E-13. Install Electric Ranges in Place of Gas Ranges

GHG Mitigation Potential

Small

Potentially small reduction in GHG emissions from building natural gas

Co-Benefits (icon key on pg. 34)

Climate Resilience

Installing electric ranges that use electricity rather than fuel can reduce sensitivity to fuel price shocks or scarcity. Electric ranges also offer more reliability if the grid has been adapted to climate change or less reliability if the grid has not been adapted.

Health and Equity Considerations

Natural gas ranges are a primary sources of residential indoor air pollution (e.g., NOx, CO, and formaldehyde), with the impacts being greater in smaller living spaces and kitchens with inefficient or no vent hoods—disproportionately affecting low-income residents and renters. Replacing natural gas ranges with electric ones thus vastly improves indoor air quality.

Measure Description

This measure requires that residential or commercial developments install an electric range (i.e., cooktop plus oven) in place of a gas range. An electric range displaces natural gas consumption with electricity use, replacing a more emissions-intensive fossil fuel-based source of energy with electricity from the grid that is increasingly transitioning to renewable sources.

Subsector

Building Decarbonization

Scale of Application

Project/Site

Implementation Requirements

The electric range must have an electric or induction cooktop and an electric oven. Because induction cooktops are superior in performance to traditional electric cooktops and comparable to gas, the use of induction cooktops is strongly recommended to help overcome any user hesitancy or preference for gas.

Cost Considerations

Electric cooktops are twice as energy efficient as gas ranges, representing a large cost savings from reduced energy consumption. Electric stoves have similar costs as natural gas stoves and are relatively inexpensive to install. Induction cooktops have higher upfront costs compared to gas ranges but similar cost savings (induction cooktops do not radiate heat, which translates into reduced home cooling costs during warm days). Buyer costs include the purchase of magnetic-based pots and pans (e.g., stainless steel or cast iron) specialized for use on induction cooktops.

Expanded Mitigation Options

Limit gas barbecue grills, which would provide additional GHG mitigation and improved localized air quality.

GHG Reduction Formula

A = (-E × **C** × G × I × J) + (F × **C** × H × K × 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 1,000 gross square feet (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	Fuel consumption for natural gas range	Table E-15.1 or Table E-15.2	therm per year per du or therm per year per KSF	CEC 2020, 2021
F	Electricity use for electric cooktop	Table E-15.1 or 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 by type of cooking appliance (E).
- (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 (2020, 2021). Because data from all 28 EDFZs are not included in the Commercial Forecast or 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, including cooking appliances. Based on this data for the year 2019, the average natural gas and electricity consumption by cooking appliance type for each EDFZ and housing type is provided in Table E-15.1 in Appendix C. If the data is missing for the EDFZ, users may elect to use the statewide averages. If the user is able to provide a project-specific value, then the user should replace the defaults in the GHG calculation formula. CEC's 2019 Building Energy Standards provide detailed equations for this calculation (CEC 2019).

  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 commercial end uses, including cooking. Based on this data for 2019, the average statewide natural gas and electricity consumption for cooking appliances for each building type is provided in Table E-15.2. If the user can provide a project-specific value, then the user should replace the defaults in the GHG calculation formula.
- (G) – The carbon intensity of residential and commercial 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 in Appendix C. 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 Appendix C), the user should replace the default in the GHG calculation formula. If the electricity provider is not known, users may elect to use the statewide grid average carbon intensity.

GHG Calculation Caps or Maximums

Mutually Exclusive Measures

If the user selects Measure E-15, *Require All-Electric Development*, 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 this measure (Measure E-13), which electrify select appliances. 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 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 installing in the proposed residential development an electric range in place of a natural gas range. In this example, the measure would be implemented for 20 low-rise apartments (C) to be constructed in EDFZ 3 (D).

Therefore, the fuel consumption for a natural gas range would be 21 therms per year per du (E), and the electricity consumption for an electric cooktop per du would be 115 kilowatt-hours per year (F_1). The project is in Pacific Gas & Electric's service territory and would begin operation by 2022. It would, therefore, have an electricity carbon intensity of 206 lb CO_2e per MWh (G). The mitigated emissions would be reduced by 2.0 MT CO_2e per year.

$$A = \left(\frac{-21\ \text{therm}}{\text{yr}\cdot\text{du}} \times \mathbf{20\ du} \times \frac{117\ \text{lb}\ CO_2e}{\text{MMBtu}} \times \frac{0.1\ \text{MMBtu}}{\text{therm}} \times \frac{0.000454\ \text{MT}}{\text{lb}}\right) + \left(\frac{115\ \text{kWh}}{\text{yr}\cdot\text{du}} \times \mathbf{20\ du} \times \frac{206\ \text{lb}\ CO_2e}{\text{MWh}} \times \frac{0.001\ \text{MWh}}{\text{kWh}} \times \frac{0.000454\ \text{MT}}{\text{lb}}\right) = -2.0\ \frac{\text{MT}\ CO_2e}{\text{yr}}$$

Quantified Co-Benefits

While the measure will achieve fuel savings, it will also increase electricity consumption. For more information on the public health effects of gas cooking appliances, refer to the resources available from the Rocky Mountain Institute (Rocky Mountain Institute 2020).

Fuel Savings (Increased Electricity)

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 installing an electric cooktop, 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

$$L = -E \times \mathbf{C} \times M \times I \times N$$

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.
- Rocky Mountain Institute. 2020. *Health Effects from Gas Stove Pollution.* May. Available: https://rmi.org/insight/gas-stoves-pollution-health/. Accessed: March 4, 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.
- U.S. Environmental Protection Agency (U.S. EPA). 2020. *Emission Factors for Greenhouse Gas Inventories*. March. Available: https://www.epa.gov/sites/production/files/2020-04/documents/ghg-emission-factors-hub.pdf. Accessed: March 2021.