modernization Programs at Local Distribution Companies: Key Issues and Considerations." US DOE, Office of Energy Policy and Systems Analysis. Washington DC, 2017.

Add new text as follows:

> **C501.7 Heat pump supplementary combustion equipment.** Heat pumps having *combustion equipment* and electric resistance equipment for supplementary space or water heating shall have controls that limit supplemental heat operation to only those times when one of the following applies:
>
> 1. The heat pump is operating in defrost mode.
> 2. The vapor compression cycle malfunctions.
> 3. For space heating systems, the thermostat malfunctions.
> 4. For space heating systems, the vapor compression cycle cannot provide the necessary heating energy to satisfy the thermostat setting.
> 5. For water heating, the heat pump water heater cannot maintain an output water temperature of at least 120°F (49°C)
>
> New supplementary space and water heating systems for heat pump equipment shall not be permitted to have a heating input capacity greater than the heating input capacity of the heat pump equipment.

Supplementary heating systems are effectively back-up systems intended to provide heating if the primary heat pump system fails, if the operating conditions (heating demand, temperature around the heat pump compressor, etc.) exceed the ability of the heat pump to effectively, or cost-effectively, provide heating. Designers sometimes utilize "hybrid heat" systems where combustion equipment provides the supplementary heat to address these situations.

This new section creates a version of the supplementary heating equipment control requirements in Section C403 that is customized for existing buildings. It addresses both space and water heating applications and ensures that any combustion heating equipment used for supplementary heat is only used when the heat pump system is unable to fully meet the buildings heating needs (the language in C403 already addresses electric resistance supplementary heat).

C502 ADDITIONS

Revise text as follows:

> **C502.1 General.** *Additions* to an existing *building*, building system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portion of the existing *building* or *building* system to comply with this code. *Additions* shall not create an unsafe or hazardous condition or overload existing *building* systems. An addition shall be deemed to comply with this code if the *addition* alone complies or if the existing *building* and *addition* comply with this code as a single *building*. *Additions* shall comply with Sections C502.2 through C502.5.

These edits implement the restructuring discussed above in the introduction. The content of the sections is unaffected. The compliance language from the original Section C502.3 has been moved here.

The requirement in C502.1 for additions to meet the requirements for new construction mean that additions will be subject to the requirements in the Building Decarbonization Code for demand responsive thermostats and water heaters, onsite renewable energy, electrification readiness, energy storage infrastructure, etc.

Add new text as follows:

C502.1.1 Combustion equipment. *Additions* shall not be permitted to contain *combustion equipment* and new equipment installed to serve *additions* shall not be *combustion equipment*. Where systems with *combustion equipment* are extended into an addition, the existing *building* and addition together shall use no more fossil fuel energy than the existing *building* alone.

This section requires additions to effectively be all-electric by prohibiting them from containing or being served by new combustion equipment additions combustion equipment. When additions are added to existing buildings, space and water heating systems are often extended into the new addition. This provision does allow the extension of systems that utilize combustion equipment into the addition. In order to ensure that the addition does not result in higher consumption of fossil fuels, the provision also requires that this extension doesn't result in an increase in combustion energy. In order to extend a system with combustion equipment into an addition, the efficiency of the existing building would need to be improved to offset the increased consumption from the addition.

Add new text as follows:

C502.1.2 Combustion equipment requirements. New *combustion equipment* serving *additions* shall comply with section C501.6.

This section ensures that combustion equipment installed in additions is both more efficient and less likely to worsen indoor air quality as required in Section C501.6.

Add new text as follows:

C502.1.3 Building Performance Standards. Where an addition to a *building* makes it subject to **[OFFICIAL NAME OF THE LOCAL BUILDING PERFORMANCE STANDARD]**, the permit application for the *addition* shall include a report that includes the following:

1. The current or last reported EUI of the *building*
2. The performance targets from **[NAME OF THE LOCAL BUILDING PERFORMANCE STANDARD]** that will be applicable to the *building* within five years from the date of the permit application

Where the current or last reported EUI exceeds the performance targets that will be applicable in the next five years, the report shall also include a plan describing how the *building* will be brought into compliance. The report shall include energy efficiency upgrades and operational improvements that will be made to the *building* before the applicable target goes into effect and the impact of the alteration under permit review.

Exceptions:

1. Where the total *building* performance of the *building* with the *alteration* determined in accordance with Section C407 demonstrates compliance with the performance targets identified in the report required by this section.

2. Additions that increase the *conditioned floor area* of the *building* by less than 10% and install no new space conditioning or water heating equipment.

In jurisdictions with a BPS it is important that all work on existing buildings support and reinforce the policy goals. Additions that either push a building into covered building status or are part of a building is already subject to the BPS that are undertaken without consideration of impending BPS performance targets represent a significant missed opportunity. This section requires that consideration by creating a requirement that permit applications include the building's current performance and any BPS performance targets that will be in effect in the next 5 years, the typical compliance cycle for US-based BPS. Where a building does not already meet those targets, it will be required to also submit what is effectively a plan for compliance with the BPS. This will ensure that project teams are thinking about a proposed alteration within the larger context of what will be required to meet up-coming BPS requirements.

The exceptions allow the compliance path to be avoided when the alteration is complying by performance modeling and that modeling shows that the alteration will bring the building into compliance with the BPS performance target, and for additions that will in and of themselves not create a major energy impact.

It may be necessary to modify the language in this provision to align with the terminology that is used in the official BPS regulation to maximize correlation and usability. For example, the provision can be modified to align with a carbon-based BPS by replacing "EUI" with "CUI" throughout and adding the following definition:

CARBON USE INTENSITY (CUI). An expression of *building* carbon emissions in terms of the equivalent carbon emissions of the net energy divided by *gross floor area*.

This definition defines a carbon use intensity that parallels the definition of EUI. It is a carbon metric where carbon emissions are divided by gross floor area in order to compare the emissions of different buildings or assess the performance a building's carbon emissions against a target.

Revise text and numbering as follows:

~~**C502.2 Change in space conditioning.** Any nonconditioned or low-energy space that is altered to become conditioned space shall be required to comply with Section C502.~~

~~**Exceptions:**~~

~~1. Where the component performance alternative in Section C402.1.5 is used to comply with this section, the proposed UA shall be not greater than 110 percent of the target UA.~~

~~2. Where the total building performance option in Section C407 is used to comply with this section, the annual energy cost of the proposed design shall be not greater than 110 percent of the annual energy cost otherwise permitted by Section C407.2.~~

This section is moved to C503, the alterations section. It is reasonable to make conversions of unconditioned space to conditioned space subject to the requirements for an addition, but they are technically alterations. Code users could naturally skip over the additions section, go straight to the alterations section, and miss this requirement. Moving the provision improves clarity and usability.

Revise text and numbering as follows:

~~**C502.3 Compliance** *Additions* shall comply with Sections C502.3.1 through C502.3.6.2.~~

C502.2 Building Envelope. New building envelope assemblies that are part of the *addition* shall comply with Sections C502.2.1 through C502.2.2.

~~**C502.3.1**~~ **C502.2.1 Vertical fenestration area.**

~~**C502.3.2**~~ **C502.2.2 Skylight area.**

~~**C502.3.3**~~ **C502.3 Building mechanical systems.**

These edits implement the restructuring discussed above in the introduction. The content of the subsections is unaffected. The compliance language from the original Section C502.3 has been moved to C503.1 and a new C502.2 has been introduced for the envelope subsections.

Add new text as follows:

C502.3.1 Space heating equipment. New space heating equipment in *additions* shall be electric heat pump equipment.

Exceptions:

1. Electric resistance supplementary heat in accordance with Section C403.4.1.1
2. Up to 5W of electric resistance heat per square foot of *conditioned floor area* in the *addition*
3. *Combustion equipment* used for supplementary heat in accordance with Section C501.7.

Requiring space heating installed during an addition to be electric will reduce carbon emissions and improve air quality in homes. Heat pumps have been shown to be technically effective in all climate zones, and cold-climate heat pump technology continues to improve, providing heating with a COP of more than 3 above 5°F.[9]

Exceptions are included for electric resistance supplementary heat and for up to 5W of electric resistance heat per square foot of conditioned floor area. The latter creates a budget for electric resistance heat that can be used for spot heating, small spaces, freeze protection and heat pump VAV systems with terminal electric resistance heat. 5W is a fairly low budget for these VAV systems that will require efficient design parameters such as delivering higher temperature air to the terminal boxes during heating that minimize the operation of the electric resistance coils. An exception for supplementary combustion heating equipment is also included, allowing new combustion equipment to be installed in the addition as long as it is only used as supplementary heat.

[9] "Achieve Comfort and Reliable Performance with Cold-Climate Heat Pumps." *Zero Energy Project*, 6 Feb. 2020, https://zeroenergyproject.org/2020/01/22/achieve-comfort-and-reliable-performance-with-cold-climate-heat-pumps/#:~:text=The%20Benefits%20of%20Heat%20Pumps%20in%20Cold%20Climates&text=Combustion%2Dbased%20heating%20systems%20such,3%20at%205%C2%B0F.

Revise text and numbering as follows:

~~C502.3.4~~ C502.4 Service water-heating systems.

~~C502.2.5~~ C502.4.1 Pools and inground permanently installed spas.

These edits implement the restructuring discussed above in the introduction. The content of the sections is unaffected.

Add new text as follows:

C502.4.2 Heat Pump Water Heating. New water heaters in *additions* shall be electric heat pump equipment.

Exceptions:

1. Supplementary water heating systems controlled in accordance with C501.7
2. Electric storage water heaters with a rated storage volume of less than 20 gallons (75.7 liters) and a rated input of less than 5kW.
3. Instantaneous electric water heaters located within 10 feet of the point of use.
4. Electric resistance equipment where not less than 75 percent of the annual service water-heating requirement is provided by an on-site renewable energy system not used to meet any other provision of this code.
5. Water heaters that serve end-uses that require water temperature of 150°F (65.6°C) or hotter.

Heat pump water heaters can be 4-6 times more efficient than their electric resistance and combustion counterparts. This provision requires new water heaters in additions to be heat pump water heaters. It includes a few key exceptions:

1. *Supplementary water heating that can be any fuel type.*
2. *Small electric resistance storage water heaters. These will have small loads and there aren't HPWH alternatives for them, so it is reasonable to allow them as electric resistance water heaters.*
3. *Instantaneous resistance water heaters used in point-of-use applications. The loads from these will also generally be very low.*
4. *There is a blanket exemption for electric resistance water heating where 75% of the annual water heating load is served by onsite renewable energy (most likely solar thermal or PV). This provides flexibility and the pairing of dedicated renewable energy with electric resistance water heating creates a system with total efficiency similar to a HPWH.*
5. *High-temperature applications are exempted since high temperature HPWHs are just now coming on the market and don't have broad market penetration.*

Revise text and numbering as follows:

~~C502.2.6~~ **C502.5 Lighting and power systems.**

~~C502.2.6.1~~ **C502.5.1 Interior lighting power.**

~~C502.2.6.2~~ **C502.5.2 Exterior lighting power.**

These edits implement the restructuring discussed above in the introduction. The content of the subsections is unaffected. The compliance language from the original Section C502.3 has been moved to C503.1 and a new C502.2 has been introduced for the envelope subsections.

Add new text as follows:

C502.5.3 Renewable energy infrastructure. Additions with a new roof shall be provided with equipment for on-site renewable energy with a rated capacity of not less than 0.25 W/ft² (2.7 W/m²) multiplied by the sum of the gross conditioned floor area of the three largest floors of the *addition*.

Exceptions:

1. Additions that increase the *conditioned floor area* of the *building* by less than 10%.
2. Additions where an unshaded flat plate collector oriented towards the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 3.5 kWh/m²·day (1.1 kBtu/ft²·day).
3. Additions where more than 80 percent of the roof area is covered by any combination of equipment other than for on-site renewable energy systems, planters, vegetated space, skylights, or occupied roof deck.
4. Additions where more than 50 percent of roof area is shaded from direct beam sunlight by natural objects or by structures that are not part of the building for more than 2,500 annual hours between 8:00 AM and 4:00 PM.

Additions with roofs provide an opportunity to introduce renewable energy systems. The requirements in the Building Decarbonization Code for renewable energy systems reference buildings and so don't capture additions. This section uses the addition to trigger the requirements. The size of the system is based on the size of the addition, rather than the whole building. The new section includes exceptions that are paralleled from the new construction requirements. These exempt small additions, roofs without good solar access and roofs that are already utilized for other uses.

Add new text as follows:

C502.5.4 Electric vehicle charging infrastructure. New parking facilities and new parking spaces added to existing parking facilities shall comply with Section C405.14 based on the number of new parking spaces.

This section requires new parking facilities to meet the EV charging requirements in the new construction portion of the Building Decarbonization Code. While this is implicitly required by Section C501, the addition of this section makes it explicit for greater clarity and enforceability.

Add new text as follows:

C502.6 Additional energy efficiency credits. *Additions* shall achieve credits in accordance with Section C506. *All-electric buildings* shall be required to 10 credits and *mixed-fuel buildings* shall be required to select 15 credits. *Alterations* to the existing building that are not part of an *addition*, but permitted with an *addition*, may be used to achieve the required credits.

Exceptions:

1. *Buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H
2. *Additions* less than 1,000 ft^2 (92.9 m^2) and less than 50% of existing floor area.
3. *Additions* that do not include the addition or replacement of equipment covered by Section C403.3 or C404.2 that achieve a total of 5 credits.
4. *Additions* that do not contain *conditioned space* that achieve a total of 5 credits.
5. *Buildings* in Residential Group R and Institutional Groups I in climate zones 3C, 4B, 4C, 5C that achieve a total of 5 credits
6. Where the *addition* alone or the existing building and *addition* together comply with Section C407

This section works with the new Section C506 (see below for more) to bring additional energy efficiency to additions through implementing the additional efficiency credits in Section C406 in "substantial" additions. The section requires 10 credits in additions to all-electric buildings, just like new buildings, and greater efficiency of 15 credits for additions to mixed-fuel buildings. It also includes a series of important exceptions for occupancy types with low building loads, small additions and buildings that comply with Section C407. It also requires only 5 credits in additions to certain building types in certain climate zones that have fewer credit options available, additions that don't include new HVAC or water heating equipment and additions that do not include conditioned space.

C503 ALTERATIONS

Add new text as follows:

C503.1.1 Change in space conditioning. Any nonconditioned or low-energy space that is altered to become conditioned space shall be required to comply with Section C502.

Exceptions:

1. Where the component performance alternative by Section C402.1.5 is used to comply with this section, the proposed UA shall be not greater than 110 percent of the target UA.
2. Where the total building performance option by Section C407 is used to comply with this section, the annual energy cost of the proposed design shall be not greater than 110 percent of the annual energy cost otherwise permitted by Section C407.2.

This content is located in the additions section in the model code (Section C502.2). As part of the restructuring needed for this overlay, it has been relocated here since it describes an alteration project. The requirements have not been changed, but the relocation will improve the usability and enforceability of the code.

Add new text as follows:

C503.1.2 Substantial improvement. Buildings undergoing *substantial improvements* shall comply with Sections C402.5 and C405.16 and meet a site EUI by building type in accordance with ASHRAE Standard 100 Table 7-2a.

Exception: Compliance with Standard 100 shall not be required where Group R-occupancies achieve an ERI score of 80 or below without on-site renewable energy included in accordance with RESNET/ICC 301, for each dwelling unit.

Substantial improvements are extensive alterations that have significant scope, large project budgets relative to the value of the building and are more likely to already include major systems that could include combustion equipment. The larger scopes and budgets of substantial improvements are likely to occur infrequently within a building lifecycle and create the best opportunity to significantly increase efficiency and establish full electric ready infrastructure for the building and its systems.

Add new text as follows:

C503.1.3 Requirements for combustion equipment. New *combustion equipment* serving *alterations* shall comply with Section C501.6.

