BUILDING ELECTRIFICATION:

HOW CITIES AND COUNTIES ARE IMPLEMENTING ELECTRIFICATION POLICIES

With Adoptable Code Language Based on 12 Case Studies

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SWEEP
SOUTHWEST ENERGY EFFICIENCY PROJECT

ABOUT SWEEP

The Southwest Energy Efficiency Project is a public interest organization dedicated to advancing energy efficiency in Arizona, Colorado, Nevada, New Mexico, Utah and Wyoming. For more information, visit www.swenergy.org.

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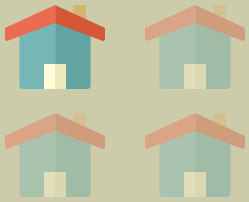
EXECUTIVE SUMMARY

Electrification means switching appliances and equipment that would otherwise run on natural gas—such as furnaces, water heating, stoves, and clothes dryers—to clean and efficient electric systems.



25% of U.S. houses are already all-electric. New, advanced electric technologies like heat pumps, heat pump water heaters, and induction stoves are already widespread and cost-effective.

Several dozen communities across the U.S. have accelerated the trend towards all-electric homes and buildings to meet their climate goals by amending their building codes and policies.

A SPECTRUM OF BUILDING CODE OPTIONS

INCENTIVES: Rebates, expedited permitting, reduced permit fees

ELECTRIC READY: Pre-wiring and panel capacity for future electric systems

ELECTRIC-PREFERRED: Extra efficiency or renewable requirements for new construction with natural gas

BUILDING TYPE SPECIFIC: All electric for certain types of buildings

ELECTRIC-ONLY WITH EXCEPTIONS: Requiring, for instance, electric heating and water heating but allowing gas stoves

ELECTRIC-ONLY: No fossil fuels allowed in new construction

INTRODUCTION

The number of U.S. cities, counties, and states with climate goals for their communities is growing by the day, accompanied by climate action plans that include more zero energy buildings, more electric vehicles, and a gradual elimination of fossil fuels.

Since buildings are responsible for about 40% of total energy use, they represent a large opportunity for reductions in energy and fossil fuels. (1) Although the focus over the last decade of many non-profits, research labs, builders, cities, states, and federal departments like Department of Energy has been on demonstrating and proliferating zero energy buildings, some cities are now looking one step beyond zero energy to zero carbon. Zero carbon requires eliminating all fossil fuels by gradually replacing fossil fueled equipment and appliances with electric versions, a process known as electrification. The electric grid, after all, is shifting over to renewable, carbon-free sources.

Can communities deploy achievable paths to reach all-electric zero carbon today? Some are trying. A few dozen communities in California and a few in Massachusetts have adopted, or are reviewing, either an outright ban of natural gas in new construction or limitations for specific appliances. Others are requiring increased energy efficiency measures when using fossil fuels in buildings, to offset some of the energy use and climate emissions.

In all cases, the communities adopted ordinances as an update to their adopted building codes. Here, we'll provide examples of some municipalities with some level of electrification requirements for new residential and commercial buildings, as well as specific proposed code language that any community can adopt to help reach zero carbon in new buildings.

WHAT IS BUILDING ELECTRIFICATION?

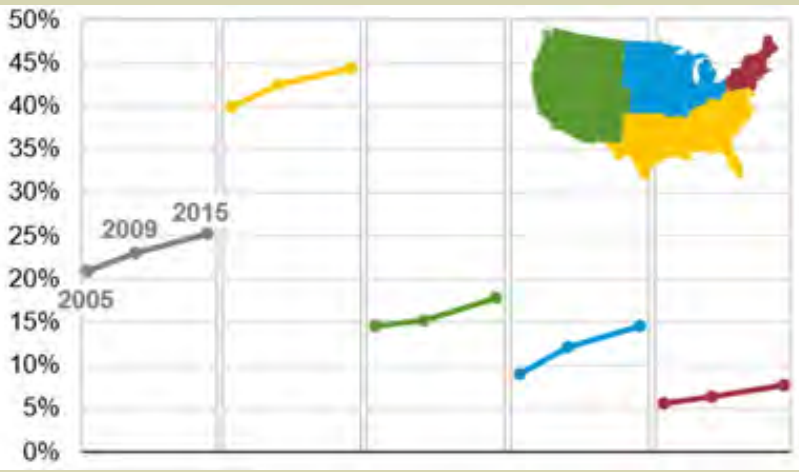
All-electric buildings have been around approximately 150 years. Building electrification is the process of moving from fossil fuel-powered buildings to electric powered buildings. Systems within the building, such as space heating, water heating, cooking appliances, and laundry, would be powered by electricity and would use highly efficient technology such as electric heat pumps and induction stoves. These are necessary steps for buildings to achieve 100 percent clean renewable energy and align with state and municipal climate goals.

DID YOU KNOW?

A QUARTER OF U.S. HOMES ARE ALREADY ALL-ELECTRIC

These homes use only electricity for space heating and cooling, cooking, clothes drying and water heat. These homes are located in both urban and rural areas and are served by both investor owned utilities and utility co-ops. Over the past decade, each U.S. census region has seen the share of all-electric homes rise, with higher concentrations occurring in the South and Midwest. (2)

ALL-ELECTRIC HOMES BY CENSUS REGION; SHARE OF PRIMARY RESIDENCES (2005, 2009, 2015)



Source: EIA Residential Energy Consumption Survey

BUILDING CODE APPROACHES

We present six approaches that states or municipalities can apply to their building codes to move towards electrification and zero carbon in new buildings:

- Electric Only
- Electric Only with Exceptions
- Electric Preferred
- Electric Ready
- Building Type-Specific
- Incentives

Each approach has its own place and benefit for a community. While one city may implement an electric-only strategy, a county may need to start with only a policy for specific systems or incentives. Over 30 cities and counties have adopted versions of these policies—most in California—starting in 2019.

