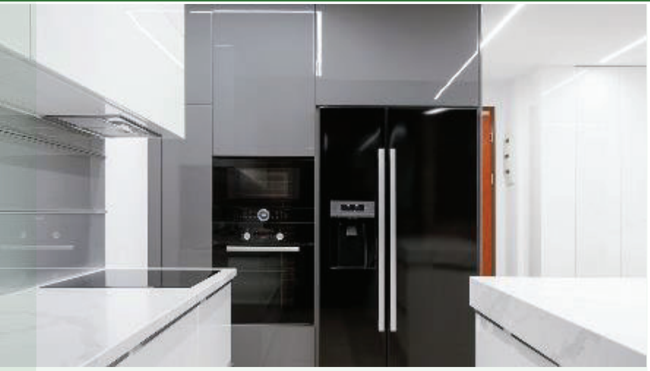
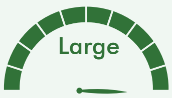
E-15. Require All-Electric Development



GHG Mitigation Potential



Potentially large reduction in GHG emissions from building energy use

Co-Benefits (icon key on pg. 34)

Climate Resilience

Requiring all-electric development can reduce sensitivity to fuel price shocks or scarcity and offer more reliability if electricity providers have been adapted to climate change. However, this may decrease resilience if the grid has not been adapted to climate change and if there are no non-electric backup options during a power outage.

Health and Equity Considerations

Elimination of natural gas combustion in homes will improve indoor air quality, as natural gas appliances produce pollutants such as NOx, formaldehyde, and CO. Plans, backups, and contingencies should be in place in the event of extended power failure (consider implementing with Measure E-23, *Use Microgrids and Energy Storage*, in Table 3-2).

Measure Description

This measure requires that residential or commercial developments use all-electric appliances and end uses. Using electric instead of natural gas-powered appliances and end uses replaces a more emissions-intensive fossil fuel source of energy with a less emissions-intensive source of energy, electricity from the grid that is increasingly transitioning to renewable sources.

Subsector

Building Decarbonization

Scale of Application

Project/Site and Plan/Community

Implementation Requirements

It is expected that user's building would electrify the most common natural gas end uses—space heating, water heating, and range (i.e., cooktop plus oven). Additional natural gas end uses include dryer, auxiliary heat, pool heat, spa heat, solar water heater with natural gas backup, and miscellaneous, as discussed below under *GHG Calculation Variables*.

Cost Considerations

Although electric appliances for residential and commercial properties sometimes cost more to purchase and install, they are more energy efficient than conventional natural gas appliances. This can lead to long-term cost savings through reduced energy consumption. Electric appliances also usually require less maintenance than conventional appliances.

Expanded Mitigation Options

One of the most efficient ways to provide space heating with electricity is to use heat pumps, which provides increased efficiency relative to traditional electric resistance heating (see Measure E-25, *Install Electric Heat Pumps*, in Table 3-2). The associated energy reduction from heat pumps was not quantified as part of this measure.

GHG Reduction Formula

$A = (-E \times C \times G \times I \times J) + (F \times C \times H \times K \times J)$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Reduction in GHG emissions from building energy	[ ]	MT CO_2e per year	calculated
User Inputs				
B	Housing or building type	[ ]	text	user input
C	Number of du or size of commercial building	[ ]	du or KSF	user input
Constants, Assumptions, and Available Defaults				
D	Electricity Demand Forecast Zone	Figure E-1.1 Table E-1.1	integer	CEC 2017
E	Existing fuel consumption for natural gas end uses without measure	Table E-15.1 Table E-15.2	therm per year per du or therm per year per KSF	CEC 2020, 2021
F	Additional electricity use for equivalent electrified end uses with measure	Table E-15.1 Table E-15.2	kWh per year per du or kWh per year per KSF	CEC 2020, 2021
G	Carbon intensity of natural gas (commercial/residential)	119/117	lb CO_2e per MMBtu	U.S. EPA 2020
H	Carbon intensity of local electricity provider	Tables E-4.3 and E-4.4	lb CO_2e per MWh	CA Utilities 2021
I	Conversion from therm to MMBtu	0.1	MMBtu per therm	conversion
J	Conversion from lb to MT	0.000454	MT per lb	conversion
K	Conversion from kWh to MWh	0.001	MWh per kWh	conversion

Further explanation of key variables:

- (B) – The housing and building types are needed to look up the energy use for electric and natural gas end uses for residential and commercial development (E and F).
- (D) – The CEC has specified 28 distinct EDFZs in California. Users should refer to Figure E-1.1 in Appendix C to determine the EDFZ for their project. This measure relies on energy consumption data from the year 2019 tied to the CEC's Commercial Forecast and the 2019 RASS (CEC 2020, 2021). Because data from all 28 EDFZs are not included in the Commercial Forecast and RASS, representative data from similar EDFZs may need to be used. Users should refer to Table E-1.1 for the proxy EDFZ that corresponds with those listed in Tables E-15.1 and E-15.2.