This section ensures that when combustion equipment is installed for water heating, it meets the requirements for testing and increased safety for combustion equipment in C501.6.

Add new text as follows:

C503.1.4 Building Performance Standards. Where the *building* is subject to **[OFFICIAL NAME OF THE LOCAL BUILDING PERFORMANCE STANDARD]**, the permit application for the *alteration* shall include a report that includes the following:

1. The current or last reported EUI of the *building*
2. The performance targets from **[NAME OF THE LOCAL BUILDING PERFORMANCE STANDARD]** that will be applicable to the *building* within five years from the date of the permit application

Where the current or last reported EUI exceeds the performance targets that will be applicable in the next five years, the report shall also include a plan describing how the *building* will be brought into compliance. The report shall include energy efficiency upgrades and operational improvements that will be made to the *building* before the applicable target goes into effect and the impact of the alteration under permit review.

Exception: Where the total *building* performance of the *building* with the *alteration* determined in accordance with Section C407 demonstrates compliance with the performance targets identified in the report required by this section.

In jurisdictions with a Building Performance Standard (BPS), it is important that all alterations support and reinforce the BPS. Alterations that are undertaken without consideration of impending BPS performance targets represent a significant missed opportunity. This section requires that consideration by creating a requirement that permit applications include the building's current performance and any BPS performance targets that will be in effect in the next 5 years, the typical compliance cycle for US-based BPS. Where a building does not already meet those targets, it will be required to also submit what is effectively a plan for compliance with the BPS. This will ensure that project teams are thinking about a proposed alteration within the larger context of what will be required to meet up-coming BPS requirements.

The exception allows the compliance path to be avoided when the alteration is complying by performance modeling and that modeling shows that the alteration will bring the building into compliance with the BPS performance target.

It may be necessary to modify the language in this provision to align with the terminology that is used in the official BPS regulation to maximize correlation and usability. For example, the provision can be modified to align with a carbon-based BPS by replacing "EUI" with "CUI" throughout and adding the following definition:

CARBON USE INTENSITY (CUI). An expression of *building* carbon emissions in terms of the equivalent carbon emissions of the net energy divided by *gross floor area*.

This definition defines a carbon use intensity that parallels the definition of EUI. It is a carbon metric where carbon emissions are divided by gross floor area in order to compare the emissions of different buildings or assess the performance a building's carbon emissions against a target.

Add new text as follows:

C503.3.2 System sizing. New heating and cooling equipment that is part of an *alteration* shall be sized in accordance with Section C403.3.1 based on the existing *building* features as modified by the *alteration.*

Exception: Where is has been demonstrated to the *code official* that compliance with this section would result in heating or cooling equipment that is incompatible with the rest of the heating or cooling system.

Space conditioning equipment is routinely oversized for its application. Even when equipment was sized appropriately when it was installed, many buildings have undergone alterations, particularly energy efficiency retrofits, that have changed the heating and cooling characteristics of the building. It is reasonable to assume that the existing equipment sizing is more likely to be wrong than right, yet many equipment replacements use existing system sizing to size new equipment. Oversized equipment is less efficient, costs more to operate, costs more to install, provides lower levels of comfort and is less effective at de-humidification.

This measure explicitly requires that new equipment installed as part of an alteration be sized based on current building characteristics and loads, using current sizing standards. It provides an exception for situations where right-sizing equipment may create an incompatibility with the rest of the system (as can be the case with steam systems where boilers are sized to the radiators/convectors and not the building).

Add new text as follows:

C503.3.3 Controls. New heating and cooling equipment that are part of the *alteration* shall be provided with controls that comply with Section C403.4.

Exception: Systems with direct digital control of individual zones reporting to a central control panel

The IECC's requirements for HVAC controls only apply to new controls. As a result, new equipment is permitted to be controlled by existing controls that can fall far short of current code requirements. This section requires new equipment to have code-compliant requirements. The exception ensures that this section won't trigger the replacement of an entire central control system when only one portion of a central HVAC system is replaced.

Add new text as follows:

C503.3.4 Mechanical system acceptance testing. Where an *alteration* requires compliance with Section C403 or any of its subsections, mechanical systems that serve the *alteration* shall comply with Sections C408.2.2, C408.2.3 and C408.2.5.

Exceptions:

1. Mechanical systems and service water heater systems in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h (140.7 kW) cooling capacity and 600,000 Btu/h (175.8 kW) combined service water-heating and space-heating capacity.
2. Systems included in Section C403.5 that serve individual *dwelling units* and *sleeping units*.

Retro-commissioning and building re-tuning is generally accepted as one of the most cost-effecting energy efficiency measures for existing buildings. Average savings for building re-tuning is 12%, and studies have found savings as high as 52%. However, the IECC only requires acceptance testing of new portions of altered systems. This section requires an altered system to meet the relevant Sections of C408 for acceptance testing to ensure that the altered system is operating as intended.

Jurisdictions with Building Performance Standards (BPS) could replace the system capacity threshold with the BPS application threshold to align the BPS and the energy code more fully. Most BPS are triggered based on building size. Where this is the case, exception #1 would be replaced with the following:

1. *Buildings* with a *gross floor area* less than **[SQUARE FOOTAGE THRESHOLD OF THE BPS]**.

Where BPS or other policies have other triggers that may be important, exceptions can be further tailored.

Add new text as follows:

C503.3.5 Combustion heating equipment. New *combustion equipment* used for space heating that is part of the *alteration* shall comply with Section C501.6.

This ensures the installation of combustion space heating equipment that is both more efficient and less likely to worsen indoor air quality as required in Section C501.6.

Add new text as follows:

C503.3.5.1 Partial electrification of space heating. New and replacement *combustion equipment* used for space heating shall only be permitted to be installed as supplementary heating controlled in accordance with C501.7.

Where there are technical barriers to the full electrification of a building's space heating system, hybrid heat systems that combine heat pumps with combustion equipment are an effective strategy to reduce carbon emissions through improving the efficiency of the system and reducing onsite combustion emissions. In these systems, a heat pump serves most of the heating loads and the combustion equipment only operates when the heat pump is unable to keep up with heating demand, particularly during low outdoor temperatures. By prohibiting new combustion equipment except as supplementary heat, this section requires that existing combustion heating systems be converted to hybrid heat systems at equipment replacement.

Add new text as follows:

C503.3.6 Cooling equipment. New and replacement unitary air conditioners shall be electric heat pump equipment sized and configured to provide both space cooling and space heating. Any existing space heating systems that serve the same zone as the new equipment shall be configured as supplementary heat in accordance with Section C501.7.

Unitary air conditioners are essentially cooling-only heat pumps. AC replacement therefore provides a valuable opportunity to electrify or partially electrify space heating. This section requires that when AC equipment is replaced that it gets replaced with a heat pump that is configured to also provide heating. It also requires that any existing heating system be reconfigured as supplementary heating (see Section C501.7). This allows existing heating equipment to remain as a backup heating system, which is particularly important in buildings that are required to have emergency backup power for space heating and to ease the transition of some jurisdictions policies to all-electric renovations.

Add new text as follows:

C503.3.7 Cooking equipment. *Alterations* of spaces containing cooking equipment shall comply with Section C405.16.4 and this section.

C503.3.7.1 Ventilation. Where a space that is part of the *alteration* includes *combustion equipment* used for cooking, the cooking equipment shall be provided with exhaust equipment that complies with Sections 505.2, 505.3 and 505.5 of the *International Mechanical Code* and the following:

1. The exhaust fan shall be sized to provide no less than 150 CFM of intermittent airflow.
2. The cooking equipment shall be provided with makeup air at a rate approximately equal to the exhaust air rate. Such makeup air systems shall be equipped with a means of closure and shall be automatically controlled to start and operate simultaneously with the exhaust system.

Exception: *Commercial cooking appliances*

Gas cooking can release levels of pollutants that, if they were measured outside, would violate the Clean Air Act.[10] As a result, households with gas cooking have nearly three times the rate of treatment for asthma.[11] Outside of commercial cooking equipment, the mechanical code has only limited ventilation requirements for cooking, only requiring ventilation for the room and not the cooking appliance itself. It also does not differentiate between gas and electric cooking, despite the significantly higher level of pollutants from gas cooking.[12] Ventilation has not always been required in spaces with cooking, so many existing buildings do not have any mechanical ventilation at all. This provision improves the health and indoor air quality of buildings with gas cooking by requiring that spaces with combustion cooking that undergo an alteration be equipped with appropriate ventilation for gas cooking. It requires exhaust specifically at the cooking equipment, and not just the space. It also requires makeup air to ensure that the exhaust fans that can effectively exhaust contaminants. The ventilation rate has been set at 150CFM. This is higher than the requirement in the mechanical code in order to account for the higher concentration of pollutants in gas cooking. The exhaust rate is based on a proposal currently being considered for the Washington state code requirements for ventilation of gas cooking.

Add new text as follows:

C503.4.1 Service hot water system acceptance testing. Where an *alteration* requires compliance with Section C404 or any of its subsections, service hot water systems that serve the *alteration* shall comply with Sections C408.2.3 and C408.2.5.

[10] Gillis, J. and Nilles, B. (2019). "Your Gas Stove Is Bad for You and the Planet" The New York Times. www.nytimes.com/2019/05/01/opinion/climate-change-gas-electricity.html

[11] Jarvis et al. (1996) "Evaluation of asthma prescription measures and health system performance based on emergency department utilization." https://www.ncbi.nlm.nih.gov/pubmed/8618483

[12] D. Michanowicz, *et al. (2022)* "Home is Where the Pipeline Ends: Characterization of Volatile Organic Compounds Present in Natural Gas at the Point of the Residential End User." American Chemical Society.

Exceptions:

1. Service water heater systems in buildings where the total mechanical equipment capacity is less than 600,000 Btu/h (175.8 kW) combined service water-heating and space-heating capacity.

2. Systems included in Section C403.5 that serve individual dwelling units and sleeping units.

Retro-commissioning and building re-tuning is generally accepted as one of the most cost-effecting energy efficiency measures for existing buildings. Average savings for building re-tuning is 12%, and studies have found savings as high as 52%. However, the IECC only requires acceptance testing of new portions of altered systems. This section requires an altered system to meet the relevant Sections of C408 for acceptance testing to ensure that the altered system is operating as intended.

Jurisdictions with Building Performance Standards (BPS) could replace the system capacity threshold with the BPS application threshold instead to align the BPS and the energy code more fully. Most BPS are triggered based on building size. Where this is the case, exception #1 would be replaced with the following:

1. *Buildings* with a *gross floor area* less than **[SQUARE FOOTAGE THRESHOLD OF THE BPS]**.

Where BPS or other policies have other triggers that may be important, exceptions can be further tailored.

Add new text as follows:

C503.4.2 Service water heating equipment. New *combustion equipment* used for water heating that is part of the *alteration* shall comply with Section C501.6.

This requires the installation of combustion water heating equipment that is both more efficient and less likely to worsen indoor air quality as stipulated in C501.6

C503.4.2.1 Partial electrification of water heating equipment. Where *combustion equipment* is replaced in service water heating systems that utilize multiple boilers or water heaters, the cold-water inlet shall be connected to electric heat pump water heating equipment.

Many central water heating systems utilize multiple smaller pieces of water heating equipment—such as boilers—ganged together rather than a single larger piece of equipment. The failure of one piece of equipment in these systems provides an opportunity for partial electrification, particularly in buildings where space limitations may pose an obstacle to full electrification. In a partial electrification, the first piece of equipment in the series is replaced with a HPWH, shifting the maximum amount of the load possible to the HPWH.

This hybrid approach has multiple advantages. Boiler rooms often have waste heat that the HPWH can scavenge for water heating if the compressor is located in the same space. HPWHs are typically most efficient at heating cold water. All-electric systems typically require large storage tanks to provide a buffer against hot water demand. A hybrid system can rely on the gas water heating equipment to serve the peak, reducing space constraints issues.

Revise text as follows:

C503.5 Lighting and power systems. New lighting and power systems that are part of the *alteration* shall comply with Sections C405 and C408.

This minor change adds "power" to the title and scope of C503.5 so that decarbonization requirements related to electrical power can be added to the section.

Add new text as follows:

C503.5.1 Interior Lighting and Controls. New and existing lighting in the *alteration* shall be provided with *controls* that comply with Section C405.2.

Exceptions:

1. Where the size or configuration of an interior spaces is not altered
2. Where less than 50 percent of the luminaires in the space are replaced

The IECC's requirements for lighting controls only apply to new controls, even when substantial changes are made to a lighting system. In some older buildings, lighting may not have any controls at all. Lighting alterations therefore provide a valuable opportunity to introduce or upgrade lighting controls. This section requires lighting controls to meet current control requirements in certain, more substantial lighting retrofits.

Add new text as follows:

C503.5.2 Lighting acceptance testing. Where an *alteration* requires compliance with Section C405 or any of its subsections, the *registered design professional* or *approved agency* shall provide a report in accordance with section C408.3.2.3 demonstrating that the new and existing lighting control systems that serve the *alteration* have been tested in accordance with the following:

1. Verify that manual controls function.
2. Verify that occupancy and vacancy sensors automatically turn off the lights when spaces are unoccupied.
3. Verify that time switch controls are functioning, set to the correct day and time, programmed with scheduled off times, and provided with new backup batteries (where applicable).

While best practices for any lighting project include ensuring that lighting controls are operating properly, the code is only required new controls. New luminaires do not trigger control testing. This provision ensures that lighting controls will be receive basic functional testing whenever a lighting system is altered. This section is based on the acceptance testing requirements for lighting in Section C408 but has tailored for existing controls since some of those requirements are only appropriate for new buildings or new controls.

Add new text as follows:

C503.5.3 Combustion lighting. New gas lighting shall not be permitted to be added to the *building* or *building* site.

Gas lighting is not common but is still used for decorative purposes and allowed in most spaces by the fire code. This provision prohibits the installation of new gas lighting but has no impact on existing installations. There is a very limited application of gas lighting to establish historically accurate lighting that may be allowed under the accommodations for historic buildings in C501.5.

Add new text as follows:

C503.5.4 Electrical Service replacement. Where a *building* electrical service is replaced, the new electrical service shall include additional electrical capacity for the following as applicable:

1. Replacement of c*ombustion equipment* used for space heating with electric heat pump equipment or reverse-cycle chiller sized for the heating load of the *building* in accordance with C403.3.1 based on the existing *building* features
2. Replacement of c*ombustion equipment* used for water heating with electric heat pump equipment sized for the service hot water load of the *building*
3. Replacement of c*ombustion equipment* used for cooking with electric cooking equipment
4. Replacement of *combustion equipment* used for clothes drying with electric equipment
5. Renewable energy infrastructure in accordance with Section C405.13
6. Sufficient electric capacity for all parking facilities served by the electrical service to comply with Section C405.14 as a new parking facility. For the purposes of compliance with this section, sizing shall be permitted to be based on the capacity requirements of *EVSE spaces* served by an *ALMS.*
7. Energy storage infrastructure in accordance with Section C405.15.1

One potential significant cost in electrification retrofit projects is electrical service replacement. This section ensures that if a building service is being replaced that it must be sized for the full electrification of combustion equipment in the building—space heating, water heating, cooking and clothes drying—and for the addition of the onsite renewable systems, EVCI and energy storage in the future. "Electrification-sizing" the electrical service at the time of normal replacement is the most cost-effective approach to providing sufficient capacity for individual electrification retrofits. This will remove that barrier for future electrification retrofits.

Where jurisdictions are concerned with increased costs for these upgrades before the service may be put to full use, several options are available to modify the language. First, the addition of new construction quantities of EV charging capacity can be significant. Item 6 could be altered to only require electrical capacity for a smaller percentage of EV charging spaces. Second, exceptions can be specifically crafted to address the cost implications of such an upgrade.