- **Electric Only:** The electric-only approach is a complete prohibition of using fossil fuels in new construction. This approach only allows the use of natural gas in buildings with rare, legitimate design constraints. For all other new construction, common end uses such as heating, water heating, cooking, and clothes drying must all be electric, with no natural gas lines running to the house or building at all. Of all the approaches, the electric-only approach is the most clear-cut—although it may not be the easiest to implement for the community. The road to adoption will depend upon the current status of the energy code, the city's ambition to reach climate goals, as well as the relationships between the building department, sustainability department, local building industry, and public.

- **Electric Only with Exception:s** This approach is an entry into the electrification space by specifying that one or more systems within a building must be electrified—for instance, specifying that water heater must only use electric technology such as a heat pump water heater. Multiple mechanical systems can be specified while leaving other systems such as cooking appliances the option to continue using gas. A number of adopted policies currently require all electric except for fireplaces and cooking appliances, a distinction made for political purposes rather than technological, climate, or health purposes.

- **Electric-Preferred:** Another way to shift the scales towards electrification, while not outright banning fossil fuels, is to require only the base code for all-electric buildings while increasing the energy efficiency requirements of the building when fossil fuels are used. For instance, a number of cities using this approach require new homes or buildings with natural gas to be 10 percent more efficient than their all-electric counterparts, or to add one or more extra efficiency package options. Some cities also require solar be installed to offset the natural gas consumption.

  These alone are a mild push towards electrification, but if both are required—extra efficiency and solar—through requiring a low energy rating score, then in some cases all-electric can become all-but-inevitable. (See the Boulder case study to see what we mean here.)

DID YOU KNOW?

HEAT PUMPS ARE JUST AIR CONDITIONERS THAT CAN RUN BACKWARDS

Air-source heat pumps (ASHPs) have been installed in homes for decades to provide efficient space heating and cooling, but until the last few years they were mainly used in moderate or warm climates. The capacity and efficiency of older, conventional ASHPs were poor during cold weather conditions, resulting in heavy reliance on backup heating systems.

However, a new generation of ASHPs using variable-speed compressors has come into the market over the past five years, and these newer heat pump systems have demonstrated significantly improved heating performance under low temperature conditions (at or below 5°F), while continuing to offer highly efficient cooling in the warmer seasons.

With this dramatically improved cold-climate performance, ASHPs are becoming cost-effective in more areas of the U.S., potentially including the colder areas of the southwestern and mountain states. Heat pumps can reduce heating costs compared to alternative electric-resistance or fossil fuel-based heating and can also reduce CO2 emissions compared to other heat sources. For a full analysis, see SWEEP's 2018 report. (3)

BUILDING CODE APPROACHES
(cont'd)

- **Building Type-Specific:** This is where the community can apply any of the above approaches to just specific building types, such as residential single family, three-stories-or-less multifamily, townhomes, offices, or retail. This allows the municipality and the building industry to implement the policy for a narrower range of the market while planning a full requirement at a future date.

- **Electric-Ready:** The electric-ready path requires buildings to be designed and constructed to support the easy transition over to electric systems at any time during the life of the building. The electric-ready approach has the least impact to business-as-usual for new construction, yet is a good first step to move a community towards zero carbon. It doesn't prevent the use of fossil fuels in new buildings, but makes it much more likely a building can go all-electric in the future. This is achieved by requiring the wiring and electric capacity for systems such as the water heater, clothes dryer, stove, and HVAC.

  The 2021 International Energy Conservation Code (IECC), undergoing final Board approval and due for publication by the end of 2020, contains electrification pre-readiness for residential new construction. (4) An electric conductor, branch, and receptacle are required at each water heater, laundry drying appliance, and cooking appliance. With many communities poised to adopt the 2021 IECC when it's published, some degree of electrification will happen by default. That still leaves opportunities, though, for commercial electric-ready codes.

- **Incentives:** Incentives help shift the scales towards electrification by reducing the cost of electric systems or electric readiness compared to natural gas options. This approach could still allow the use of fossil fuels in buildings, or could be combined with any of the above approaches. Incentives could include rebates to consumers, builders, or installers, or it could include reductions in other soft costs such as expedited permitting or reduced permit fees. This option is the least controversial among builders but requires more local funds to support it.

DID YOU KNOW?

15% OF HOUSES USE ELECTRIC HEAT PUMPS AS MAIN SOURCE FOR HEATING

The Electric Power Research Institute's 2018 National Electrification Assessment shows that 15 percent of residential buildings and 9 percent of commercial buildings use electric heat pumps as the primary mechanical systems for space heating. An additional 19 percent of residential units and 17 percent of commercial buildings use electricity as the primary space heating source, with technologies other than air source heat pumps. We see big opportunities for electric heat pumps to support state and municipal environmental goals. Electric heat pumps use a third to half less energy than is required for heating systems using natural gas or propane. (5)


Photo: Peter Stevens via Flickr

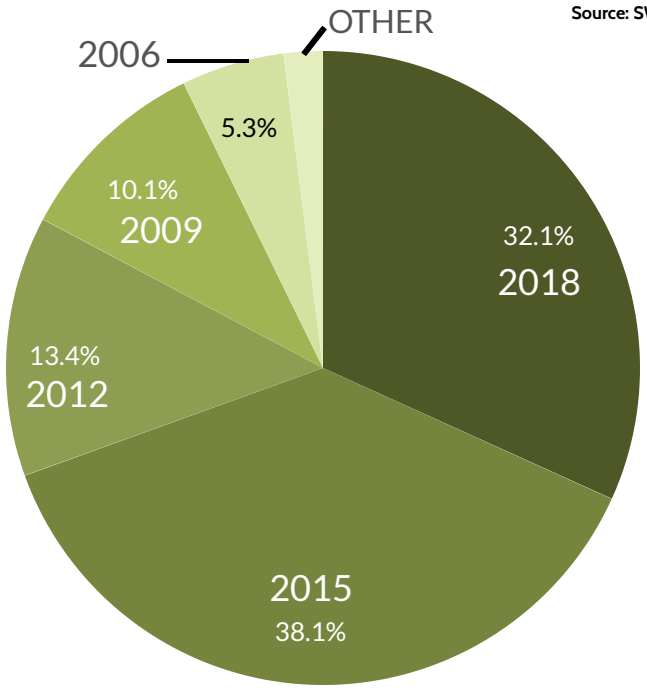
BASELINE OF NEW CODES

Understanding the baseline of new construction is the first step to move forward with an electrification strategy. The majority of new construction in the Southwest complies with at least the 2018 or 2015 IECC. And nearly all building construction in the Southwest is constructed to at least the 2009 IECC. (6) Because of this level of adoption and the similarities between the 2018 and 2015 IECC, we suggest the baseline code for electrification of buildings to begin with at least the 2018 IECC.