- (E and F) – The CEC administered the statewide RASS in 2019. The study yielded energy consumption estimates for 27 electric and 10 natural gas residential end uses. Based on this data for the year 2019, the average natural gas and electricity consumption by end use for each EDFZ and housing type is provided in Table E-15.1. The natural gas end uses included in the RASS and reflected in this measure include space heating, water heating, range/oven, dryer, auxiliary heat, pool heat, spa heat, solar water heater with natural gas backup,[25] and miscellaneous.[26] There are electric equivalent end uses for each of these end uses, with the addition of heat pumps as an option for space heating and the exception of pool heat, which requires a manual user input. Users should only evaluate the end uses applicable to their project. For example, most residences will not be built with spas, and only single-family housing has solar water heaters. A minimum recommendation is that the primary natural gas end uses that are commonly electrified be included—space heating, water heating, and range/oven. If the data is missing for the EDFZ or end use, users may elect to use the statewide averages. If users are able to provide a project-specific value, then they should replace the defaults in the GHG calculation formula.

  The CEC prepared the Commercial Forecast in October 2019. The Commercial Forecast is generated by a computer model developed by the CEC to forecast electricity and natural gas consumption for commercial building types in California. The data that informs the model includes previous commercial end use surveys, floor space and vacancy estimates (based on econometric and demographic data), adopted building and appliances standards, weather data (cooling and heating degree days), and electricity and natural gas rates. The Commercial Forecast provides energy consumption estimates for 13 electric and 6 natural gas commercial end uses. Based on this data for 2019, the average statewide natural gas and electricity consumption by end use for each building type is provided in Table E-15.2. The natural gas end uses included in the Commercial Forecast and reflected in this measure include space heating, cooling, water heating, range/oven, refrigeration, and miscellaneous.[27] Users should only evaluate the end uses applicable to their project. A minimum recommendation is that the primary natural gas end uses that are commonly electrified be included—space heating, water heating, and range/oven. If the data is missing for the EDFZ or end use, users may elect to use the statewide averages. If users are able to provide a project-specific value, then they should replace the defaults in the GHG calculation formula.

- (G) – The carbon intensity of natural gas was calculated in terms of CO_2e by multiplying the U.S. natural gas combustion emission factors for CO_2, CH_4, and N_2O (U.S. EPA 2020) by the corresponding 100-year GWP values from the IPCC's Fourth Assessment Report (IPCC 2007). See Table E-4.5 in Appendix C for more natural gas emission factors.

- (H) – GHG intensity factors for major California electricity providers are provided in Tables E-4.3 and E-4.4. If the project study area is not serviced by a listed electricity provider, or the user is able to provide a project-specific value (i.e., for the future year not referenced in Tables E-4.3 and E-4.4), the user should use that specific value in the

[25] Only allowed for single-family housing.

[26] The RASS "miscellaneous" end use category includes approximately 20 appliances, ranging from portable fans to wine coolers to aquariums. Users should exercise caution in applying the average energy consumption data for this category to their project.

[27] The commercial energy forecast "miscellaneous" end use category includes over 50 equipment types, ranging from specialized medical equipment for hospital buildings to ATM machines for retail buildings to shop tools for warehouses. Users should exercise caution in applying the average energy consumption data for this category to their project.

GHG calculation formula. If the electricity provider is not known, the user may elect to use the statewide grid average carbon intensity.

GHG Calculation Caps or Maximums

Mutually Exclusive Measures

If users select this measure (Measure E-15), they may not also take credit for Measure E-12, *Install Alternative Type of Water Heater in Place of Gas Storage Tank Heater in Residences*, or Measure E-13, *Install Electric Ranges in Place of Gas Ranges,* which electrify select appliances. This measure (Measure E-15) accounts for the combined GHG reductions achieved by each of these measures, as well as the electrification of other end uses. To combine the GHG reductions from this measure (Measure E-15) with Measure E-12 or Measure E-13 would be considered double counting.