Alternate add new text as follows:

> **Exception:** Where it has been demonstrated to the code official that compliance with this section will result in increased costs for electrical utility service be charged to the *building* owner that create a substantial burden, the electrical service size shall be permitted to be reduced to a size that will not increase utility infrastructure costs charged to the *building* owner.

This exception has been crafted to provide discretion to the code official that the cost is not simply increased but will show a substantial burden on the building owner. While this phrasing may be widely interpreted, it is suggested that jurisdictions adopting this exception work to tailor this language to be more prescriptive and appropriate to their local considerations.

Add new text as follows:

> **C503.5.5 Onsite renewable energy.** *Substantial improvements* and *alterations* that include *roof replacements* of more than 75 percent of the total roof area of the *building*, the *building* or *building* site shall comply with Section C405.13.
>
> > **Exception:** Where *roof replacements* do not alter the existing structure and it has been demonstrated to the *code official* that the existing structure cannot support the addition of solar panels.

This provision requires roof replacement projects to be paired with the installation of an onsite renewable energy system. There are different kinds of re-roofing projects. A roof recover only involves putting a new layer of roofing material on top of existing roofing. A roof replacement includes the removal of old roofing material, repair of exposed sheathing and installation of a new roof. Roof replacements provide an advantageous opportunity to install an onsite renewable energy system like a photovoltaic array. It exposes the roof structure under the roof cover, providing a clearer picture of the condition and configuration of the roof structure. It also presents a more cost-effective time to make structural improvements. It synchronizes the service life of the roof and the renewable energy system, eliminating concerns about the need to repair a roof under the system. Synchronizing roof replacement and rooftop renewable energy systems also reduces costs as both projects can often utilize the same onsite construction and safety equipment.

If there is pushback to using roof replacement as a code trigger for the onsite renewable energy system, substantial improvement could be used as a standalone trigger instead.

Alternate add new text as follows:

> **C503.5.5 Onsite renewable energy.** *Substantial improvements* shall comply with Section C405.13.

This would only require the renewable system when the building is undergoing a major renovation, as substantial improvement is defined, giving the opportunity for reinforcing structure to be added to accommodate future solar installations.

Add new text as follows:

C503.5.6 Electric vehicle charging infrastructure. Parking facilities serving *substantial improvements* shall comply with Section C405.14 as a new parking facility. All other *alterations* shall be provided with *electric vehicle* parking infrastructure in accordance with this section.

There are several building lifecycle events that support the addition of EV charging to existing sites or the addition of electrical infrastructure to support future EV charging retrofits. This top section requires that parking facilities that serve substantial improvements be retrofit to fully comply with the EV charging requirements for new construction. All other alterations are directed to the subsections that include targeted opportunistic electrical infrastructure upgrades during certain kinds of alterations.

C503.5.6.1 New parking facilities. New parking facilities and new parking spaces added to existing parking facilities shall comply with Section C405.14 based on the number of new parking spaces.

This section makes explicitly clear that new parking facilities are subject to the EVCI requirements of C405.14. This section may not be strictly necessary, but it ensures that there is no ambiguity in the code.

C503.5.6.2 Alterations to parking lots. Where more than 25% of the paving of a parking lot is removed, the affected parking spaces shall be *EV-capable spaces,* up to the total number of *EV-capable spaces* indicated in Table C405.14 based on the total number of parking spaces in the parking lot. Where the parking lot serves more than one occupancy type, the number of required *EV-capable spaces* shall be based on a weighted average of the different occupancies. *EV-capable spaces* shall be provided with raceway in accordance with the following:

1. Continuous between a junction box or outlet located within 3 feet (914 mm) of the parking space and an electrical panel serving the area of the parking space or a space containing an electrical panel serving the area of the parking space.
2. The raceway shall be sized and rated to accommodate a 40-amp, 208/240-volt branch circuit and have a minimum nominal trade size of 1 inch.
3. Both ends of the raceway shall have labels stating “For future electric vehicle charging”

Parking lot repaving is a cost effective time to undertake the retrenching of a parking lot that EVCI retrofits often require. The paving material is already being removed and replaced, which limits the cost of retrofitting a parking lot to only the cost of the retrenching. This section leverages these parking lot repaving projects to introduce raceways for EV-Capable spaces. It sets a minimum threshold for paving of 25% to ensure that the requirement is not triggered by simple repair projects. It also only includes requirements for the raceway component of EV-Capable spaces, and not other components such as panel capacity or physical space since those are not generally part of the scope of a re-paving project. As such, it only requires the raceways to get into proximity of the panel and not connect as is required in new construction. The section also sets a cap for the number of spaces that need to be provided with this raceway, so that a retrofit project would not need to provide more EV-Capable spaces than are required of new construction in C405.14.

C503.5.6.3 Alterations to parking structure electrical service. Where the electrical service serving a parking garage is replaced, the electrical service shall be sized to provide capacity for the parking garage to meet the requirements of Section C405.14 as a new parking facility. For the purposes of compliance with this section, sizing shall be permitted to be based on the capacity requirements of *EVSE spaces* served by an *ALMS*.

Parking garages sometimes have independent electrical service connections and may not be captured by the service upgrade requirements in Section C403.5.4 above. This ensures that parking garage electrical service replacements are sized to accommodate an EV charging retrofit.

Add new text as follows:

C503.6 Additional energy efficiency credits. *Substantial energy alterations* shall comply with Sections C506 in accordance with this section. *All-electric buildings* shall achieve a total of 5 credits and *mixed-fuel buildings* shall achieve a total of 10 credits.

Exceptions:

1. *Alterations* that are part of an *addition* complying with section C502.
2. *Alterations* that comply with Section C407.
3. *Alterations* that comply with Section C503.1.2.

This section works with the new section C506 (see below for more) to bring additional energy efficiency through implementing the additional efficiency credits in C406 in substantial energy alterations. Substantial energy alterations are defined in a way that they are projects that impact multiple building energy systems, which creates multiple opportunities for acquiring credits from C406. The section requires 5 credits in alterations to all-electric buildings—half of the credit target for new construction—and 10 credits for mixed-fuel buildings. It includes a series of important exceptions:

1. *An exception that reflects the allowance for alterations and additions to comply together under Section C502 when they are part of the same project (see Section C502.6 above).*
2. *An exception for buildings that model using Section C407.*
3. *An exception for substantial improvements that comply with the EUI requirements of C503.1.2.*

C505 CHANGE OF OCCUPANCY

Add new text as follows:

C505.1.1 Combustion equipment. New *combustion equipment* shall not be installed in a space undergoing a change of occupancy.

This provision will result in the partial electrification of a change of occupancy by prohibiting the installation of new combustion equipment. Existing combustion equipment is allowed to remain. This would build on whatever electrification provisions the jurisdiction chooses for the alterations section and should be seen as going beyond the requirements for alterations.

Add new text as follows:

C505.2 Additional energy efficiency packages for changes of occupancy with combustion equipment. Where a space being converted from one occupancy type to another occupancy type is served by *combustion equipment,* it shall achieve 5 credits in accordance with Section C406 in addition to the credits required by Section C406.1.

Exception: *Alterations* complying with Section C503.1.2 or C503.6.

Many changes of occupancy are subject to full code compliance, which includes section C406. This section requires that changes of occupancy that are served by combustion equipment achieve an additional 5 credits from C406. The provision includes an exception for mixed-fuel alterations that are already required to comply with the EUI requirements of C503.1.2 or the additional points required by Section C503.6.

C506 ADDITIONAL EFFICIENCY

Add new text as follows:

SECTION C506
ADDITIONAL EFFICIENCY CREDITS

C506.1 General. Where required by Section C502 or C503, credits shall be achieved from Tables C406.1(1) through C406.1 (5) where the table is selected based on the use group of the building and from credit calculations as specified in relevant subsections of Section C406. 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 from the tables of 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 space-conditioning 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. Where not required by Section C405.12, include an energy monitoring system in accordance with Section C406.10.
10. Where not required by Section C403.2.3, include a fault detection and diagnostics (FDD) system in accordance with Section C406.11.
11. Efficient kitchen equipment in accordance with Section C406.12.

This new section C506 creates a framework to use the additional efficiency credits from Section C406 in alterations and additions been leveraged to achieve additional energy savings in the IECC in a very flexible way. Over the last several code cycles, Section C406 has b C506.1 serves the same role as C406.1, directing projects how to achieve credits from the various credit options in sections C406.2-12.

Unlike Section C406, the credit target is not set in this section. Those targets are set in the companion Sections C502.6 for additions and C503.6 for alterations. It makes sense to apply Section C406 to all new buildings, but not all alterations and additions. Less substantial additions and alterations and certain other existing projects with limited scopes are less likely to be able to accommodate a reasonable number of credit options to meet a credit target. By setting the targets in Sections C502 and C503, the credit targets can be selectively applied to only those projects where it is reasonable to incorporate Section C406 credit options as a requirement. It also allows for a clear distinction between the unique exceptions for additions and alterations.

Chapter 6 – Referenced Standards

Add new standard as follows:

ASHRAE

100---2018: Energy Efficiency in Existing Buildings

C503.1.2


CAUTION
SLIPPERY
WHEN WET

Existing Building Decarbonization Code:

Residential Overlay

All-Electric

Residential Overlay (All-Electric)

Chapter 1 – Scope and Application

R101 SCOPE AND GENERAL REQUIREMENTS

Revise text as follows:

> **R101.3 Intent.** This code shall regulate the design, ~~and~~ construction, repair, alteration, change of occupancy, and additions of new and existing buildings for the ~~effective use and conservation~~ reduction of greenhouse gas emissions and for the efficient production, use and storage of energy over the useful life of each building. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. This code is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.

Intent has been modified to push beyond simply the inclusion of considerations of greenhouse gas emissions and production and storage of energy, to clearly emphasize the intent of the code to regulate existing buildings.

Chapter 2 – Definitions

R202 GENERAL DEFINITIONS

Add new definitions as follows:

> **ELECTRIC EQUIPMENT.** Any equipment or *appliance* used for space heating, *service water heating*, cooking, clothes drying, or lighting that uses electricity as its sole source of energy.

This new definition for electric equipment is a parallel of the definition of "combustion equipment" introduced in the Building Decarbonization Code.

> **ENERGY USE INTENSITY (EUI).** An expression of *building* energy use in terms of net energy divided by *gross floor area*.

EUI is an energy metric used in some performance-based energy policies, including many building performance standards (BPS). It is included here to allow provisions of the Existing Building Decarbonization Code integrate with BPSs. EUI is not currently defined in the suite of I-Codes, so it is added here. If a jurisdiction already has a formal definition of EUI, particularly in a building performance standard, then that definition should be integrated here as well.

> **SUBSTANTIAL ENERGY ALTERATION.** An *alteration* that includes replacement of two or more of the following:
>
> 1. 50% or more of the area of interior wall-covering material of the *building thermal envelope* or *fenestration.*
> 2. 50% or more of the area of the exterior wall-covering material of the *building thermal envelope* or *fenestration.*
> 3. Space-conditioning equipment constituting 50% or more of the total input capacity of the space heating or space cooling equipment serving the *building*.

4. Water-heating equipment constituting 50% of more of the total input capacity of all the water heating equipment serving the *building.*

5. 50% or more of the luminaires in the *building*

This new definition for substantial energy alteration is intended to capture projects that have the opportunity to greatly increase efficiency by nature of their scope and clarify when certain requirements related to the energy use of the building are triggered. By defining such scopes, confusion around generic terms like major renovations and applicability of work classifications in the IEBC can be removed. Other terms that define large-scale alterations such as Level III alteration or substantial improvement are not specific to the energy systems. An alteration could cross their thresholds without having a significant impact on the energy systems since they are based on metrics such as monetary value and reconfiguration of spaces. Similarly, an alteration that has significant impact on the energy systems of the building may not cross these other thresholds.

SUBSTANTIAL IMPROVEMENT. Any *repair*, reconstruction, rehabilitation, *alteration*, *addition* or other improvement of a building or structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the improvement or repair is started. If the structure has sustained *substantial damage*, any repairs are considered substantial improvement regardless of the actual *repair* work performed. The term does not, however, include either:

1. Any project for improvement of a *building* required to correct existing health, sanitary or safety code violations identified by the *building official* and that are the minimum necessary to assure safe living conditions.

2. Any *alteration* of a *historic structure* provided that the *alteration* will not preclude the structure's continued designation as a historic structure.

The definition of substantial improvement comes from the IBC and IEBC. The term generally aligns with vernacular use of "major renovation," which is not defined in code. It is used as a threshold for when certain flood protection requirements are triggered for existing building alterations. Since it is based on the monetary value of the alteration, it sets a useful threshold for introducing additional efficiency and decarbonization requirements.

In addition, the Existing Building Decarbonization Code leverages definitions from the Building Decarbonization Code including:

ALL-ELECTRIC BUILDING
APPLIANCE
COMBUSTION EQUIPMENT
COMMERCIAL COOKING APPLIANCES
ELECTRIC VEHICLE (EV)
EQUIPMENT
EV-CAPABLE SPACE
FUEL GAS

The use of these terms throughout assumes that adopting jurisdictions will adopt the Building Decarbonization Code alongside this existing building overlay.

Chapter 5 – Existing Buildings

R501 GENERAL

Add new text as follows:

R501.7 Requirements for combustion equipment. Where existing *combustion equipment* remains following an *addition, alteration* and change of occupancy the building shall comply with this section.

This section creates an additional set of requirements for combustion equipment when it is allowed to be installed in existing buildings. These requirements are intended to generally improve the emissions of the equipment and the interior and exterior air quality.

R501.7.1 Phase out documentation. Permit applications for projects retaining *combustion equipment* serving space heating and water heating in control of the applicant shall include a plan for the future replacement of the *combustion equipment* with electric equipment. The documentation shall include the following:

1. Calculations of the electric load required by the replacement electric equipment and of the available electric capacity of the *building*.
2. Identification of any existing onsite electrical infrastructure, including but not limited to transformers, switchgear, electrical panels and conductors, that will need to be altered to accommodate the replacement electric equipment.
3. Floor plans identifying any spaces that will need to be reconfigured to accommodate the replacement electric equipment.\

Exception: Owner-occupied single family, two-family, and townhouses.

Where buildings are retaining combustion equipment, building owners should understand the need for long term phase out and switch to electric equipment to avoid potential abandoned assets. The primary focus of this section is on multifamily and rental units, with a specific exception for owner occupied detached and attached homes. Jurisdictions could also expand this section to include specifics related to other policies such as appliance emission standards or replacement policies targeting specific dates for combustion equipment phase out.

R501.7.2 Fuel gas pipe testing. All *fuel gas* piping serving *combustion equipment* shall be tested in accordance with Section 406 of the *International Fuel Gas Code*.

Exceptions:

1. For the purposes of demonstrating compliance with this section, unexposed pipe joints and welds shall not be required to be exposed for examination during the test.
2. Where it has been demonstrated to the code official that the *fuel gas* piping has met the requirements of this section within the previous five years.
3. Where compliance with this section would require interruption of *fuel gas* supply to *combustion equipment* that serves other tenant spaces or other *dwelling units*, provided all exposed pipe joints of the piping subject to the requirements of this

section have been inspected for leaks by means of an *approved* gas detector, a noncorrosive leak detection fluid or other *approved* leak detection method once the equipment has been placed in operation.

Gas piping degrades over time, creating the possibility of natural gas leakage. Even though the natural gas is treated with mercaptan to give it that rotten egg smell, small leaks may go undetected, particularly in buildings where pipes are not exposed and older buildings that are likely to have envelopes that are less tight than newer construction. According to US DOE, building leakage accounts for nearly 27% of the natural gas leakage in the US natural gas distribution system.[13] Leaking natural gas represents a loss in energy, and even small leaks can add up over long periods of time. Additionally, natural gas is also a potent Green House Gas, with over 86 times the global warming potential of CO_2 on a short-term basis.