Location is another important factor for policymakers to understand. Nationwide, approximately 25 percent of homes are already all-electric. (7) Buildings in most major metropolitan areas have kept pace with newer codes. These buildings are energy efficient and can support occupant comfort needs with electric only space conditioning systems. Locations in colder climates almost always have gas heating systems for occupant comfort, since until recently, electric heating options such as air source heat pumps couldn't supply enough heat for the extra-cold temperatures. While the technology can now reach -20 degrees F, and dual-fuel can be an option, it will take a while for full market acceptance.

ENERGY CODE VERSIONS ADOPTED IN THE SOUTHWEST

Source: SWEEP estimates, 2020



EXAMPLES OF CITIES WITH ELECTRIFICATION IN CODES

The cities highlighted below have added electrification to their building codes through a municipal ordinance, with the participation of city councils, building departments, and sustainability staff. California cities leveraged the language in the statewide building energy code, Title 24, as their baseline code, which simplified the time requirements and development of code language at the municipality level.

WHAT SHOULD BE THE BASELINE CODE?

While California cities use the highly efficient and solar requirements of the California energy code Title 24, southwest states and most other U.S. states use the International Energy Conservation Code (IECC) as the primary mechanism for energy code design and compliance. The 2021 IECC, as approved by governmental members, includes the first step of electrification for homes. We encourage all jurisdictions to update to at least the 2021 IECC when it's available, and to stay up to date on code adoption.

DID YOU KNOW?

INDUCTION COOKING IS FASTER, SAFER, AND MORE EFFICIENT

Induction cooking was first introduced at the World's Fair in Chicago in 1933, and their market share has risen to about 8 percent today. (8) Chefs, consumer review organizations, and everyday cooks are lauding the benefits of induction cooking.

Consumer Reports has shown that no other cooking technology they have tested is faster at bringing six quarts of water to a boil —two to four minutes faster than gas stoves or regular electric stoves. (9) HGTV states induction cooktops are among the safest technologies for a kitchen. (10) Induction cooking is also more energy efficient than electric or gas—10-20 percent more efficient —because heat isn't lost in the transfer of heat to the cookware. (11)

ELECTRIC-ONLY


Photo: snickclunk via Flickr

BERKELEY, CA

Berkeley moved first in the nation with an ordinance in July 2019 to prohibit natural gas in all new construction, for reasons of public health and safety. (14) Reaching out to stakeholders, the city gained support for the ordinance from utilities, builders, trades, and environmental groups. In 2019 the city found itself 18% behind its incremental 2020 goals in its climate action plan, so this next step took on more importance. (15)

The city did not provide incremental pathways for the building community to electrify buildings. The ordinance provides limited exceptions where all-electric is unfeasible. (16) Any building with natural gas still must provide sufficient electric capacity and conduit/systems to facilitate the building being fully electrified.

LOCATION: San Francisco bay area
POPULATION 2019: 120,000 (12)
RES CONSTRUCTION STARTS 2019: 300 (13)
APPLICABILITY: Residential, commercial


Photo: Rojer via Flickr

WINDSOR, CA

Windsor, a small town in northern Sonoma County, passed an updated building code ordinance in September 2019 that mandates all-electric construction for new low-rise residential buildings, including multifamily three stories or less, single family, and new detached accessory dwelling units (ADUs). Natural gas infrastructure is not allowed in these buildings and no exceptions are provided. (17)

The Windsor ordinance is a very simple law. It defines an all-electric building and then requires construction to meet the definition. The remainder of the base energy and construction codes continue to be the state building codes.

LOCATION: Northern Sonoma County
POPULATION: 27,000 (12)
RES CONSTRUCTION STARTS: N/A
APPLICABILITY: Low-rise residential, detached ADUs

SAN JOSE, CA

San Jose, the tenth largest city in the U.S., and the center of Silicon Valley, moved forward with an electrification ordinance in September 2019. It applies to new low-rise residential buildings and new municipal buildings. At first, San Jose required pre-wiring including a reserved space in the electric panel, conductors, receptacles, and junction boxes for electric appliances and electric vehicles. (18) One month later San Jose replaced their ordinance with a full prohibition of natural gas infrastructure in new single family, low-rise residential (3-stories or less) and detached ADUs. (19) The natural gas ban does not apply to commercial buildings.

LOCATION: Heart of Silicon Valley
POPULATION 2019: 1 million (12)
RES CONSTRUCTION STARTS 2019: 2,300 (13)
APPLICABILITY: Low-rise residential, municipal


Photo: Eric Fredericks via Flickr

ELECTRIC-ONLY WITH EXCEPTIONS

SANTA ROSA, CA

LOCATION: Sonoma County
POPULATION: 177,000 (12)
RES CONSTRUCTION STARTS: 1,200 (13)
APPLICABILITY: Low-rise residential

The City of Santa Rosa city council voted unanimously in November 2019 to implement an all-electric code for new construction. The city council focused on the benefits of electrification for the city's long-term climate resilience plan. (20) The city also saw a devastating wildfire in October 2017 where over 5,600 structures were destroyed. The council saw electrification as a path for increased safety for its citizens.