Example GHG Reduction Quantification

The user reduces building energy emissions by electrifying the proposed development with electric end uses in place of natural gas end uses. In this example, the measure would be implemented at 20 apartments in a high-rise building (C) to be constructed in EDFZ 11 (D). Natural gas end uses without the measure include water heater, primary heat, range/oven, and dryer resulting in 261 therms per year per du (E). The electricity consumption to electrify these end uses would be 2,611 kilowatt-hours per year per du (F_1). The project is in City of Riverside's service territory and would begin operation by 2022. It would therefore have an electricity carbon intensity of 791 lb CO_2e per megawatt-hour (G). The mitigated emissions would be reduced by 9 MT CO_2e per year.

$$A = \left(\frac{-261\ \text{therm}}{\text{yr}\cdot\text{du}} \times \mathbf{20\ du} \times \frac{117\ \text{lb}\ CO_2e}{\text{MMBtu}} \times \frac{0.1\ \text{MMBtu}}{\text{therm}} \times \frac{0.000454\ \text{MT}}{\text{lb}}\right) + \left(\frac{2{,}611\ \text{kWh}}{\text{yr}\cdot\text{du}} \times \mathbf{20\ du} \times \frac{791\ \text{lb}\ CO_2e}{\text{MWh}} \times \frac{0.001\ \text{MWh}}{\text{kWh}} \times \frac{0.000454\ \text{MT}}{\text{lb}}\right) = -9\ \frac{\text{MT}\ CO_2e}{\text{yr}}$$

Quantified Co-Benefits

Energy and Fuel Savings

Energy use conversion from major natural gas appliances to their equivalent electric replacements tends not to be straightforward given that most significant gas appliances (e.g., water heaters, space heaters, ovens and cooktops) have varying input-to-output efficiencies and losses from product to product. Equivalent electric appliances also have differing efficiencies, and usage patterns for these equivalent appliances may differ in some way. If electrifying a building, the user would decrease the building natural gas consumption (E) and increase the electricity use (F).

Improved Air Quality

The reduction in natural gas fuel consumption from this measure would result in local improvements in air quality because the fuel consumption occurs on site of the project. The reduction in criteria pollutant emissions (L) achieved by the measure can be calculated as follows.

Criteria Pollutant Emission Reduction Formula

$$L = -E \times C \times M \times I \times N$$

Criteria Pollutant Emission Reduction Calculation Variables

ID	Variable	Value	Unit	Source
Output				
L	Reduction in criteria pollutant emissions from building energy	[ ]	tons per year	calculated
User Inputs				
	None			
Constants, Assumptions, and Available Defaults				
M	Criteria pollutant emission factors of natural gas	Table E-4.5	lb per MMBtu	U.S. EPA 1998
N	Conversion from lb to ton	0.0005	tons per lb	conversion

Further explanation of key variables:

- (M) – Table E-4.5 presents the criteria pollutant emission factors of natural gas for residential and commercial uses (U.S. EPA 1998).
- Please refer to the *GHG Calculation Variables* table above for definitions of variables that have been previously defined.

Sources

- California Energy Commission (CEC). 2017. *California Electricity Demand Forecast Zones*. Available: https://cecgis-caenergy.opendata.arcgis.com/datasets/86fef50f6f344fabbe545e58aec83edd_0/data?geometry=-165.327%2C31.004%2C-72.427%2C43.220. Accessed: June 2021.
- California Energy Commission (CEC). 2019. *Residential Alternative Calculation Method Reference Manual for the 2019 Building Energy Efficiency Standards.* May. Available: https://www.energy.ca.gov/sites/default/files/2020-10/2019%20Residential%20ACM%20Reference%20Manual_ada.pdf. Accessed: January 2021.
- California Energy Commission (CEC). 2020. Excel database with the 2019 Residential Appliance Saturation Study (RASS), provided to ICF. November 13, 2020.
- California Energy Commission (CEC). 2021. Excel database with the 2018-2030 Uncalibrated Commercial Sector Forecast, provided to ICF. January 21, 2021.
- California Utilities. 2021. Excel database of GHG emission factors for delivered electricity, provided to the Sacramento Metropolitan Air Quality Management District and ICF. January through March 2021.

- Intergovernmental Panel on Climate Change (IPCC). 2007. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp. Available: https://www.ipcc.ch/report/ar4/wg1/. Accessed: January 2021.
- U.S. Environmental Protection Agency (U.S. EPA). 1998. *AP 42, Fifth Edition, Volume I. Chapter 1: External Combustion Sources. 1.4, Natural Gas Combustion*. July. Available: https://www3.epa.gov/ttnchie1/ap42/ch01/final/c01s04.pdf. Accessed: January 2021.
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