The installation of new gas equipment provides an ideal time to test gas pipe leakage. Contractors are already on site and the gas will often be partially or fully turned off for the new equipment installation. Additionally, new equipment installation can disturb and inflict additional stresses on existing piping, creating opportunities for the formation of new leaks where existing natural gas piping has weakened but not previously failed

This provision requires that existing fuel gas piping be tested like a new installation according the International Fuel Gas Code (IFGC). It includes targeted exceptions for elements of the IFGC testing methodology that is not appropriate for existing buildings. It also includes an exception for piping that has been tested in the last five years in order to prevent repeated testing. Finally, it includes an exception to ensure that testing requirements don't necessitate other tenants losing service, which could be a considerable in larger buildings with multiple tenant spaces. In those cases, it only requires visual inspection of the exposed joints with a testing fluid.

Add new text as follows:

R501.8 Heat pump supplementary combustion equipment. Heat pumps having *combustion equipment* or electric resistance equipment for supplementary space or water heating shall have controls that limit supplemental heat operation to only those times when one of the following applies:

1. The heat pump is operating in defrost mode.
2. The vapor compression cycle malfunctions.
3. For space heating systems, the thermostat malfunctions.
4. For space heating systems, the vapor compression cycle cannot provide the necessary heating energy to satisfy the thermostat setting.
5. For water heating, the heat pump water heater cannot maintain an output water temperature of at least 120°F (49°C)

New supplementary space and water heating systems for heat pump equipment shall not be permitted to have a heating input capacity greater than the heating input capacity of the heat pump equipment.

[13] "Natural Gas Infrastructure Modernization Programs at Local Distribution Companies: Key Issues and Considerations." US DOE, Office of Energy Policy and Systems Analysis. Washington DC, 2017.

Supplementary heating systems are effectively back-up systems intended to provide heating if the primary heat pump system fails, if the operating conditions (heating demand, temperature around the heat pump compressor, etc.) exceed the ability of the heat pump to effectively, or cost-effectively, provide heating. Designers sometimes utilize "hybrid heat" systems where combustion equipment provides the supplementary heat to address these situations.

This new section creates a version of the supplementary heating equipment control requirements that is customized for existing buildings. It addresses both space and water heating applications, and ensures that any combustion heating equipment used for supplementary heat is only used when the heat pump system is unable to fully meet the buildings heating needs (the language in C403 already addresses electric resistance supplementary heat).

R502 ADDITIONS

Revise text as follows:

> **R502.1 General.** *Additions* to an existing *building*, *building* system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portion of the existing building or building system to comply with this code. *Additions* shall not create an unsafe or hazardous condition or overload existing building systems. An *addition* shall be deemed to comply with this code where the addition alone complies, where the existing building and addition comply with this code as a single building, or where the building with the *addition* does not use more energy, than the existing building. *Additions* shall be in accordance with Sections R502.2 ~~or R502.3~~ through R502.6.

These edits implement the restructuring discussed above in the introduction. It moves the prescriptive compliance language from R502.3 here. The requirement in R502.1 for additions to meet the requirements for new construction mean that additions will be subject to the requirements in the Building Decarbonization Code for electrification.

Add new text as follows:

> **R502.1.1 Combustion equipment**. *Additions* shall not be permitted to contain *combustion equipment* and new equipment installed to serve *additions* shall be *electric equipment*.

This section requires that new equipment installed in and to serve additions be all-electric Where additions are large enough to require new equipment, it is critical that the new equipment be electric equipment. This provision would allow for existing combustion equipment to be employed as back up if deemed necessary and be extended from the existing building.

> **R502.1.1.1 Energy consumption of existing combustion equipment**. Where systems with *combustion equipment* are extended into an addition, the existing *building* and addition together shall use no more fossil fuel energy than the existing *building* alone.

Additions, particularly smaller ones, often don't have stand-alone systems; ductwork and hot water piping is extended into the addition to provide space conditioning and water heating. When these systems utilize combustion equipment, the expanded loads will result in increased use of total combustion energy. This provision allows systems with combustion equipment to be extended into additions but requires that this extension doesn't result in an increase in combustion energy. In order to extend a system with combustion equipment into an addition, the efficiency of the existing building would need to be improved in order to offset the increased consumption from the addition.

Revise text as follows:

~~**R502.2 Change in space conditioning.** Any unconditioned or low-energy space that is altered to become conditioned space shall be required to be brought into full compliance with this code.~~

~~**Exceptions:**~~

1. ~~Where the simulated performance option in Section R405 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110 percent of the annual energy cost otherwise allowed by Section R405.2.~~
2. ~~Where the Total UA, as determined in Section R402.1.5, of the existing building and the addition, and any alterations that are part of the project, is less than or equal to the Total UA generated for the existing building.~~
3. ~~Where complying in accordance with Section R405 and the annual energy cost or energy use of the addition and the existing building, and any alterations that are part of the project, is less than or equal to the annual energy cost of the existing building. The addition and any alterations that are part of the project shall comply with Section R405 in its entirety.~~

This content is located in the additions section in the model code (Section C502.2). As part of the restructuring needed for this overlay, it has been relocated here since it describes an alteration project. The requirements have not been changed, but the relocation will improve the usability and enforceability of the code.

Revise text as follows:

~~**R502.3 Prescriptive compliance.** *Additions* shall comply with Sections R502.3.1 through R502.3.4.~~

R502.~~3.1~~2 Building envelope.

These edits implement the restructuring discussed above in the introduction. The content of the subsections is unaffected.

Revise text as follows:

> ~~**R502.3.2**~~ **R502.3 Heating and cooling systems.** New heating and cooling systems installed as part of an addition and serving multiple *dwelling units* shall comply with Section C502.3. All other heating and cooling systems ~~HVAC ducts newly~~ installed as part of an *addition* shall comply with Section R403 and this section.

Previously this section only provided specific guidance on ductwork. The revision allows this section to more easily accommodate additional items around heating and cooling systems. It also directs central systems that serve multiple dwelling units to the commercial section to ensure that they are subject to all-electric requirements that are appropriate for larger, central systems.

Add new text as follows:

> **R502.3.3 Space heating equipment.** New space heating equipment in *additions* shall be electric heat pump equipment. Where existing systems with *combustion equipment* are extended to serve the addition, they shall comply with Section R501.8
>
> **Exceptions:**
> 1. Electric resistance supplementary heat in accordance with R501.8
> 2. Up to 2kW of electric resistance heat per *dwelling unit*

Requiring space heating installed during an addition to be electric will reduce carbon emissions and improve air quality in homes. Heat pumps have been shown to be technically effective in all climate zones, and cold-climate heat pump technology continues to improve, providing heating with a COP of more than 3 above 5°F.[14] Exceptions are included for electric resistance supplementary heat and for up to 2kW of electric resistance heat. The 2kW budget will allow for electric resistance spot heating and for dwelling units that are very small or very well-insulated where there may not be appropriate heat pump options. The provision allows an existing combustion system can be extended to serve the addition, but it must be controlled as supplementary heat, and it can't be new combustion equipment.

Add new text as follows:

> **R502.3.4 Ductwork.** HVAC ducts newly installed as part of an addition shall comply with Section R403.
>
> **Exception:** Where ducts from an existing heating and cooling system are extended into an addition and the capacity of the heating or cooling equipment is not increased, Sections R403.3.5 and R403.3.6 shall not be required.

[14] "Achieve Comfort and Reliable Performance with Cold-Climate Heat Pumps." *Zero Energy Project*, 6 Feb. 2020, https://zeroenergyproject.org/2020/01/22/achieve-comfort-and-reliable-performance-with-cold-climate-heat-pumps/#:~:text=The%20Benefits%20of%20Heat%20Pumps%20in%20Cold%20Climates&text=Combustion%2Dbased%20heating%20systems%20such,3%20at%205%C2%B0F.

Currently, ducts that extend an existing system into an addition are exempt from all of the requirements for new ductwork, including the requirements for duct construction. While it can be reasonable to exempt these ducts from the duct testing requirements, all of the other requirements should still apply. This modification closes that loophole. It does provide an exemption from duct testing, but only when the system extension doesn't increase the equipment size.

Revise text as follows:

R502.~~3.3~~4 Service hot water systems. New service hot water systems that are part of the addition and serve multiple *dwelling units* shall comply with Section C502.4. New service hot water systems that are part of the *addition* and serve individual *dwelling units* shall comply with Section R403.5 and this section.

These edits implement the restructuring discussed above in the introduction. It also directs central systems that serve multiple dwelling units to the commercial section to ensure that they are subject to all-electric requirements that are appropriate for larger, central systems.

Add new text as follows:

R502.4.1 Service hot water equipment replacement. Where service hot water systems are replaced, new equipment shall be heat pump equipment.

Exceptions:

1. Electric resistance elements integrated into heat pump equipment.
2. Electric storage water heaters with a rated storage volume of less than 20 gallons and a rated input of less than 5kW.
3. Electric resistance equipment where not less than 75 percent of the annual service water-heating requirement is provided by an on-site renewable energy system not used to meet any other provision of this code.
4. Where it has been demonstrated to the *code official* that the dimensions of the space in which the water heater is located cannot accommodate a heat pump water heater sized to serve the hot water load of the *dwelling unit*.

Heat pump water heaters, often installed in both conditioned and semi-conditioned spaces such as basements and garages, can provide service water heating with efficiencies greater than 300%, thus reducing the energy use of service water heating to less than 1/3 of the energy required by gas or electric resistance water heaters. Buildings that cannot accommodate heat pump water heaters because of insufficient space are exempt from this requirement. Buildings with small electric storage water heaters that cannot be replaced by current heat pump water heaters are also exempt.

If a jurisdiction finds that requiring HPWHs is not a viable option, this section can be replaced with an alternative that only requires electrification (below), which would allow electric resistance options.

Alternate add new text as follows:

> **R502.4.1 Service hot water equipment replacement.** Where service hot water systems are replaced, new equipment shall be electric equipment.

Although such an approach would be more flexible, it also allows for electric resistance equipment, which can have serious implications for carbon emissions and energy affordability. This approach should only be chosen in jurisdictions served by an electricity supply that has a carbon intensity comparable to onsite natural gas combustion. Additionally, the utility cost implications should be analyzed in order to ensure this requirement will not have an unacceptably adverse effect on utility bills. Replacement of combustion equipment with electric resistance equipment will also exacerbate the building electrical capacity issues for electrification.

Revise text as follows:

> ~~**R502.3.4**~~ **R502.5 Lighting and power.** New lighting and electrical power systems that are part of the addition shall comply with this section and Section R404~~.1~~.

Previously this section only included requirements for lighting. The edit changes the scope of the section to include power, aligning it with the commercial section of the code and allowing it to accommodate additional requirements related to power such as EV charging, electrical service replacements, etc.

Add new text as follows:

> **R502.5.1 Lighting equipment.** New interior and exterior lighting serving additions shall be electric. Fuel gas lighting systems shall be prohibited.

While the use of gas lighting is nearly extinct for both indoor and outdoor new construction uses, gas lamps remain a nostalgic feature in some residential buildings. Similar to the new construction language, it is critical to ensure that the adoption of this overlay prohibits new installations of gas lighting and the gas infrastructure they require.

Add new text as follows:

> **R502.5.1 Electric vehicle charging infrastructure.** New parking facilities, new parking spaces added to existing parking facilities and new attached and detached garages shall comply with Section R404.5.

It is critical to install EV charging infrastructure when construction provides an opportunity. R404.5 requires one and two-family dwellings and townhouses to have one parking space with an EV Ready space that is sized to accommodate the most common EVSE on the market. The requirements for EV charging infrastructure for multifamily buildings are referenced to the commercial requirements as those are more appropriate for EV charging in parking lots.

Add new text as follows:

R502.5.2 Renewable energy infrastructure. Additions shall comply with the requirements of Section R502.5.2.1 or R502.5.2.2.

Exception: Additions where the new roof area is less than less than 600 square feet (55 m2) of roof area oriented between 110 degrees and 270 degrees of true north.

R502.5.2.1 One- and two- family dwellings and townhouses. Where an *addition* with a roof is added, the *dwelling unit* shall comply with Section R404.4.

R502.5.2.2 Group R occupancies. Where an *addition* with a roof is added to an R-2, R-3 or R-4 occupancy, the *building* shall comply with Section C502.5.3.

The requirements in the Building Decarbonization Code for renewable energy systems reference buildings and so don't capture additions, as they are not stand-alone buildings. This section uses the addition to trigger the requirements, ensuring that new additions with roofs also have solar-ready zones or are provided with solar generation in accordance with the occupancy type, referring R-2, R-3, and R-4 occupancies to the commercial section for additions. It also draws the distinction between the building and the dwelling unit, as two-family or townhouse structures contain several units within the same building, this measure is targeted at the individual unit level. It includes an exception for additions with less than 600 sf of roof area since they are not large enough for the solar-ready zone required in the Building Decarbonization Code.

Add new text as follows:

R502.5.3 Energy storage infrastructure. Additions with new attached or detached garages shall comply with Section R404.6.

New attached and detached garages provide an ideal location for energy storage systems in residential construction. This provision requires energy storage readiness that meets the requirements of the Building Decarbonization Code be include in these projects.

Add new text as follows:

R502.6 Additional Efficiency Packages. *Additions* shall comply with Sections R506.1. *All-electric buildings* shall be required to select one package and *mixed-fuel buildings* shall be required to select two packages. *Alterations* to the existing building that are not part of the *addition*, but permitted with the *addition*, shall be permitted to be used to achieve this requirement.

Exceptions:

1. *Additions* that increase the *building*'s total *conditioned floor area* by less than 25 percent.
2. *Additions* that do not include the addition or replacement of equipment covered by Sections R403.5 or R403.7.

3. *Additions* that do not contain *conditioned space*.
4. Where the *addition* alone or the existing building and *addition* together comply with Section R405 or R406.

There are many opportunities to cost-effectively improve the efficiency, comfort and indoor air quality of a home during an alteration. This section works with the new section R506 (see below for more) to bring additional energy efficiency through implementing the additional efficiency packages in R408 in "substantial" additions. The section requires one package in most additions just like new buildings. It also includes a series of important exceptions for additions that may not be able to reasonably implement an additional efficiency package due to limited scope and for additions that comply through sections R405 or R406.

All-electric homes typically use less energy when compared to mixed-fuel homes. By requiring additions served by combustion equipment to select two energy efficiency packages, this measure seeks to encourage electrification and improve the efficiency of existing buildings. Language is identical between the all-electric and mixed-fuel sections to recognize the variety of existing building configurations and systems, even under an "all-electric" application, the electrification at strategic points may not individually result in an all-electric building.

R503 ALTERATIONS

Revise text as follows:

R503.1 General. *Alterations* to any *building* or structure shall comply with the requirements of the code for new construction, without requiring the unaltered portions of the existing *building* or *building* system to comply with this code. *Alterations* shall be such that the existing *building* or structure is not less conforming to the provisions of this code than the existing *building* or structure was prior to the *alteration*.

Alterations shall not create an unsafe or hazardous condition or overload existing *building* systems. *Alterations* shall be such that the existing *building* or structure does not use more energy than the existing *building* or structure prior to the alteration. *Alterations* to existing *buildings* shall comply with Sections ~~R503.1.1 through R503.1.4~~ R503.2 through R503.6.

These edits implement the restructuring discussed above in Section R501. The new referenced sections are the subsections dedicated to building systems and additional efficiency.

Add new text as follows:

R503.1.1 Change in space conditioning. Any unconditioned or low-energy space that is altered to become conditioned space shall be required to be brought into full compliance with this code.

Exceptions:

1. Where the simulated performance option in Section R405 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110 percent of the annual energy cost otherwise allowed by Section R405.2.

2. Where the Total UA, as determined in Section R402.1.5, of the existing building and the addition, and any alterations that are part of the project, is less than or equal to the Total UA generated for the existing building.

3. Where complying in accordance with Section R405 and the annual energy cost or energy use of the addition and the existing building, and any alterations that are part of the project, is less than or equal to the annual energy cost of the existing building. The addition and any alterations that are part of the project shall comply with Section R405 in its entirety.