The ordinance applies to low-rise residential buildings. The only exemption is for fireplaces. It provides a few options for electric hot water systems, including an electric heat pump water heater, a solar water heating system, or plumbing designed with recirculation loops and pumps. (21)

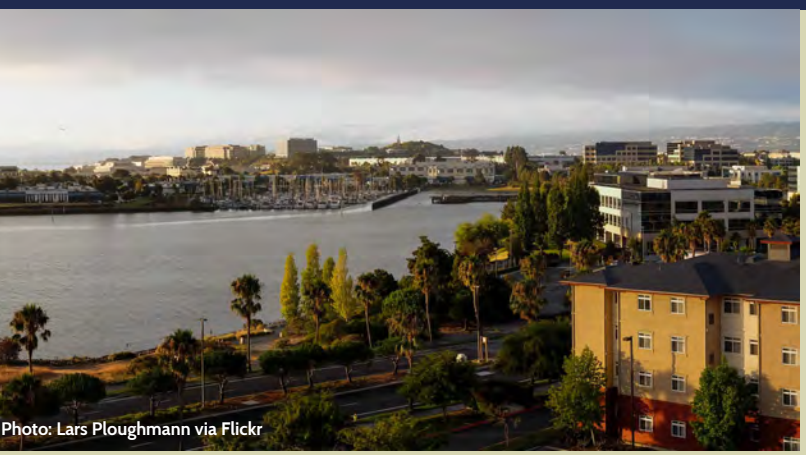


Photo: Lars Ploughmann via Flickr

BRISBANE, CA

LOCATION: Adjacent to San Francisco
POPULATION 2019: 6,000 (12)
RES CONSTRUCTION STARTS 2019: 10 (13)
APPLICABILITY: Residential

Brisbane is a small city, only 20 square miles, tucked in between San Francisco and the San Francisco International Airport. Since it's small, it has relatively little construction activity. The ordinance passed city council in November 2019 and requires electric-only residential new buildings, with the exception of cooking appliances and fireplaces, which may continue to use gas. Electric pre-wire is required with panel capacity and outlets if gas cooking appliances are installed. (22)

CUPERTINO, CA

LOCATION: West of San Jose
POPULATION 2019: 60,000 (12)
RES CONSTRUCTION STARTS 2019: 70 (13)
APPLICABILITY: Residential, commercial

The City of Cupertino, home of Apple Inc., adopted an electrification ordinance in late 2019 to align with the city's climate action plan to reduce carbon emissions 83% by 2050. (23) It applies to residential and commercial new construction and includes the exterior of new buildings such as outdoor pools, spas and barbeques, as well as Accessory Dwelling Units (ADUs). The ordinance does not include commercial F, H, and L occupancies; additions and tenant improvements in commercial buildings; and kitchens in commercial buildings, though pre-wiring for each gas appliance is required. Pre-wire provisions include the reserved space in the electric panel, conductors, receptacles, and junction boxes. (24)

ELECTRIC-ONLY WITH EXCEPTIONS
(cont'd)

PACIFICA, CA

The City of Pacifica passed an ordinance in November, 2019 to require several appliances be electrified, while exempting other appliances.

The ordinance is written to require buildings to be all-electric, but provides exceptions for certain appliances stoves and fireplaces in residential units as well as additions, remodels, and ADUs. On the commercial side, the code exempts public emergency centers like police and fire as well as non-residential kitchens. Where gas is used, the code requires panel capacity, appropriately sized conduit, junction boxes, labeling, and prewiring installation within three feet of the gas plumbing appliance connections. (25)

LOCATION: Pacific coast south of San Francisco
POPULATION: 38,000 (12)
RES CONSTRUCTION STARTS: 20 (13)
APPLICABILITY: Residential and commercial

BROOKLINE, MA

The Town of Brookline's environmental goals along with the state climate goals incentivized the town to move forward with some level of electrification for new construction and major renovations. Brookline started with the approach of Berkeley and other cities to ban gas and oil outright, but settled on only allowing gas connections for specific systems including commercial cooking, outdoor heating and cooking, and back-up generators. (26)

The city received notification from the Massachusetts attorney general that Brookline cannot update its building code to all-electric requirements, since Massachusettes has a statewide code. The communities of Cambridge, Lexington, and Newton, Massachusetts have also advanced similar local bans on natural gas and oil. These communities will now observe any changes at the state level as a result of this ruling.

LOCATION: Greater Boston area
POPULATION 2019: 58,000 (12)
RES CONSTRUCTION STARTS 2019: 12 (13)
APPLICABILITY: Residential and commercial

Photo: Peyton Chung via Flickr

ELECTRIC-PREFERRED

SANTA MONICA, CA

The City of Santa Monica was the first city in Los Angeles County to pass an electrification code in September 2019. Santa Monica's ordinance does not require new construction to be built gas free, but they do encourage electrification readiness by requiring increased energy efficiency measures in a mixed-fuel building. The ordinance applies to new residential and commercial buildings and is an outgrowth from the city's climate action plan to move to 100% renewable grid electricity. (27)

All-electric buildings must comply with base state code energy requirements. When new heated pools are installed either a heat pump or solar water heating system is also required.

Mixed-fuel residential buildings have increased efficiency requirements where they must reach Tier 1 of the state's green code, and single family houses must have an Energy Design Rating (EDR) of ≤10 points. (The EDR is comparable to the IECC's Energy Rating Index (ERI) compliance path.) (28)

Mixed-fuel high rise multifamily buildings and hotels must be five percent more efficient than the state code and other commercial buildings must be 10 percent more efficient than state code. Major additions have requirements for solar to offset the increased conditioned space. (29)

LOCATION: L.A. metro area
POPULATION 2019: 91,000 (12)
RES CONSTRUCTION STARTS 2019: 90 (13)
APPLICABILITY: Residential, commercial

MARIN COUNTY, CA

Marin County, located across the Golden Gate Bridge from San Francisco, saw its county commissioners update the building code in October 2019. Marin County's approach is to provide flexibility to the building industry and code while incorporating the county's goal of electrification.

The Marin County code favors electrification through three compliance paths; all electric, limited mixed fuel, and mixed fuel buildings. The county only requires the state code baseline as the basis for constructing an all-electric building. The limited mixed-fuel approach only allows gas cooking appliances and has a minimal number of increased efficiency requirements. A mixed fuel building has the highest level of stringency, requiring electrification readiness and Tier 1 of the state green code. The building must also have an EDR margin of 10. (28)

Additions to single family and two-family buildings do not have electrification requirements. Multifamily three stories or less have similar compliance paths as single family but require electric vehicle parking spaces.