This content is located in the additions section in the model code (Section R502.2). As part of the restructuring needed for this overlay, it has been relocated here since it describes an alteration project. The requirements have not been changed, but the relocation will improve the usability and enforceability of the code.

R503.1.1.1 Garages and basements. Garages and basements in single family and two-family residential buildings and townhouses converted to conditioned space, the space shall comply with R501.7. Where the space contains water heating equipment, the space shall comply Section R404.7.2.

A common alteration and space conditioning change in residential construction is the conversion of a garage or basement space. This is also a location that most often contains water heating equipment. By implementing electrification readiness requirements at the time of that renovation, costs for replacement of combustion water heating equipment will be greatly reduced in the future. The explicit link back to combustion equipment requirement will ensure safety for residents and families to spend longer periods of time in those spaces.

Add new text as follows:

R503.1.2 Substantial improvement. Buildings undergoing *substantial improvements* shall be *all-electric buildings*, comply with R402.4 and one of the following:

1. For each dwelling unit in the project, achieve an ERI score of 80 or below, without on-site renewable energy included in accordance with RESNET/ICC 301.

2. Meet a site EUI by building type in accordance with ASHRAE Standard 100 Table 7-2a.

Substantial improvements are extensive alterations that have significant scope, large project budgets relative to the value of the building and are more likely to already include major systems that could include combustion equipment. The larger scopes and budgets of substantial improvements are likely to occur infrequently within a building lifecycle and create the best opportunity to significantly increase efficiency and electrify the full building. In jurisdictions where requiring substantial improvements to be all-electric is not feasible, substantial alterations can be require to be electric ready. See Mixed Fuel Section R503.1.3.

Add new text as follows:

> **R503.1.3 Combustion equipment**. New *combustion equipment* and plumbing for *combustion equipment* shall not be permitted to be installed in *alterations*.

This requirement prohibits the installation of new combustion equipment in alterations but does not require the full removal of existing combustion equipment.

Add new text as follows:

> **R503.1.4 Building Performance Standards.** Where the *building* is subject to **[OFFICIAL NAME OF THE LOCAL BUILDING PERFORMANCE STANDARD]**, the permit application for the *alteration* shall include a report that includes the following:
>
> 1. The current or last reported EUI of the *building*
> 2. The performance targets from **[NAME OF THE LOCAL BUILDING PERFORMANCE STANDARD]** that will be applicable to the *building* within five years from the date of the permit application
>
> Where the current or last reported EUI exceeds the performance targets that will be applicable in the next five years, the report shall also include a plan describing how the *building* will be brought into compliance. The report shall include energy efficiency upgrades and operational improvements that will be made to the *building* before the applicable target goes into effect and the impact of the alteration under permit review.
>
> **Exception:** Where the total *building* performance of the *building* with the *alteration* determined in accordance with Section C407 demonstrates compliance with the performance targets identified in the report required by this section.

Some jurisdictions include low-rise multifamily in their Building Performance Standard (BPS) because the BPS application is based on overall square footage of buildings, unrelated to building height which is used in the energy code. In these jurisdictions, it is important that all alterations support and reinforce the BPS. Alterations that are undertaken without consideration of impending BPS performance targets represent a significant missed opportunity. This section requires that consideration by creating a requirement that permit applications include the building's current performance and any BPS performance targets that will be in effect in the next 5 years, the typical compliance cycle for US-based BPS. Where a building does not already meet those targets, it will be required to also submit what is effectively a plan for compliance with the BPS. This will ensure that project teams are thinking about a proposed alteration within the larger context of what will be required to meet up-coming BPS requirements. The exception allows the compliance path to be avoided when the alteration is complying by performance modeling and that modeling shows that the alteration will bring the building into compliance with the BPS performance target.

It may be necessary to modify the language in this provision to align with the terminology that is used in the official BPS regulation to maximize correlation and usability. For example, the provision can be modified to align with a carbon-based BPS by replacing "EUI" with "CUI" throughout and adding the following definition:

CARBON USE INTENSITY (CUI). An expression of *building* carbon emissions in terms of the equivalent carbon emissions of the net energy divided by *gross floor area*.

This definition defines a carbon use intensity that parallels the definition of EUI. It is a carbon metric where carbon emissions are divided by gross floor area in order to compare the emissions of different buildings or assess the performance a building's carbon emissions against a target.

Renumber as follows:

~~R503.1.1~~ R503.2 Building envelope.

~~R503.1.1.1~~ R503.2.1 Replacement fenestration.

These edits implement the restructuring discussed above in Section R501. The content of the sections is unaffected.

Revise text as follows:

~~R503.1.2~~R503.3 Heating and cooling systems. New heating, and cooling systems ~~HVAC ducts newly~~ installed as part of an alteration shall comply with Section R403 and this section. *Alterations* to heating, cooling and duct systems shall comply with this section.

New HVAC and ducts in an alteration must meet the requirements for new construction of Section R403 along with specific requirements in this section tailored for decarbonization of existing buildings. Work that is purely alteration to HVAC is directed to follow specific language in this section.

Add new text as follows:

R503.3.1 Ducts. Ducts and air handlers that are a part of the *alteration* shall be installed in accordance with this section.

R503.3.1.1 New ducts. Newly installed ducts and air handlers shall be installed in accordance with R403.3.

Exception. Where the capacity of the heating or cooling equipment is not increased Sections R403.3.5 and R403.3.6 shall not be required.

R503.3.1.2 Existing ducts. Existing duct systems shall be tested in accordance with Section R403.3.5 and shall have a total leakage less than or equal to 12.0 cubic feet per minute (339.9 L/min) per 100 square feet (9.29 m2) of conditioned floor area.

Exceptions:

1. Where the total length of all ducts in the system is increased by less than 25%.
2. Where less than 25% of the registers, and less than 25% of the total length of the ducts in the system are relocated.

During an alteration, building owners often re-use and extensively alter their ductwork without testing and meeting any kind of air-leakage requirement. Because the standards for duct construction in the IECC have changed dramatically over time, existing duct systems often have substantial leakage far beyond what is allowed in new construction. This section requires that existing ductwork that is substantially altered will have to meet a maximum leakage requirement. The leakage criterion is set at 3x the requirement for new construction, so the altered ductwork would not be required to be as tight as new construction. Existing ductwork that does not receive substantial alteration is unaffected by this section.

Add new text as follows:

> **R503.3.2 System Sizing.** New heating and cooling equipment that is part of an *alteration* shall be sized in accordance with Section R403.7 based on the existing *building* features as modified by the *alteration.*
>
> > **Exception:** Where it has been demonstrated to the *code official* that compliance with this section would result in heating or cooling equipment that is incompatible with the remaining portions of the existing heating or cooling system.

Oversized equipment results in increased energy use, decreased occupant comfort and increased wear-and-tear on equipment. Oversized equipment is also less effective at dehumidification. Like-for-like equipment replacement are particularly vulnerable to oversizing. This requirement ensures that new heating and cooling equipment installed in existing buildings is properly sized based on the buildings features as modified by the alteration. It provides an exception for situations where right-sizing equipment may create an incompatibility with the rest of the system (as can be the case with steam systems where boilers are sized to the radiators/convectors and not the building).

Add new text as follows:

> **R503.3.3 Controls.** New heating and cooling equipment that are part of the *alteration* shall be provided with controls that comply with Section R403.1 and Section R403.2.

Controls are a vital component of effective and efficient operation of heating and cooling systems and older controls that do not meet current code requirements significantly hamper efficiency in buildings. This section requires that new heating and cooling equipment installed as part of an alteration be provided with controls that will ultimately reduce the energy use and thus utility bills of an existing building. This section also ensures that thermostats are demand responsive, thus improving the resiliency and reducing emissions of the electrical grid.

Add new text as follows:

> **R503.3.4 Space heating.** New and replacement equipment providing space heating shall be electric heat pump equipment. Where existing *combustion equipment* serves the same heating zone, it shall be configured as supplementary heat in accordance with R501.8.

Exceptions:

1. Electric resistance heat controlled in accordance with Section R501.8.

2. Up to 2kW of electric resistance heat per *dwelling unit.*

All heating equipment must be electrified at time of replacement. Unlike new construction, existing buildings may have particularly high heating loads that cannot be effectively or cost-effectively met in some climates and applications. Therefore, the section still allows new combustion equipment installations, but only as supplementary heat. These "hybrid heat" configurations partially electrify the space heating.

Add new text as follows:

R503.3.5 Cooling equipment. New and replacement unitary air conditioners shall be electric heat pump equipment sized and configured to provide both space cooling and space heating. Any other space heating systems that serve the same zone shall be configured as supplementary heat in accordance with Sections R403.1.2 and R501.8.

Exception: Where a space heating system serves multiple *dwelling units* the system is not required to be configured to supplementary heat.

Unitary air conditioners are essentially cooling-only heat pumps. AC replacement therefore provides a valuable opportunity to electrify or partially electrify space heating. This section requires that when AC equipment is replaced that it gets replaced with a heat pump sized for the home's heating load. It also requires that any existing heating system be reconfigured as supplementary heating. This allows existing heating equipment to remain as a backup heating system, which is particularly important in buildings that are required to have emergency backup power for heating.

Add new text as follows:

R503.3.6 Combustion cooking. *Combustion equipment* used for cooking shall not be permitted in spaces undergoing an *alteration.*

This provision leverages an alteration to a space to require the electrification of any combustion cooking equipment in that space. Gas cooking can release levels of pollutants that, if they were measured outside, would violate the Clean Air Act.[15] *By removing combustion cooking at the time of renovation to spaces containing cooking equipment, jurisdictions act at the right time in the lifecycle of a residential building to increase safety and indoor air quality, as well as decarbonize.*

Revise text as follows:

~~**R503.1.3**~~ **R503.4 Service hot water systems.** New service hot water systems that are part of the *alteration* and serve multiple *dwelling units* shall comply with Section C503.4. New service hot water systems that are part of the *alteration* and serve individual *dwelling units* shall comply with Section R403.5 and this section.

[15] Gillis, J. and Nilles, B. (2019). "Your Gas Stove Is Bad for You and the Planet" The New York Times. www.nytimes.com/2019/05/01/opinion/climate-change-gas-electricity.html

This provision ensures that systems that serve multiple dwelling units comply with the commercial alterations section, which has requirements that are more appropriate for large central systems. It directs smaller systems that serve individual dwelling units to comply with the new construction requirements in Chapter 4 and new water heating electrification requirements for water heating in the subsections. The numbering change implements the restructuring discussed above in Section R501.

Add new text as follows:

R503.4.1 Service hot water equipment replacement. Where service hot water systems are replaced, new equipment shall be heat pump equipment.

Exceptions:

1. Electric resistance elements integrated into heat pump equipment.
2. Electric storage water heaters with a rated storage volume of less than 20 gallons and a rated input of less than 5kW.
3. Electric resistance equipment where not less than 75 percent of the annual service water-heating requirement is provided by an on-site renewable energy system not used to meet any other provision of this code.
4. Where it has been demonstrated to the *code official* that the dimensions of the space in which the water heater is located cannot accommodate a heat pump water heater sized to serve the hot water load of the *dwelling unit*.

Heat pump water heaters, often installed in both conditioned and semi-conditioned spaces such as basements and garages, can provide service water heating with efficiencies greater than 300%, thus reducing the energy use of service water heating to less than 1/3 of the energy required by gas or electric resistance water heaters. Buildings that cannot accommodate heat pump water heaters because of insufficient space are exempt from this requirement. Buildings with small electric storage water heaters that cannot be replaced by current heat pump water heaters are also exempt.

If a jurisdiction finds that requiring HPWHs is not a viable option, this section can be replaced with an alternative that only requires electrification (below), which would allow electric resistance options.

Alternate add new text as follows:

R503.4.1 Service hot water equipment replacement. Where service hot water systems are replaced, new equipment shall be electric equipment.

Although such an approach would be more flexible, it also allows for electric resistance equipment, which can have serious implications for carbon emissions and energy affordability. This approach should only be chosen in jurisdictions served by an electricity supply that has a carbon intensity comparable to onsite natural gas combustion. Additionally, the utility cost implications should be analyzed in order to ensure this requirement will not have an unacceptably adverse effect on utility bills. Replacement of combustion equipment with electric resistance equipment will also exacerbate the building electrical capacity issues for electrification.

Revise text as follows:

~~R503.1.4~~ R503.5 Lighting. New lighting and power systems that are part of the *alteration* shall comply with Section R404.1 and this section.

This minor change adds "power" to the title and scope of R503.5 so that decarbonization requirements related to electrical power can be added to the section.

Add new text as follows:

R503.5.1 Electrical Service replacement. Where a *building* electrical service is replaced, the new electrical service shall include electrical capacity sized in accordance with IRC Section E3702 for the following future branch circuits:

1. Replacement of all currently installed c*ombustion equipment* used for cooking with electric cooking equipment
2. Replacement of all currently installed c*ombustion equipment* used for space heating with electric heat pump equipment or reverse-cycle chiller sized for the heating load of the *building* in accordance with R403.7 based on the existing *building* features
3. Replacement of all currently installed c*ombustion equipment* used for water heating with electric heat pump equipment sized for the service hot water load of the *building*
4. Replacement of all currently installed combustion equipment used for clothes drying with electric clothes drying equipment
5. Replacement of all currently installed combustion lighting with electric lighting.
6. *Electric vehicle* charging infrastructure in accordance with Section R404.5
7. Energy storage infrastructure in accordance with Section R404.6
8. Renewable energy infrastructure in accordance with Section R404.4

The required capacity of space and water heating equipment shall be able to be reduced by any energy recovery systems serving the water or space heating equipment in the *building*.

One potential significant cost in electrification retrofit projects is electrical service replacement. This section ensures that if a building service is being replaced that it must be sized for the full electrification of combustion equipment in the building—space heating, water heating and cooking—and for the addition of the EVCI requirements in R404.5. "Electrification-sizing" the electrical service at the time of normal replacement is the most cost-effective approach to providing sufficient capacity for individual electrification retrofits. This will remove that barrier for future electrification retrofits.

Add new text as follows:

R503.5.3 Electric vehicle charging infrastructure. *Alterations* shall be provided with e*lectric vehicle* charging infrastructure in accordance with this section.

R503.5.3.1 One- and two-family dwellings and townhouses. An *alteration* of a one- and two-family dwelling and townhouse where any of the following apply shall meet the requirements of R404.5.1.

1. *Substantial improvements*
2. Where the alteration includes a new dedicated attached or detached garage or on-site parking space
3. Where alteration work in a garage includes the installation of a new branch circuit

This section requires new parking facilities to meet the EV charging requirements in the new construction portion of the Building Decarbonization Code. While this is implicitly required by Section C501, the addition of this section makes it explicit for greater clarity and enforceability.

R503.5.3.2 R-2 occupancies. *Alterations* to existing parking facilities in R-2 occupancies shall comply Section C503.5.3.

This section requires that any substantial alteration or alteration that includes a new attached or detached garage of single and two-family dwellings or townhouses meets the electric vehicle charging infrastructure requirements in Section R404.5.1. R404.5.1 requires one and two-family dwellings and townhouses to have one parking space with an EV Ready space that is sized to accommodate the most common EVSE on the market. The requirements for EV charging infrastructure for multifamily buildings are referenced to the commercial alteration requirements as those are more appropriate for EV charging in parking lots.

Add new text as follows:

R503.5.4 Fuel gas lighting equipment. Fuel gas lighting systems shall not be installed.

While the use of gas lighting is nearly extinct for both indoor and outdoor new construction uses, gas lamps remain a nostalgic feature in historic neighborhoods. Since the IRC Chapter 24 Fuel Gas does not prohibit the installation of fuel gas lighting, it is critical to ensure that the adoption of this overlay does prohibit these installations.

Add new text as follows:

R503.5.5 Renewable energy infrastructure. *Substantial improvements* and *alterations* that include *roof replacements* shall meet the requirements of R404.4.