Commercial buildings, including high rise residential, have three similar paths for compliance demonstrating energy savings above the baseline building, and the buildings must have electric vehicle spaces that are ready or capable. (30)

LOCATION: Adjacent to San Francisco
POPULATION 2019: 250,000 (12)
RES CONSTRUCTION STARTS 2019: 49 (13)
APPLICABILITY: Residential, commercial

Photo: Brocken Inaglory via Wikimedia

ELECTRIC-PREFERRED (cont'd)

SAN MATEO, CA

The City of San Mateo first passed its climate action plan in 2015 which contained electric vehicle goals but did not include building electrification. (31) As the climate plan evolved, building electrification was brought into the scope and the later versions include electrification across industries in the city. The city passed a building electrification ordinance in September 2019. (32)

The city has chosen to use an incentive mechanism to encourage buildings using electricity instead of gas.

The code allows all-electric buildings with no gas or propane plumbing installed in the building. It also allows mixed fuel buildings where gas or propane can be used for space heating, water heating, cooking appliances or clothes drying. If a building includes gas infrastructure the building will need to be more energy efficient than an all-electric building. Office buildings need to be at least 10 percent more efficient than the state building code baseline, and multifamily and single-family buildings need to be at least 2.5 EDR points lower than code. (28, 33)

LOCATION: South of San Francisco, north of Silicon Valley
POPULATION 2019: 770,000 (12)
RES CONSTRUCTION STARTS 2019: 12 (infill) (13)
APPLICABILITY: Residential, commercial

SAN LUIS OBISPO, CA

Photo: Marelbu via Wikimedia

In September 2019, the City of San Luis Obispo adopted an ordinance called the Clean Energy Choice Program that steers residential builders and developers toward all-electric. It incentivizes builders and developers to modify new home designs with electrification readiness and more energy efficiency. An in-lieu fee for mixed fuel buildings will be based on the building's expected gas consumption. The city plans to also create a fund for consumers to use for retrofitting home appliances to electric.

The building code requires buildings with gas and electric to be designed and built using the energy budget method in California (comparable to the performance pathway in the IECC).

The code also requires designated space for a future heat pump compressor unit(s) with drainage requirements, plus electric panel capacity of 208/240 volt, 30-amp or greater circuit terminating no further than three feet from the compressor space. Multifamily buildings have additional requirements when space conditioning equipment serves more than one dwelling unit.

Water heating systems must also support electrification and future installation of a heat pump water heater. Requirements include electric panel capacity of 30-amp, pre-wire and labeling. Clothes drying (30-amp) and cooking appliances (40-amp) follow the pattern and require electrical panel capacity and pre-wire within three feet of appliance location. (34, 35. 36)

LOCATION: Central coast of California
POPULATION 2019: 47,400 (12)
RES CONSTRUCTION STARTS 2019: 330 (13)
APPLICABILITY: Residential, commercial

ELECTRIC-PREFERRED (cont'd)

BOULDER, CO

The City of Boulder requires its adopted code be at least a 20 percent more efficient than the latest national model energy code. It also has several ordinances for building efficiency including rental housing updates and zero energy codes, plus a climate action plan to move to 100% renewable energy by 2030. (37, 38, 39)

The City of Boulder's approach for new residential construction electrification differs from other approaches by using RESNET's Home Energy Rating System (HERS) scoring system, similar to IECC's energy rating index. Rather than banning gas, the city requires new homes over 5,000 square feet to be net zero (HERS score of 0) and homes 3,000-4,999 square feet to achieve a HERS score of 20 or less. After a house is designed to be as efficient as possible (typically with HERS scores in the low 40s), it must obtain the rest of its energy from solar—not just covering electric load but compensating for natural gas therms as well. However, because the calculation includes therms converted to kW, some houses need more solar than is allowed under state law (which caps solar at 120% of a customer's connected electric load). Thus, new homes in Boulder can only practicably achieve these low scores with electrification. The new homes would still be able to use natural gas for cooking if desired, one of the main reasons the city took this approach.

LOCATION: Northwest of Denver, CO
POPULATION 2019: 107,000
RES CONSTRUCTION STARTS 2019: N/A
APPLICABILITY: Residential, commercial

CONCLUSION

Increased electrification is a must for the Southwest. All-electric buildings present significant opportunities for municipalities to support economic savings for new construction, long term operating costs savings for owners/tenants, and reductions in carbon emissions for the community. These benefits support families across the economic spectrum from affordable housing to new luxury properties. Moving new construction to electric space heating, cooking, laundry, water heating, and transportation future-proofs communities and the buildings themselves.

Cities, counties, and states can ease into electrification or make a leap to all-electric buildings,depending upon the demographics of the community, the building industry knowledge, and conservation goals set by governmental entities. Many cities have taken the first steps and more will follow. Knowing that a quarter of new homes are already all electric makes it a light lift for jurisdictions to adopt and implement electrification policy. The International Code Council's governmental members approved the first steps for residential electrification in the 2021 IECC by including EV infrastructure and prewiring for heating, cooking, and clothes drying.

For the electrification trend to continue, city councils, county commissions, utilities, regulators and building efficiency advocates must be increasingly aware of policy options in energy codes. Electrification has the potential to bring savings, economic growth, and environmental benefits to all citizens across the Southwest.

POTENTIAL ELECTRIFICATION MODEL CODE LANGUAGE APPENDIX

Included in this report's appendix are potential model code language options a municipality can use when implementing electrification in their community. As you can see, municipalities have implemented a variety of approaches, with some stepping into electrification cautiously and others allowing only the construction of electric buildings.

The model code conceptual language can be adopted and modified based upon the needs of each community and the types of new building stock anticipated.

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APPENDIX: ADOPTABLE CODE LANGUAGE

This appendix provides conceptual code language for jurisdictions to use when implementing an electrification policy at the city or county level. The narrative includes language for communities moving to all-electric construction, electric preferred construction, or electric mechanical systems such as water heat or spacing conditioning systems. Language is included for new residential and commercial buildings. Existing buildings are not addressed in this appendix language but could easily be adapted from new construction requirements.

As described in the main report, here are varying approaches, including incentive code language and the concept from the proposed 2021 IECC approved by the online governmental ICC member voters.