Exception: Where *roof replacements* do not alter the existing structure and it has been demonstrated to the *code official* that the existing structure cannot support the addition of solar panels.

Roof replacements need to include the solar readiness requirements or install solar as specified in R404.4.

Add new text as follows:

R503.6 Additional Efficiency Packages. *Substantial energy alterations* shall comply with Sections R506 in accordance with this section. *All-electric buildings* shall install one package and *mixed-fuel buildings* shall install two packages.

Exceptions:

1. *Alterations* that are permitted with an addition complying with Section R502.6.
2. Where the *alteration* complies with Section R405 or R406.
3. *Alterations* that comply with Section R503.1.2.

This section works with the new section R506 (see below for more) to bring additional energy efficiency through implementing the additional efficiency packages from R408 in "major alterations". It is structured to apply only to substantial energy alterations. This ensures that this requirement will only be triggered by projects that already have a large enough scope for which there are multiple package options available to implement. All-electric homes are required to select one while mixed-fuel buildings are required to select 2, ensuring that fossil fuels are additionally conserved through efficiency gains.

The section includes exceptions for alterations that are permitted and comply in conjunction with an addition and alterations that comply with sections R405 and R406 are presented. It also includes an exception for substantial improvements that are subject to the ERI or EUI requirements of Section R503.1.2 or substantial energy alterations that would choose to use that path instead of the efficiency packages.

R505 CHANGE OF OCCUPANCY

Revise text as follows:

R505.1 General. Any space that is converted to a dwelling unit or portion thereof from another occupancy shall comply with this code and shall not be served by *combustion equipment*.

Exception: Where a central heating or water heating system serving other dwelling units in the same building is extended to serve spaces converted to a dwelling unit.

This provision prohibits changes of occupancy from being served by combustion equipment. This would effectively require changes of occupancy to result in an all-electric space or all-electric building. Jurisdictions should bear in mind that this could discourage changes of occupancy and the efficiency gains that would have otherwise been gained through a standard change of occupancy. Where these changes are likely to require substantial alterations, this type of trigger may be already sufficiently captured in the alterations section of this code and this section could be removed by an adopting jurisdiction. The exception presented allows for areas of multifamily buildings to extend existing systems to areas that have undergone a change of occupancy to provide more dwelling or sleeping units.

R506 ADDITIONAL EFFICIENCY

Add new text as follows:

SECTION R506
ADDITIONAL EFFICIENCY PACKAGE OPTIONS

R506.1 General. This section establishes additional requirements to achieve additional energy efficiency in existing buildings. Additional efficiency package options for compliance with Section R502.6, R503.6, and R505.2 are as follows:

1. Enhanced envelope performance in accordance with Section R408.2.1.
2. More efficient space-conditioning equipment performance in accordance with Section R408.2.2
3. Reduced energy use in service water-heating in accordance with Section R408.2.3
4. More efficient duct thermal distribution system in accordance with Section R408.2.4
5. Improved air sealing and efficient ventilation system in accordance with Section R408.2.5

Section R408 was added to the IECC in 2021. It requires new homes to include an additional efficiency option to achieve greater efficiency. There is one significant gap in R408, it does not apply to additions or alterations. R502 and R503 do not reference R408 in the sections with which additions and alterations must comply. The exclusion from Section R408 is a significant missed opportunity for efficiency in additions and alterations.

This proposal creates a framework to apply R408 to additions and substantial alterations. It creates a new Section R506 that provides guidance for how to utilize R408 packages for existing buildings. It works in conjunction with new sections R502.6 and R503.6 (see above) that establish which additions and alterations will need to comply with this section.

Where adopted, jurisdictions should include the revisions to Section R408 that are captured in the new construction versions of the Building Decarbonization Code which removes the incentive for more efficient gas equipment for all-electric requirements and adds an additional option for water heating systems for mixed fuel buildings.

Chapter 6 – Referenced Standards

Add new standard as follows:

ASHRAE

100---2018: Energy Efficiency in Existing Buildings

R503.1.2

Existing Building Decarbonization Code:

Residential Overlay

Mixed-Fuel

Residential Overlay (Mixed-Fuel)

Chapter 1 – Scope and Application

R101 SCOPE AND GENERAL REQUIREMENTS

Revise text as follows:

> **R101.3 Intent.** This code shall regulate the design, ~~and~~ construction, repair, alteration, change of occupancy, and additions of new and existing buildings for the ~~effective use and conservation~~ reduction of greenhouse gas emissions and for the efficient production, use and storage of energy over the useful life of each building. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. This code is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.

Intent has been modified to push beyond simply the inclusion of considerations of greenhouse gas emissions and production and storage of energy, to clearly emphasize the intent of the code to regulate existing buildings.

Chapter 2 – Definitions

R202 GENERAL DEFINITIONS

Add new definitions as follows:

> **ELECTRIC EQUIPMENT.** Any equipment or *appliance* used for space heating, *service water heating*, cooking, clothes drying, or lighting that uses electricity as its sole source of energy.

This new definition for electric equipment is a parallel of the definition of "combustion equipment" introduced in the Building Decarbonization Code.

> **ENERGY USE INTENSITY (EUI).** An expression of *building* energy use in terms of net energy divided by *gross floor area*.

EUI is an energy metric used in some performance-based energy policies, including many building performance standards (BPS). It is included here to allow provisions of the Existing Building Decarbonization Code integrate with BPSs. EUI is not currently defined in the suite of I-Codes, so it is added here. If a jurisdiction already has a formal definition of EUI, particularly in a building performance standard, then that definition should be integrated here as well.

> **SUBSTANTIAL ENERGY ALTERATION.** An *alteration* that includes replacement of two or more of the following:
>
> 1. 50% or more of the area of interior wall-covering material of the *building thermal envelope* or *fenestration.*
> 2. 50% or more of the area of the exterior wall-covering material of the *building thermal envelope* or *fenestration.*
> 3. Space-conditioning equipment constituting 50% or more of the total input capacity of the space heating or space cooling equipment serving the *building*.

4. Water-heating equipment constituting 50% of more of the total input capacity of all the water heating equipment serving the *building.*

5. 50% or more of the luminaires in the *building*

This new definition for substantial energy alteration is intended to capture projects that have the opportunity to greatly increase efficiency by nature of their scope and clarify when certain requirements related to the energy use of the building are triggered. By defining such scopes, confusion around generic terms like major renovations and applicability of work classifications in the IEBC can be removed. Other terms that define large-scale alterations such as Level III alteration or substantial improvement are not specific to the energy systems. An alteration could cross their thresholds without having a significant impact on the energy systems since they are based on metrics such as monetary value and reconfiguration of spaces. Similarly, an alteration that has significant impact on the energy systems of the building may not cross these other thresholds. Because there can be overlap in projects that are substantial improvements and substantial energy alterations, substantial improvements are explicitly excluded in the definition and treated differently in the code.

SUBSTANTIAL IMPROVEMENT. Any *repair*, reconstruction, rehabilitation, *alteration*, *addition* or other improvement of a building or structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the improvement or repair is started. If the structure has sustained *substantial damage*, any repairs are considered substantial improvement regardless of the actual *repair* work performed. The term does not, however, include either:

1. Any project for improvement of a *building* required to correct existing health, sanitary or safety code violations identified by the *building official* and that are the minimum necessary to assure safe living conditions.

2. Any *alteration* of a *historic structure* provided that the *alteration* will not preclude the structure's continued designation as a historic structure.

The definition of substantial improvement comes from the IBC and IEBC. The term generally aligns with vernacular use of "major renovation," which is not defined in code. It is used as a threshold for when certain flood protection requirements are triggered for existing building alterations. Since it is based on the monetary value of the alteration, it sets a useful threshold for introducing additional efficiency and decarbonization requirements.

In addition, the Existing Building Decarbonization Code leverages definitions from the Building Decarbonization Code including:

ALL-ELECTRIC BUILDING
APPLIANCE
COMBUSTION EQUIPMENT
COMMERCIAL COOKING APPLIANCES
ELECTRIC VEHICLE (EV)
EQUIPMENT
EV-CAPABLE SPACE
FUEL GAS

The use of these terms throughout assumes that adopting jurisdictions will adopt the Building Decarbonization Code alongside this existing building overlay.

Chapter 5 – Existing Buildings

R501 GENERAL

Add new text as follows:

R501.7 Requirements for combustion equipment. Where new, replacement, and existing *combustion equipment* remains following an *addition, alteration* and change of occupancy the building shall comply with this section.

This section creates a set of requirements for combustion equipment when it is allowed to be installed in existing buildings. These requirements are intended to generally improve the emissions of the equipment, the interior and exterior air quality, and provide necessary electric readiness for the next round of replacements.

R501.7.1 Replacement of electric equipment. *Combustion equipment* shall not be permitted to be installed to replace *electric equipment*.

The largest cost for existing buildings to electrify is to install the infrastructure to swap the equipment. Where electric appliances and equipment already exist, it is critical to maintain the electric energy source and not install new fossil fuel infrastructure or equipment.

R501.7.2 Phase out documentation. Permit applications for projects installing new and replacement *combustion equipment* or retaining existing *combustion equipment* serving space heating and water heating shall include a plan for the future replacement of the *combustion equipment* with *electric equipment*. The documentation shall include the following:

1. Calculations of the electric load required by the replacement *electric equipment* and of the available electric capacity of the *building*.
2. Identification of any existing onsite electrical infrastructure, including but not limited to transformers, switchgear, electrical panels and conductors, that will need to be altered to accommodate the replacement *electric equipment*.
3. Floor plans identifying any spaces that will need to be reconfigured to accommodate the replacement *electric equipment*.

Exception: Owner-occupied single family, two-family, and townhouses.

Where replacements are made with combustion equipment, building owners should understand the need for long term phase out and switch to electric equipment to avoid potential abandoned assets. The primary focus of this section is on multifamily and rental units, with a specific exception for owner occupied detached and attached homes. Jurisdictions could also expand this section to include specifics related to other policies such as appliance emission standards or replacement policies targeting specific dates for combustion equipment phase out.

R501.7.3 Sealed combustion and direct venting. *Combustion equipment* used for space and water heating shall be direct vent or sealed combustion.

Space and water heating equipment that utilize direct venting or sealed combustion techniques improve the efficiency of the equipment and the indoor air quality of a home by ensuring that hazardous byproducts of the combustion process are vented outside of the living space.

R501.7.4 Low NOx furnaces. Warm-air furnaces shall have no more than 14 nanograms of nitrogen dioxide emissions per joule of useful heat delivered to the heated space.

Exception: Equipment with an AFUE of not less than 90 percent.

This requirement limits the nitrogen dioxide emissions from these appliances. Appliances in buildings emit twice the amount of NOx as power plants, a major pollutant which causes asthma. The air quality limit is based on NOx emission limits imposed by California's South Coast Air Quality Management District and the San Joaquin Valley Air Pollution Control District. An exception is given to equipment that exhibit an AFUE of 90 percent or more because those systems use direct vent or sealed combustion technology and comply with the NOx limit.

R501.7.5 Fuel gas pipe testing. All *fuel gas* piping that serves new or replacement *combustion equipment* shall be tested as a new installation in accordance with Section G2415.20 of the *International Residential Code*.

Exceptions:

1. For the purposes of demonstrating compliance with this section, unexposed pipe joints and welds shall not be required to be exposed for examination during the test.
2. For the purposes of demonstrating compliance with this section, where it has been demonstrated to the code official that the *fuel gas* piping has met the requirements of this section within the previous five years.
3. Where compliance with this section would require interruption of *fuel gas* supply to *combustion equipment* that serves other tenant spaces or other *dwelling units,* provided all exposed pipe joints of the piping subject to the requirements of this section have been inspected for leaks by means of an *approved* gas detector, a noncorrosive leak detection fluid or other *approved* leak detection method once the equipment has been placed in operation.

Gas piping degrades over time, creating the possibility of natural gas leakage. Even though the natural gas is treated with mercaptan to give it that rotten egg smell, small leaks may go undetected, particularly in buildings where pipes are not exposed and older buildings that are likely to have envelopes that are less tight than newer construction. According to US DOE, building leakage accounts for nearly 27% of the natural gas leakage in the US natural gas distribution system.[16] Leaking natural gas represents a loss in energy, and even small leaks can add up over long periods of time. Additionally, natural gas is also a potent Green House Gas, with over 86 times the global warming potential of CO2 on a short-term basis.

The installation of new gas equipment provides an ideal time to test gas pipe leakage. Contractors are already on site and the gas will often be partially or fully turned off for the new equipment installation. Additionally, new equipment installation can disturb and inflict additional stresses on existing piping, creating opportunities for the formation of new leaks where existing natural gas piping has weakened but not previously failed.

This provision requires that existing fuel gas piping be tested like a new installation according to the fuel-gas piping requirements in the International Residential Code (IRC). It includes targeted exceptions for

[16] "Natural Gas Infrastructure Modernization Programs at Local Distribution Companies: Key Issues and Considerations." US DOE, Office of Energy Policy and Systems Analysis. Washington DC, 2017.

elements of the IFGC testing methodology that is not appropriate for existing buildings. It also includes an exception for piping that has been tested in the last five years in order to prevent repeated testing. Finally, it includes an exception to ensure that testing requirements don't necessitate other tenants losing service, which could be a considerable in larger buildings with multiple tenant spaces. In those cases, it only requires visual inspection of the exposed joints with a testing fluid.

Add new text as follows:

R501.8 Heat pump supplementary combustion equipment. Heat pumps having *combustion equipment* or electric resistance equipment for supplementary space or water heating shall have controls that limit supplemental heat operation to only those times when one of the following applies:

1. The heat pump is operating in defrost mode.
2. The vapor compression cycle malfunctions.
3. For space heating systems, the thermostat malfunctions.
4. For space heating systems, the vapor compression cycle cannot provide the necessary heating energy to satisfy the thermostat setting.
5. For water heating, the heat pump water heater cannot maintain an output water temperature of at least 120°F (49°C)

New supplementary space and water heating systems for heat pump equipment shall not be permitted to have a heating input capacity greater than the heating input capacity of the heat pump equipment.

Supplementary heating systems are effectively back-up systems intended to provide heating if the primary heat pump system fails, if the operating conditions (heating demand, temperature around the heat pump compressor, etc.) exceed the ability of the heat pump to effectively, or cost-effectively, provide heating. Designers sometimes utilize "hybrid heat" systems where combustion equipment provides the supplementary heat to address these situations.

This new section creates a version of the supplementary heating equipment control requirements that is customized for existing buildings. It addresses both space and water heating applications, and ensures that any combustion heating equipment used for supplementary heat is only used when the heat pump system is unable to fully meet the buildings heating needs (the language in C403 already addresses electric resistance supplementary heat).

R502 ADDITIONS

Revise text as follows:

R502.1 General. *Additions* to an existing *building*, *building* system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portion of the existing building or building system to comply with this code. *Additions* shall not create an unsafe or hazardous condition or overload existing building systems. An *addition* shall be deemed to comply with this code where the addition alone complies, where the existing

building and addition comply with this code as a single building, or where the building with the *addition* does not use more energy, than the existing building. *Additions* shall be in accordance with Section R404.7 and Sections R502.2 ~~or R502.3~~ through R502.6.

These edits implement the restructuring discussed above in the introduction. It moves the prescriptive compliance language from R502.3 here. The requirement in R502.1 for additions to meet the requirements for new construction mean that additions will be subject to the requirements in the Building Decarbonization Code for electrification readiness where combustion equipment is newly installed.

Add new text as follows:

R502.1.1 Combustion equipment. *Additions* shall not be permitted to contain *combustion equipment* and new equipment installed to serve *additions* shall be *electric equipment*.

This section requires that new equipment installed in and to serve additions be all-electric Where additions are large enough to require new equipment, it is critical that the new equipment be electric equipment. This provision would allow for existing combustion equipment to be employed as back up if deemed necessary and be extended from the existing building.