Note: The code language uses the Times New Roman font while the narrative and descriptions use the Cabin font like this paragraph. The code language is also indented to better distinguish code language from narrative and descriptive information.

- Electric Only
- Electric Only for Specific Systems
- Electric Preferred
- Electric-Ready (2021 IECC Residential Buildings)
- Electric Incentives

ELECTRIC ONLY

The following all-electric code concept language can be amended into a jurisdiction's adoption of the IECC. Suggested section numbering may differ because of the IECC version adopted in each jurisdiction. The numbering sequence for this concept language aligns with the 2018 IECC.

COMMERCIAL CODE CONCEPT

Add to C202 Definitions:

> **ALL-ELECTRIC BUILDING**. A building that has no natural gas or propane plumbing installed within the building, and that uses electricity as the sole source of energy for its space heating and cooling, water heating (including pools and spas), cooking appliances, and clothes drying appliances. All-electric buildings may include solar thermal water and pool heating.

Add new sections to Chapter 4 of the commercial energy code:

> **C401.1.1 Building Electrification**. All newly constructed buildings shall be constructed as an *all-electric building*. Natural gas or propane plumbing shall not be installed within the building or the building site.
>
> > **Exception:** Where it is unfeasible to construct the building without a gas infrastructure the builder/developer must substantiate feasibility to the building official.

[List additional exceptions, if any, that may be appropriate for the jurisdiction. Exceptions may include additions to buildings, tenant improvements or other renovations to the building. Certain building occupancies may not comply due to the uses of the building. Examples include factories and industrial, buildings where high-hazard occupancy exists, and institutional group buildings such as hospitals.]

C403.1.2 Heating and cooling electrification. Space conditioning equipment shall meet the requirements for an *all-electric building*.

C404.1.1 Water heating electrification. Service water-heating equipment shall meet the requirements for an *all-electric building*.

C405.10 Cooking and clothes drying electrification. Clothes drying and cooking equipment shall meet the requirements for an *all-electric building.*

Exception:
[List individual exceptions for each new code sections, if any, that may be appropriate for the jurisdiction.]

RESIDENTIAL CODE CONCEPT

Add to R202 Definitions:

ALL-ELECTRIC BUILDING. A building that has no natural gas or propane plumbing installed within the building, and that uses electricity as the sole source of energy for its space heating and cooling, water heating (including pools and spas), cooking appliances, and clothes drying appliances. All-electric buildings may include solar thermal water and pool heating.

Replace Section R401.2 Compliance, to require building electrification:

R401.2 (N1101.13) Compliance. Projects shall comply with section R404.2 and with one of the following:

Options 1, 2 and 3 of section R401.2 remain unchanged.

Remove Section R404.1.1. Gas infrastructure is not included within the building and therefore this section is no longer relevant.

Add new sections to R404:

R404.2 (N1104.2) Building Electrification (Mandatory). All newly constructed *residential buildings* shall be constructed as an *all-electric building*. Natural gas or propane plumbing shall not be installed within the building.

R404.2.1 (N1104.2.1) Utility infrastructure. Where it is unfeasible to construct the *residential building* without a gas infrastructure the builder/developer must substantiate feasibility to the building official.

Exception:
[List exceptions, if any, that may be appropriate for the jurisdiction.]

Add text and the following new sections in the IECC residential provisions to support all-electric buildings:

> **R404.3 (N1104.3) Heating and cooling electrification (Mandatory)**. Space conditioning equipment shall meet the requirements for an *all-electric building*. Equipment shall comply with the National Appliance Energy Conservation Act of 1987 (NAECA).
>
> **R404.3.1 (N1104.3.1) Heating and cooling system**. Space conditioning systems shall be a heat pump system and comply with Section R404.3.
>
> **R404.4 (N1104.4) Cooking and clothes drying electrification (Mandatory)**. Clothes drying and cooking equipment shall meet the requirements for an *all-electric building.*
>
> **Exceptions:**
> [List exceptions, if any, that may be appropriate for the jurisdiction.]

Update R403.5 to include the electrification of water heating systems. Replace R403.5 with the following language. This language includes the renumbering of sections R403.5.x:

> **R403.5. (N1103.5) Service hot water systems**. Energy conservation measures for service hot water systems shall be in accordance with Sections R403.5.1 through R403.5.5.

Insert the following water heating requirements as R403.5.1 and R403.5.1.1 and renumber the 2018 IECC section R403.5.1 requirements to follow as R403.5.2 through R403.5.5:

> **R403.5.1 (N1103.5.1) Water heating electrification (Mandatory)**. Service water-heating equipment shall meet the requirements for an *all-electric building*.
>
> **R403.5.1.1 (N1103.5.1.1) Water heating system.** Water heating systems shall be a heat pump water heating system and shall comply with the National Appliance Energy Conservation Act of 1987 (NAECA).

ELECTRIC PREFERRED + ELECTRIC READY

The following electric-preferred concept language provides a mechanism for jurisdictions to allow fossil fuels but tilt builders towards all-electric. Two ways to do this—prescriptive and performance—can both be incorporated into the IECC.

Municipalities that have adopted these codes have required mixed-fuel buildings to be a certain percent more efficient than all-electric, often 10 percent. This performance-based method requires that all buildings have some level of energy modeling performed, and since California's code is primarily a performance-based code, this type of modeling is already standard.

The IECC, though, has both prescriptive and performance compliance pathways, so it's a good idea to incorporate a comparable prescriptive solution. The 2018 IECC prescriptive pathway in C406 requires designers to choose a minimum of one additional efficiency package, out of eight total. Expanding the number of required additional efficiency packages for mixed-fuel buildings to three, four, or more will increase the building's efficiency and possibly influence building design as an all-electric building.

Suggested section numbering may differ because of the IECC version adopted in each jurisdiction. The numbering sequence for this concept language aligns with the 2018 IECC.

COMMERCIAL CODE CONCEPT

Add to C202 Definitions:

ALL-ELECTRIC BUILDING. A building that has no natural gas or propane plumbing installed within the building, and that uses electricity as the sole source of energy for its space heating and cooling, water heating (including pools and spas), cooking appliances, and clothes drying appliances. All-electric buildings may include solar thermal water and pool heating.

MIXED-FUEL BUILDING. A building that uses natural gas or propane as fuel for space heating and cooling, water heating (including pools and spas), cooking appliances or clothes drying appliances, or is plumbed for such equipment.

Add new sections to Chapter 4 of the commercial energy code:

C401.1.1 Building electrification (Mandatory). All newly constructed buildings shall be constructed as an *all-electric building* or *mixed-fuel building* pre-wired for future space heating, water heating, cooking and clothes drying equipment.

C401.1.2 Mixed-fuel buildings. *Mixed-fuel buildings* shall use less energy than *all-electric buildings* by complying with [X] or more efficiency package options in Section C406.

Exception:
[List exceptions, if any, that may be appropriate for the jurisdiction. Exceptions may include additions to buildings, tenant improvements, or other renovations to the building. Certain building occupancies may not comply due to the uses of the building. Examples include factories and industrial, buildings where high-hazard occupancy exists, and institutional group buildings such as hospitals.]

Add text and the following new sections in the IECC commercial provisions to support all-electric or mixed-fuel buildings.

C403.1.2 Heating electrification. Space conditioning equipment shall meet the requirements for an *all-electric building* or *mixed-fuel building* with Section C401.1.1.

C404.1.1 Water heating electrification. Service water-heating equipment shall meet the requirements for an *all-electric building* or *mixed-fuel building* with Section C401.1.1.

C405.10 Cooking and clothes drying electrification. Clothes drying and cooking equipment shall meet the requirements for an *all-electric building* or *mixed-fuel building* with Section C401.1.1.

Exception:
[List exceptions, if any, that may be appropriate for the jurisdiction.]

RESIDENTIAL CODE CONCEPT

Add to R202 Definitions:

ALL-ELECTRIC BUILDING. A building that has no natural gas or propane plumbing installed within the building, and that uses electricity as the sole source of energy for its space heating and cooling, water heating (including pools and spas), cooking appliances, and clothes drying appliances. All-electric buildings may include solar thermal water and pool heating.

MIXED-FUEL BUILDING. A building that uses natural gas or propane as fuel for space heating and cooling, water heating (including pools and spas), cooking appliances or clothes drying appliances, or is plumbed for such equipment.

Replace Section R401.2 Compliance, to require building electrification:

R401.2 (N1101.13) Compliance. Projects shall comply with Section R404.2 through R404.5, R403.5 and with one of the following:

Options 1, 2 and 3 of section R401.2 remain unchanged.

R404.2 (N1104.2) Building electrification (Mandatory). All newly constructed *residential buildings* shall be constructed as an *all-electric building* or *mixed-fuel building* pre-wired for future space heating and cooling, water heating, cooking and clothes drying equipment.

R404.2.1 (N1104.2.1) Future electrical requirements. *Mixed-fuel buildings* shall provide dedicated electric panel space, electrical wire, electrical receptacles, and adequate panel capacity for the future installation of space heating and cooling, water heating, cooking and clothes drying equipment.

R404.3 (N1104.3) Mixed-fuel buildings (Mandatory). *Mixed-fuel buildings* shall use less energy than the allowed energy budget of the base energy code requirements. Mixed-fuel buildings shall use either Section R405 or R406 to show energy code compliance.

R404.3.1 (N1104.3.1) Simulated performance for single and two-family mixed-fuel buildings. Where single and two-family buildings are constructed as *mixed-fuel buildings* the simulated performance compliance margin shall be [X] percent more efficient than the standard reference design.

R404.3.2 (N1104.3.2) Simulated performance for multi-family mixed-fuel buildings. Where multi-family buildings are constructed as *mixed-fuel buildings* the simulated performance compliance margin shall be [X] percent more efficient than the standard reference design.

R404.3.3 (N1104.3.3) ERI compliance for single and two-family mixed-fuel buildings. Where single and two-family buildings are constructed as *mixed-fuel building*s the ERI compliance margin shall be [X] ERI points lower than values in Table R406.4.

R404.3.4 (N1104.3.4) ERI compliance for multi-family mixed-fuel buildings. Where multi-family buildings are constructed as *mixed-fuel building*s the ERI compliance margin shall be [X] ERI points lower than values in Table R406.4.

Exception:
[List exceptions, if any, that may be appropriate for the jurisdiction. Exceptions may include additions to buildings, partial or major renovations to the building and Accessory Dwelling Units.]

Separating requirements for single-family and multi-family buildings allows municipalities to apply different local requirements for each building type. This is not a requirement and the same Energy Rating Index (ERI) or performance efficiency requirements can be applied to both single and multifamily buildings.

Add text and the following new sections in the IECC residential provisions to support all-electric buildings. The residential provisions of the IECC do not specify heating or cooling efficiency, as the National Appliance Energy Conservation Act (NAECA) sets the efficiency requirements for the residential IECC.

R404.4 (N1104.4) Heating and cooling electrification (Mandatory). Space conditioning equipment shall meet the requirements for an *all-electric building* or *mixed-fuel building* with Section R404.2. Equipment shall comply with the National Appliance Energy Conservation Act of 1987 (NAECA).

R404.4.1 (N1104.4.1) Heating system. Heating systems shall be a heat pump heating system. Where a heat pump is not installed in a *mixed-fuel building*, compliance is with Section R404.2.

R404.5 (N1104.5) Cooking and clothes drying electrification (Mandatory). Clothes drying and cooking systems shall meet the requirements for an *all-electric building* or *mixed-fuel building* with Section R404.2.

Exception:
[List exceptions, if any, that may be appropriate for the jurisdiction.]

Update R403.5 to include the electrification of water heating systems. Replace R403.5 with new language and add section R403.5.5.

R403.5 (N1103.5) Service hot water systems. Energy conservation measures for service hot water systems shall be in accordance with Sections R403.5.1 through R403.5.5.

R403.5.5 (N1103.5.5) Water heating electrification (Mandatory). Service water-heating equipment shall meet the requirements for an *all-electric building* or *mixed-fuel building* with Section R404.2.