R502.1.1.1 Energy consumption of existing combustion equipment. Where systems with *combustion equipment* are extended into an addition, the existing *building* and addition together shall use no more fossil fuel energy than the existing *building* alone.

Additions, particularly smaller ones, often don't have stand-alone systems; ductwork and hot water piping is extended into the addition to provide space conditioning and water heating. When these systems utilize combustion equipment, the expanded loads will result in increased use of total combustion energy. This provision allows systems with combustion equipment to be extended into additions but requires that this extension doesn't result in an increase in combustion energy. In order to extend a system with combustion equipment into an addition, the efficiency of the existing building would need to be improved in order to offset the increased consumption from the addition.

Add new text as follows:

R502.1.2 Combustion equipment requirements. New *combustion equipment* serving *additions* shall comply with section R501.7.

New combustion equipment is allowed in additions, provided they meet the additional requirements for combustion equipment in Section R501.7.

Revise text as follows:

~~**R502.2 Change in space conditioning.** Any unconditioned or low-energy space that is altered to become conditioned space shall be required to be brought into full compliance with this code.~~

~~**Exceptions:**~~

~~**1.** Where the simulated performance option in Section R405 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110 percent of the annual energy cost otherwise allowed by Section R405.2.~~

~~**2.** Where the Total UA, as determined in Section R402.1.5, of the existing building and the addition, and any alterations that are part of the project, is less than or equal to the Total UA generated for the existing building.~~

~~3. Where complying in accordance with Section R405 and the annual energy cost or energy use of the addition and the existing building, and any alterations that are part of the project, is less than or equal to the annual energy cost of the existing building. The addition and any alterations that are part of the project shall comply with Section R405 in its entirety.~~

This content is located in the additions section in the model code (Section C502.2). As part of the restructuring needed for this overlay, it has been relocated here since it describes an alteration project. The requirements have not been changed, but the relocation will improve the usability and enforceability of the code.

Revise text as follows:

~~**R502.3 Prescriptive compliance.** *Additions* shall comply with Sections R502.3.1 through R502.3.4.~~

R502.~~3.1~~2 Building envelope.

These edits implement the restructuring discussed above in the introduction. The content of the subsections is unaffected.

Revise text as follows:

~~**R502.3.2**~~ **R502.3 Heating and cooling systems.** New heating and cooling systems installed as part of an addition and serving multiple *dwelling units* shall comply with Section C502.3. All other heating and cooling systems ~~HVAC ducts newly~~ installed as part of an *addition* shall comply with Section R403 and this section.

Previously this section only provided specific guidance on ductwork. The revision allows this section to more easily accommodate additional items around heating and cooling systems. It also directs central systems that serve multiple dwelling units to the commercial section to ensure that they are subject to all-electric requirements that are appropriate for larger, central systems.

Add new text as follows:

R502.3.3 Space heating equipment. New space heating equipment in *additions* shall be electric heat pump equipment.

Exceptions:

1. Supplementary heat in accordance with R501.8

2. Up to 2kW of electric resistance heat per *dwelling unit*

Requiring space heating installed during an addition to be electric will reduce carbon emissions and improve air quality in homes. Heat pumps have been shown to be technically effective in all climate zones, and cold-climate heat pump technology continues to improve, providing heating with a COP of more than 3 above 5°F.[17] The provision includes an exception that allows combustion equipment, including new combustion equipment, to be used as supplementary heat. These "hybrid heat" configurations partially electrify the space heating. Unlike new construction, existing buildings may have particularly high heating loads that cannot be effectively or cost-effectively met by heat pumps alone in some climates and applications.

Add new text as follows:

R502.3.4 Ductwork. HVAC ducts newly installed as part of an addition shall comply with Section R403.

Exception: Where ducts from an existing heating and cooling system are extended into an addition and the capacity of the heating or cooling equipment is not increased, Sections R403.3.5 and R403.3.6 shall not be required.

Currently, ducts that extend an existing system into an addition are exempt from all of the requirements for new ductwork, including the requirements for duct construction. While it can be reasonable to exempt these ducts from the duct testing requirements, all of the other requirements should still apply. This modification closes that loophole. It does provide an exemption from duct testing, but only when the system extension doesn't increase the equipment size.

Revise text as follows:

R502.~~3.3~~4 Service hot water systems. New service hot water systems that are part of the addition and serve multiple *dwelling units* shall comply with Section C502.4. New service hot water systems that are part of the *addition* and serve individual *dwelling units* shall comply with Section R403.5 and this section.

These edits implement the restructuring discussed above in the introduction. It also directs central systems that serve multiple dwelling units to the commercial section to ensure that they are subject to all-electric requirements that are appropriate for larger, central systems.

[17] "Achieve Comfort and Reliable Performance with Cold-Climate Heat Pumps." *Zero Energy Project*, 6 Feb. 2020, https://zeroenergyproject.org/2020/01/22/achieve-comfort-and-reliable-performance-with-cold-climate-heat-pumps/#:~:text=The%20Benefits%20of%20Heat%20Pumps%20in%20Cold%20Climates&text=Combustion%2Dbased%20heating%20systems%20such,3%20at%205%C2%B0F.

Add new text as follows:

> **R502.4.1 Service hot water equipment replacement.** New *combustion equipment* used for water heating that is part of the *alteration* shall comply with Section R501.7.

This requires the installation of combustion water heating equipment that is both more efficient and less likely to worsen indoor air quality as stipulated in R501.7. Where jurisdictions would like to move toward electrification but allow supplementary water heating, alternative language is provided.

Alternate Add new text as follows:

> **R502.4.1 Service hot water equipment replacement.** Where service hot water systems are replaced, new primary water heating equipment shall be heat pump equipment. Where new or existing *combustion equipment* is used to provide supplementary water heating, the equipment shall comply with Section R501.7.

This provision requires partial electrification, providing a "hybrid" water heating system that is reliant on heat pump technology primarily, but allowed to use combustion equipment for supplementary heating.

Revise text as follows:

> ~~R502.3.4~~ **R502.5 Lighting and power.** New lighting and electrical power systems that are part of the addition shall comply with this section and Section R404~~.1~~.

Previously this section only included requirements for lighting. The edit changes the scope of the section to include power, aligning it with the commercial section of the code and allowing it to accommodate additional requirements related to power such as EV charging, electrical service replacements, etc.

Add new text as follows:

> **R502.5.1 Lighting equipment.** New interior and exterior lighting serving additions shall be electric. Fuel gas lighting systems shall be prohibited.

While the use of gas lighting is nearly extinct for both indoor and outdoor new construction uses, gas lamps remain a nostalgic feature in some residential buildings. Similar to the new construction language, it is critical to ensure that the adoption of this overlay prohibits new installations of gas lighting and the gas infrastructure they require.

Add new text as follows:

> **R502.5.1 Electric vehicle charging infrastructure.** New parking facilities, new parking spaces added to existing parking facilities and new attached and detached garages shall comply with Section R404.5.

It is critical to install EV charging infrastructure when construction provides an opportunity. R404.5 requires one and two-family dwellings and townhouses to have one parking space with an EV Ready space that is sized to accommodate the most common EVSE on the market. The requirements for EV

charging infrastructure for multifamily buildings are referenced to the commercial requirements as those are more appropriate for EV charging in parking lots.

Add new text as follows:

R502.5.2 Renewable energy infrastructure. Additions shall comply with the requirements of Section R502.5.2.1 or R502.5.2.2.

Exception: Additions where the new roof area is less than less than 600 square feet (55 m2) of roof area oriented between 110 degrees and 270 degrees of true north.

R502.5.2.1 One- and two- family dwellings and townhouses. Where an *addition* with a roof is added, the *dwelling unit* shall comply with Section R404.4.

R502.5.2.2 Group R occupancies. Where an *addition* with a roof is added to an R-2, R-3 or R-4 occupancy, the *building* shall comply with Section C502.5.3.

The requirements in the Building Decarbonization Code for renewable energy systems reference buildings and so don't capture additions, as they are not stand-alone buildings. This section uses the addition to trigger the requirements, ensuring that new additions with roofs also have solar-ready zones or are provided with solar generation in accordance with the occupancy type, referring R-2, R-3, and R-4 occupancies to the commercial section for additions. It also draws the distinction between the building and the dwelling unit, as two-family or townhouse structures contain several units within the same building, this measure is targeted at the individual unit level. It includes an exception for additions with less than 600 sf of roof area since they are not large enough for the solar-ready zone required in the Building Decarbonization Code.

Add new text as follows:

R502.5.3 Energy storage infrastructure. Additions with new attached or detached garages shall comply with Section R404.6.

New attached and detached garages provide an ideal location for energy storage systems in residential construction. This provision requires energy storage readiness that meets the requirements of the Building Decarbonization Code be include in these projects.

Add new text as follows:

R502.6 Additional Efficiency Packages. *Additions* shall comply with Sections R506.1. *All-electric buildings* shall be required to select one package and *mixed-fuel buildings* shall be required to select two packages. *Alterations* to the existing building that are not part of the *addition*, but permitted with the *addition*, shall be permitted to be used to achieve this requirement.

Exceptions:

1. *Additions* that increase the *building*'s total *conditioned floor area* by less than 25 percent.
2. *Additions* that do not include the addition or replacement of equipment covered by Sections R403.5 or R403.7.

3. *Additions* that do not contain *conditioned space*.
4. Where the *addition* alone or the existing building and *addition* together comply with Section R405 or R406.

There are many opportunities to cost-effectively improve the efficiency, comfort and indoor air quality of a home during an alteration. This section works with the new section R506 (see below for more) to bring additional energy efficiency through implementing the additional efficiency packages in R408 in "substantial" additions. The section requires one package in most additions just like new buildings. It also includes a series of important exceptions for additions that may not be able to reasonably implement an additional efficiency package due to limited scope and for additions that comply through sections R405 or R406.

All-electric homes typically use less energy when compared to mixed-fuel homes. By requiring additions served by combustion equipment to select two energy efficiency packages, this measure seeks to encourage electrification and improve the efficiency of existing buildings. Language is identical between the all-electric and mixed-fuel sections to recognize the variety of existing building configurations and systems, even under an "all-electric" application, the electrification at strategic points may not individually result in an all-electric building.

R503 ALTERATIONS

Revise text as follows:

R503.1 General. *Alterations* to any *building* or structure shall comply with the requirements of the code for new construction, without requiring the unaltered portions of the existing *building* or *building* system to comply with this code. *Alterations* shall be such that the existing *building* or structure is not less conforming to the provisions of this code than the existing *building* or structure was prior to the *alteration*.

Alterations shall not create an unsafe or hazardous condition or overload existing *building* systems. *Alterations* shall be such that the existing *building* or structure does not use more energy than the existing *building* or structure prior to the alteration. *Alterations* to existing *buildings* shall comply with Sections ~~R503.1.1 through R503.1.4~~ R503.2 through R503.6.

These edits implement the restructuring discussed above in Section R501. The new referenced sections are the subsections dedicated to building systems and additional efficiency.

Add new text as follows:

R503.1.1 Change in space conditioning. Any unconditioned or low-energy space that is altered to become conditioned space shall be required to be brought into full compliance with this code.

Exceptions:

1. Where the simulated performance option in Section R405 is used to comply with this section, the annual energy cost of the proposed design is permitted to be 110 percent of the annual energy cost otherwise allowed by Section R405.2.

2. Where the Total UA, as determined in Section R402.1.5, of the existing building and the addition, and any alterations that are part of the project, is less than or equal to the Total UA generated for the existing building.

3. Where complying in accordance with Section R405 and the annual energy cost or energy use of the addition and the existing building, and any alterations that are part of the project, is less than or equal to the annual energy cost of the existing building. The addition and any alterations that are part of the project shall comply with Section R405 in its entirety.

This content is located in the additions section in the model code (Section R502.2). As part of the restructuring needed for this overlay, it has been relocated here since it describes an alteration project. The requirements have not been changed, but the relocation will improve the usability and enforceability of the code.

R503.1.1.1 Garages and basements. Garages and basements in single family and two-family residential buildings and townhouses converted to conditioned space, the space shall comply with R501.7. Where the space contains water heating equipment, the space shall comply Section R404.7.2.

A common alteration and space conditioning change in residential construction is the conversion of a garage or basement space. This is also a location that most often contains water heating equipment. By implementing electrification readiness requirements at the time of that renovation, costs for replacement of combustion water heating equipment will be greatly reduced in the future. The explicit link back to combustion equipment requirement will ensure safety for residents and families to spend longer periods of time in those spaces.

Add new text as follows:

R503.1.2 Substantial improvement. Buildings undergoing *substantial improvements* shall comply with Sections R402.4 and R404.7, and one of the following:

1. For each dwelling unit in the project, achieve an ERI score of 80 or below, without on-site renewable energy included in accordance with RESNET/ICC 301.

2. Meet a site EUI by building type in accordance with ASHRAE Standard 100 Table 7-2a.

Substantial improvements are extensive alterations that have significant scope, large project budgets relative to the value of the building and are more likely to already include major systems that could include combustion equipment. The larger scopes and budgets of substantial improvements are likely to occur infrequently within a building lifecycle and create the best opportunity to significantly increase efficiency and establish full electric ready infrastructure for the building and its systems.

Add new text as follows:

R503.1.3 Combustion equipment. New *combustion equipment* serving *alterations* shall comply with Section R501.7.

Requiring the installation of combustion space and water heating equipment that is both more efficient and less likely to worsen indoor air quality in alterations can both reduce carbon emissions and improve the health of building occupants. Requiring certain types of alterations to implement energy efficiency measures as described in Section R503.6 will also cost-effectively reduce a home's utility bills.

Add new text as follows:

> **R503.1.4 Building Performance Standards.** Where the *building* is subject to **[OFFICIAL NAME OF THE LOCAL BUILDING PERFORMANCE STANDARD]**, the permit application for the *alteration* shall include a report that includes the following:
>
> 1. The current or last reported EUI of the *building*
> 2. The performance targets from **[NAME OF THE LOCAL BUILDING PERFORMANCE STANDARD]** that will be applicable to the *building* within five years from the date of the permit application
>
> Where the current or last reported EUI exceeds the performance targets that will be applicable in the next five years, the report shall also include a plan describing how the *building* will be brought into compliance. The report shall include energy efficiency upgrades and operational improvements that will be made to the *building* before the applicable target goes into effect and the impact of the alteration under permit review.
>
> **Exception:** Where the total *building* performance of the *building* with the *alteration* determined in accordance with Section C407 demonstrates compliance with the performance targets identified in the report required by this section.

Some jurisdictions include low-rise multifamily in their Building Performance Standard (BPS) because the BPS application is based on overall square footage of buildings, unrelated to building height which is used in the energy code. In these jurisdictions, it is important that all alterations support and reinforce the BPS. Alterations that are undertaken without consideration of impending BPS performance targets represent a significant missed opportunity. This section requires that consideration by creating a requirement that permit applications include the building's current performance and any BPS performance targets that will be in effect in the next 5 years, the typical compliance cycle for US-based BPS. Where a building does not already meet those targets, it will be required to also submit what is effectively a plan for compliance with the BPS. This will ensure that project teams are thinking about a proposed alteration within the larger context of what will be required to meet up-coming BPS requirements. The exception allows the compliance path to be avoided when the alteration is complying by performance modeling and that modeling shows that the alteration will bring the building into compliance with the BPS performance target.

It may be necessary to modify the language in this provision to align with the terminology that is used in the official BPS regulation to maximize correlation and usability. For example, the provision can be modified to align with a carbon-based BPS by replacing "EUI" with "CUI" throughout and adding the following definition:

> **CARBON USE INTENSITY (CUI).** An expression of *building* carbon emissions in terms of the equivalent carbon emissions of the net energy divided by *gross floor area*.