R403.5.5.1 (N1103.5.5.1) Water heating system. Water heating systems shall be a heat pump water heating system and shall comply with the National Appliance Energy Conservation Act of 1987 (NAECA).

R403.5.5.2 (N1103.5.5.2) Water heating serving individual dwelling units. Electric water heating systems shall be a heat pump water heating system. Where a heat pump water heating system is not installed in a *mixed-fuel building*, compliance is with Section R404.2.

R403.5.5.3 (N1103.5.5.3) Water heating serving multiple dwelling units. Service water-heating systems shall meet the requirements for an *all-electric building* or *mixed-fuel building* with Section R404.2. Water heating systems supporting multiple dwelling units shall meet the requirements of Sections C404.3 through C404.8.

R403.5.5.4 (N1103.5.5.4) Water heater space. Indoor water heater space shall be at least 3 feet by 3 feet by 7 feet high surrounding or within 3 feet of the installed water heater.

Exception: The water heater space requirement is not required where a heat pump water heater or tankless water heater is installed.

ELECTRIC-READY (2021 IECC PRE-WIRE FOR RESIDENTIAL BUILDINGS)

At the time of the release of this report, the 2021 IECC is still awaiting final approval by the ICC Board. The following code language is the new requirements approved by the online governmental ICC member voters in December 2019. Several appeals are pending, including the electrification readiness.

This language only supports residential new construction; commercial buildings were not addressed for electrification readiness in the 2021 IECC.

RESIDENTIAL CODE CONCEPT

Add new sections to R404 in the IECC.

> **R404.2 (N1104.2) Electric readiness (Mandatory)** Systems using gas or propane water heaters, dryers, or conventional cooking equipment to serve individual dwelling units shall comply with the requirements of Sections R404.2.1 and R404.2.2. All water heating systems shall comply with Section R404.2.3.
>
> **R404.2.1 (N1104.2.1) Receptacle.** A dedicated 125-volt, 20-amp electrical receptacle that is connected to the electric panel with a 120/240 volt 3 conductor, 10 AWG copper branch circuit, shall be provided within 3 feet from each gas or propane water heater, dryer, and conventional cooking equipment, accessible with no obstructions.
>
> **R404.2.2 (N1104.2.2) Electrification-ready circuits.** Both ends of the unused conductors shall be labeled with the word "SPARE" and be electrically isolated. A single pole circuit breaker space shall be reserved in the electrical panel adjacent to each circuit breaker for the branch circuit and labeled with the words "FUTURE 240V USE."
>
> **R404.2.3 (N1104.2.3) Water heater space.** An indoor space that is at least 3 feet by 3 feet by 7 feet high shall be available within 3 feet of the water heater.
>
> > **Exception:** The water heater space requirement does not need to be met where a heat pump water heater is installed.

ELECTRIC-READY FOR SPECIFIC SYSTEMS

The following residential building concepts supports a municipality that intends to move forward with electrification in their code development process, albeit only one system at a time.

The following language supports the movement of domestic water heat systems to electricity. Fossil fuel water heating systems are allowed, but additional electric requirements must also be installed.

This concept code language only updates section R404 of the IECC and applies only to a specific system. Since there is not an all-electric approach for the building, the definition of an all-electric building and the requirements are not included in Chapter 3. This water heating concept is similar to the new requirements approved by the online governmental ICC member voters in the 2021 IECC.

This approach could be used to electrify other systems such as heating, cooking, or laundry in a future code update. The numbering sequence for this concept aligns with the 2018 IECC.

RESIDENTIAL CODE CONCEPT FOR HEAT PUMP WATER HEATING SYSTEM

Add new section to Chapter 4:

R404.2 (N1104.2) Water heating electrification (Mandatory). All newly constructed *residential buildings* shall be constructed with an electric heat pump water heating system or pre-wired to support an electric heat pump water heating system.

R404.2.1 (N1104.2.1) Future water heating electrical requirements. Residential buildings using gas or propane as the fuel source for heating domestic water shall include a dedicated 125 volt, 20 amp electrical receptacle that is connected to the electric panel with a 120/240 volt 3 conductor, 10 AWG copper branch circuit within 3 feet from the water heater and accessible to the water heater with no obstructions.

R404.2.2 (N1104.2.2) Labeling. Both ends of the unused conductor shall be labeled with the word "SPARE" and be electrically isolated.

R404.2.3 (N1104.2.3) Circuit. A single pole circuit breaker space shall be reserved in the electrical panel adjacent to the circuit described in Section R304.1.1 and labeled with the words "Future 240V Use."

R404.2.4 (N1104.2.4) Water heating serving multiple dwelling units. Water heating systems supporting multiple dwelling units shall meet the requirements of Sections R404.2.1, R404.2.2, R404.2.3 and Sections C404.3 through C404.8.

RESIDENTIAL CODE CONCEPT FOR HEAT PUMP HEATING AND COOLING SYSTEM

Concept for heat pump heating and cooling system requirements.

Add new section to Chapter 4:

R404.2 (N1104.2) Heating and cooling electrification (Mandatory). Space conditioning equipment shall be constructed with an electric heat pump space conditioning system or pre-wired to support an electric heat pump system. Equipment shall comply with the National Appliance Energy Conservation Act of 1987 (NAECA).

R404.2.1 (N1104.2.1) Future heating and cooling electrical requirements. Residential buildings using gas or propane as the fuel source for space conditioning shall include a dedicated 208/240 volt, 30 amp or greater electrical circuit connected to the electric panel, terminating within 3 feet from the designated future location of the compressor unit and shall comply with:

1. Both ends of the conductor shall be labeled with the word "For Future Heat Pump Heat/Cooling" and electrically isolated.
2. A double pole circuit breaker in the electrical panel labeled with the words "For Future Heat Pump Heat/Cooling", and

3. Other electrical components, including conductors and receptacles supporting this section and installed in accordance with the National Electric Code.

R404.2.2 (N1104.2.2) Future electric heating and cooling requirements serving multiple dwelling units. Equipment serving more than one dwelling unit shall include all three requirements from R404.2.1. The electric capacity, determined at 240 volts per the National Electric Code, shall include raceways and service and panel capacity for a termination point 3 feet from each gas space conditioning outlet.