This definition defines a carbon use intensity that parallels the definition of EUI. It is a carbon metric where carbon emissions are divided by gross floor area in order to compare the emissions of different buildings or assess the performance a building's carbon emissions against a target.

Renumber as follows:

~~R503.1.1~~ R503.2 Building envelope.

~~R503.1.1.1~~ R503.2.1 Replacement fenestration.

These edits implement the restructuring discussed above in Section R501. The content of the sections is unaffected.

Revise text as follows:

~~R503.1.2~~R503.3 Heating and cooling systems. New heating, and cooling systems ~~HVAC ducts newly~~ installed as part of an alteration shall comply with Section R403 and this section. *Alterations* to heating, cooling and duct systems shall comply with this section.

New HVAC and ducts in an alteration must meet the requirements for new construction of Section R403 along with specific requirements in this section tailored for decarbonization of existing buildings. Work that is purely alteration to HVAC is directed to follow specific language in this section.

Add new text as follows:

R503.3.1 Ducts. Ducts and air handlers that are a part of the *alteration* shall be installed in accordance with this section.

R503.3.1.1 New ducts. Newly installed ducts and air handlers shall be installed in accordance with R403.3.

Exception: Where the capacity of the heating or cooling equipment is not increased Sections R403.3.5 and R403.3.6 shall not be required.

R503.3.1.2 Existing ducts. Existing duct systems shall be tested in accordance with Section R403.3.5 and shall have a total leakage less than or equal to 12.0 cubic feet per minute (339.9 L/min) per 100 square feet (9.29 m2) of conditioned floor area.

Exceptions:

1. Where the total length of all ducts in the system is increased by less than 25%.
2. Where less than 25% of the registers, and less than 25% of the total length of the ducts in the system are relocated.

During an alteration, building owners often re-use and extensively alter their ductwork without testing and meeting any kind of air-leakage requirement. Because the standards for duct construction in the IECC have changed dramatically over time, existing duct systems often have substantial leakage far

beyond what is allowed in new construction. This section requires that existing ductwork that is substantially altered will have to meet a maximum leakage requirement. The leakage criterion is set at 3x the requirement for new construction, so the altered ductwork would not be required to be as tight as new construction. Existing ductwork that does not receive substantial alteration is unaffected by this section.

Add new text as follows:

> **R503.3.2 System Sizing.** New heating and cooling equipment that is part of an *alteration* shall be sized in accordance with Section R403.7 based on the existing *building* features as modified by the *alteration.*
>
> > **Exception:** Where it has been demonstrated to the *code official* that compliance with this section would result in heating or cooling equipment that is incompatible with the remaining portions of the existing heating or cooling system.

Oversized equipment results in increased energy use, decreased occupant comfort and increased wear-and-tear on equipment. Oversized equipment is also less effective at dehumidification. Like-for-like equipment replacement are particularly vulnerable to oversizing. This requirement ensures that new heating and cooling equipment installed in existing buildings is properly sized based on the buildings features as modified by the alteration. It provides an exception for situations where right-sizing equipment may create an incompatibility with the rest of the system (as can be the case with steam systems where boilers are sized to the radiators/convectors and not the building).

Add new text as follows:

> **R503.3.3 Controls.** New heating and cooling equipment that are part of the *alteration* shall be provided with controls that comply with Section R403.1 and Section R403.2.

Controls are a vital component of effective and efficient operation of heating and cooling systems and older controls that do not meet current code requirements significantly hamper efficiency in buildings. This section requires that new heating and cooling equipment installed as part of an alteration be provided with controls that will ultimately reduce the energy use and thus utility bills of an existing building. This section also ensures that thermostats are demand responsive, thus improving the resiliency and reducing emissions of the electrical grid.

Add new text as follows:

> **R503.3.4 Space heating.** New *combustion equipment* used for space heating that is part of the *alteration* shall comply with Section R501.8.

This ensures the installation of combustion space heating equipment that is both more efficient and less likely to worsen indoor air quality as required in Section R501.8.

Add new text as follows:

R503.3.4.1 Partial electrification of space heating. New and replacement *combustion equipment* used for space heating shall only be permitted to be installed as supplementary heating controlled in accordance with R501.8.

Where there are technical barriers to the full electrification of a building's space heating system, hybrid heat systems that combine heat pumps with combustion equipment are an effective strategy to reduce carbon emissions through improving the efficiency of the system and reducing onsite combustion emissions. In these systems, a heat pump serves most of the heating loads and the combustion equipment only operates when the heat pump is unable to keep up with heating demand, particularly during low outdoor temperatures. By prohibiting new combustion equipment except as supplementary heat, this section requires that existing combustion heating systems be converted to hybrid heat systems at equipment replacement.

Add new text as follows:

R503.3.5 Cooling equipment. New and replacement unitary air conditioners shall be electric heat pump equipment sized and configured to provide both space cooling and space heating. Any other space heating systems that serve the same zone shall be configured as supplementary heat in accordance with Sections R403.1.2 and R501.8.

Exception: Where a space heating system serves multiple *dwelling units* the system is not required to be configured to supplementary heat.

Unitary air conditioners are essentially cooling-only heat pumps. AC replacement therefore provides a valuable opportunity to electrify or partially electrify space heating. This section requires that when AC equipment is replaced that it gets replaced with a heat pump sized for the home's heating load. It also requires that any existing heating system be reconfigured as supplementary heating. This allows existing heating equipment to remain as a backup heating system, which is particularly important in buildings that are required to have emergency backup power for heating.

Add new text as follows

R503.3.6 Combustion cooking. Where a space that is part of the *alteration* includes *combustion equipment* for domestic cooking, the domestic cooking equipment shall be provided with exhaust equipment that complies with Sections M1503.2 through M1503.4 of the *International Residential Code* and the following:

1. The exhaust fan shall be sized to provide no less than 150 CFM of intermittent airflow.
2. The domestic cooking equipment shall be provided with makeup air in accordance with Section M1503.6.1 and makeup air dampers that comply with Section M1503.6.2 of the *International Residential Code*.

Gas cooking can release levels of pollutants that, if they were measured outside, would violate the Clean Air Act.[18] As a result, households with gas cooking have nearly three times the rate of treatment for asthma.[19] Outside of commercial kitchens, the mechanical code has only limited ventilation requirements for cooking, only requiring ventilation for the room and not the cooking appliance itself. It also does not differentiate between gas and electric cooking, despite the significantly higher level of pollutants from gas cooking.[20] Ventilation has not always been required in spaces with cooking, so many existing buildings do not have any mechanical ventilation at all. This provision improves the health and indoor air quality of buildings with gas cooking by requiring that spaces with combustion cooking that undergo an alteration be equipped with appropriate ventilation for gas cooking. It requires exhaust specifically at the cooking equipment, and not just the space. It also requires makeup air to ensure that the exhaust fans are effectively exhausting contaminants. The ventilation rate has been set at 150CFM. This is higher than the requirement in the mechanical code in order to account for the higher concentration of pollutants in gas cooking. The exhaust rate is based on Washington state code requirements for ventilation of gas cooking.

Revise text as follows:

> ~~**R503.1.3**~~ **R503.4 Service hot water systems.** New service hot water systems that are part of the *alteration* and serve multiple *dwelling units* shall comply with Section C503.4. New service hot water systems that are part of the *alteration* and serve individual *dwelling units* shall comply with Section R403.5 and this section.

This provision ensures that systems that serve multiple dwelling units comply with the commercial alterations section, which has requirements that are more appropriate for large central systems. It directs smaller systems that serve individual dwelling units to comply with the new construction requirements in Chapter 4 and new water heating electrification requirements for water heating in the subsections. The numbering change implements the restructuring discussed above in Section R501.

Add new text as follows:

> **R503.4.1 Service hot water equipment replacement.** New *combustion equipment* used for water heating that is part of the *alteration* shall comply with Section R501.7.

This requires the installation of combustion water heating equipment that is both more efficient and less likely to worsen indoor air quality as stipulated in R501.7

[18] Gillis, J. and Nilles, B. (2019). "Your Gas Stove Is Bad for You and the Planet" The New York Times. www.nytimes.com/2019/05/01/opinion/climate-change-gas-electricity.html
[19] Jarvis et al. (1996) "Evaluation of asthma prescription measures and health system performance based on emergency department utilization." https://www.ncbi.nlm.nih.gov/pubmed/8618483
[20] D. Michanowicz, *et al. (2022)* "Home is Where the Pipeline Ends: Characterization of Volatile Organic Compounds Present in Natural Gas at the Point of the Residential End User." American Chemical Society.

Revise text as follows:

~~R503.1.4~~ R503.5 Lighting. New lighting and power systems that are part of the *alteration* shall comply with Section R404.1 and this section.

This minor change adds "power" to the title and scope of R503.5 so that decarbonization requirements related to electrical power can be added to the section.

Add new text as follows:

R503.5.1 Electrical Service replacement. Where a *building* electrical service is replaced, the new electrical service shall include electrical capacity sized in accordance with IRC Section E3702 for the following future branch circuits:

1. Replacement of all currently installed c*ombustion equipment* used for cooking with electric cooking equipment
2. Replacement of all currently installed c*ombustion equipment* used for space heating with electric heat pump equipment or reverse-cycle chiller sized for the heating load of the *building* in accordance with R403.7 based on the existing *building* features
3. Replacement of all currently installed c*ombustion equipment* used for water heating with electric heat pump equipment sized for the service hot water load of the *building*
4. Replacement of all currently installed combustion equipment used for clothes drying with electric clothes drying equipment
5. Replacement of all currently installed combustion lighting with electric lighting.
6. *Electric vehicle* charging infrastructure in accordance with Section R404.5
7. Energy storage infrastructure in accordance with Section R404.6
8. Renewable energy infrastructure in accordance with Section R404.4

The required capacity of space and water heating equipment shall be able to be reduced by any energy recovery systems serving the water or space heating equipment in the *building*.

One potential significant cost in electrification retrofit projects is electrical service replacement. This section ensures that if a building service is being replaced that it must be sized for the full electrification of combustion equipment in the building – space heating, water heating and cooking – and for the addition of the EVCI requirements in R404.5. "Electrification-sizing" the electrical service at the time of normal replacement is the most cost-effective approach to providing sufficient capacity for individual electrification retrofits. This will remove that barrier for future electrification retrofits.

Add new text as follows:

R503.5.3 Electric vehicle charging infrastructure. *Alterations* shall be provided with e*lectric vehicle* charging infrastructure in accordance with this section.

R503.5.3.1 One- and two-family dwellings and townhouses. An *alteration* of a one- and two-family dwelling and townhouse where any of the following apply shall meet the requirements of R404.5.1.

1. *Substantial improvements*
2. Where the alteration includes a new dedicated attached or detached garage or on-site parking space
3. Where alteration work in a garage includes the installation of a new branch circuit

This section requires new parking facilities to meet the EV charging requirements in the new construction portion of the Building Decarbonization Code. While this is implicitly required by Section C501, the addition of this section makes it explicit for greater clarity and enforceability.

R503.5.3.2 R-2 occupancies. *Alterations* to existing parking facilities in R-2 occupancies shall comply Section C503.5.3.

This section requires that any substantial alteration or alteration that includes a new attached or detached garage of single and two-family dwellings or townhouses meets the electric vehicle charging infrastructure requirements in Section R404.5.1. R404.5.1 requires one and two-family dwellings and townhouses to have one parking space with an EV Ready space that is sized to accommodate the most common EVSE on the market. The requirements for EV charging infrastructure for multifamily buildings are referenced to the commercial alteration requirements as those are more appropriate for EV charging in parking lots.

Add new text as follows:

R503.5.4 Fuel gas lighting equipment. Fuel gas lighting systems shall not be installed.

While the use of gas lighting is nearly extinct for both indoor and outdoor new construction uses, gas lamps remain a nostalgic feature in historic neighborhoods. Since the IRC Chapter 24 Fuel Gas does not prohibit the installation of fuel gas lighting, it is critical to ensure that the adoption of this overlay does prohibit these installations.

Add new text as follows:

R503.5.5 Renewable energy infrastructure. *Substantial improvements* and *alterations* that include *roof replacements* shall meet the requirements of R404.4.

Exception: Where *roof replacements* do not alter the existing structure and it has been demonstrated to the *code official* that the existing structure cannot support the addition of solar panels.

Roof replacements need to include the solar readiness requirements or install solar as specified in R404.4.

Add new text as follows:

R503.6 Additional Efficiency Packages. *Substantial energy alterations* shall comply with Sections R506 in accordance with this section. *All-electric buildings* shall install one package and *mixed-fuel buildings* shall install two packages.

Exceptions:

1. *Alterations* that are permitted with an addition complying with Section R502.6.
2. Where the *alteration* complies with Section R405 or R406.

This section works with the new section R506 (see below for more) to bring additional energy efficiency through implementing the additional efficiency packages from R408 in "major alterations". It is structured to apply only to substantial energy alterations. This ensures that this requirement will only be triggered by projects that already have a large enough scope for which there are multiple package options available to implement. All-electric homes are required to select one while mixed-fuel buildings are required to select 2, ensuring that fossil fuels are additionally conserved through efficiency gains. Exceptions for alterations that are permitted and comply in conjunction with an addition and alterations that comply with sections R405 and R406 are presented.

R505 CHANGE OF OCCUPANCY

Add new text as follows:

R505.1.2 Combustion equipment. New *combustion equipment* shall not be installed in a space undergoing a change of occupancy.

This provision will result in the partial electrification of a change of occupancy by prohibiting the installation of new combustion equipment. Existing combustion equipment is allowed to remain or be extended into the changed spaces. This would build on whatever electrification provisions the jurisdiction chooses for the alterations section and should be seen as going beyond the requirements for alterations.

Add new text as follows:

R505.2 Additional energy efficiency packages. Where a space undergoing a change of occupancy is served by *combustion equipment,* it shall install one additional efficiency package option in addition to the requirements of Section R401.2.5.

Exception: *Alterations complying with Section R503.1.2 or R503.6.*

Many changes of occupancy are subject to full code compliance, which includes Section R408. This section requires that changes of occupancy that are served by combustion equipment implement an additional package option beyond new construction, for a total of two packages. The provision includes an exception for mixed-fuel alterations that are already required to comply with the ERI or EUI requirements of R503.1.2 or the additional package required by Section R503.6.

R506 ADDITIONAL EFFICIENCY

Add new text as follows:

SECTION R506
ADDITIONAL EFFICIENCY PACKAGE OPTIONS

R506.1 General. This section establishes additional requirements to achieve additional energy efficiency in existing buildings. Additional efficiency package options for compliance with Section R502.6, R503.6, and R505.2 are as follows:

1. Enhanced envelope performance in accordance with Section R408.2.1.
2. More efficient space-conditioning equipment performance in accordance with Section R408.2.2
3. Reduced energy use in service water-heating in accordance with Section R408.2.3
4. More efficient duct thermal distribution system in accordance with Section R408.2.4
5. Improved air sealing and efficient ventilation system in accordance with Section R408.2.5

Section R408 was added to the IECC in 2021. It requires new homes to include an additional efficiency option to achieve greater efficiency. There is one significant gap in R408, it does not apply to additions or alterations. R502 and R503 do not reference R408 in the sections with which additions and alterations must comply. The exclusion from Section R408 is a significant missed opportunity for efficiency in additions and alterations.

This proposal creates a framework to apply R408 to additions and substantial alterations. It creates a new Section R506 that provides guidance for how to utilize R408 packages for existing buildings. It works in conjunction with new sections R502.6 and R503.6 (see above) that establish which additions and alterations will need to comply with this section.

Where adopted, jurisdictions should include the revisions to Section R408 that are captured in the new construction versions of the Building Decarbonization Code which removes the incentive for more efficient gas equipment for all-electric requirements and adds an additional option for water heating systems for mixed fuel buildings.

Chapter 6 – Referenced Standards

Add new standard as follows:

ASHRAE

100---2018: Energy Efficiency in Existing Buildings

R503.1.2


Chicago, IL

Codes for Climate™

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