E-2. Require Energy Efficient Appliances

GHG Mitigation Potential

Up to 15.0% of GHG emissions from building electricity

Co-Benefits (icon key on pg. 34)

Climate Resilience

Increased energy efficiency can reduce the strain on the overall grid, particularly the risk of power outages during peak loads. Increased efficiency can also reduce energy costs, particularly if extreme heat would otherwise increase these costs.

Health and Equity Considerations

The use of ENERGY STAR appliances can increase upfront purchase costs; thus, it should be clearly explained to occupants or buyers that these costs can be offset by reduced operational utility costs. This can be particularly beneficial for low-income residents.

Measure Description

This measure will require installation of ENERGY STAR-certified appliances that exceed the energy efficiency of conventional appliances. By committing to more efficient appliances, the building's energy use is reduced, thereby reducing GHG emissions.

Subsector

Energy Efficiency Improvements

Scale of Application

Project/Site

Implementation Requirements

This measure can be used for commercial refrigerators. It can also be used for residential refrigerators, clothes washers, dishwashers, and ceiling fans. This measure will only result in reductions associated with electricity use and does not apply to natural gas as no ENERGY STAR appliances that use natural gas were evaluated.

Cost Considerations

More energy-efficient appliances are typically more expensive than less efficient ones, leading to greater upfront costs. However, the replacement of less efficient appliances with more efficient models reduces energy consumption and thereby reduces long-term energy costs.

Expanded Mitigation Options

Pair with Measure E-1, *Exceed Title 24 Building Envelope Energy Efficiency Standards*, to reduce energy use from both end use categories subject to Title 24 requirements and those that are not to yield increased GHG reductions.

GHG Reduction Formula

$$A = (E_1 \times F_1) + (E_2 \times F_2) + (E_3 \times F_3) + (E_4 \times F_4)$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from building electricity	0–15.0	%	calculated
User Inputs				
B	Building/housing type	[ ]	text	user input
$C_{1,2,3...}$	ENERGY STAR appliance(s) installed	[ ]	text	user input
Constants, Assumptions, and Available Defaults				
D	Electricity Demand Forecast Zone	Figure E-1.1 Table E-1.1	integer	CEC 2017
$E_{1,2,3...}$	Percent reduction in electricity for ENERGY STAR appliance compared to conventional appliance	Table E-2.1	%	ENERGY STAR 2014; 2016; 2017; 2018a; 2018b
$F_{1,2,3...}$	Percent of total building electricity by appliance	Table E-2.2 Table E-2.3	%	CEC 2020, 2021

Further explanation of key variables:

- (A) – The output provides the percent reduction in GHG emissions from building electricity. To determine the percent reduction in GHG emissions from building energy (i.e., electricity plus natural gas), the user would need to know the percent of total GHG emissions from electricity. For example, if 40 percent of building energy emissions come from electricity, the percent reduction in GHG emissions from building energy could be calculated as follows.

  $$A_{energy} = (40\% \times A_{electricity})$$

  Further, to determine the percent reduction in GHG emissions for a project with multiple buildings, the user would need to know the percent of total building energy emissions from each building. For example, if 67 percent of building energy emissions come from Building 1 and 33 percent come from Building 2, the percent reduction in GHG emissions from all building energy could be calculated as follows.

  $$A_{energy\_total} = (67\% \times A_{energy\_1}) + (33\% \times A_{energy\_2})$$

- (B) – The building and housing types are needed to lookup the percent of total building electricity by appliance (F). Commercial refrigerators were evaluated for the non-residential building types of grocery stores, restaurants, and refrigerated warehouses. Residential refrigerators, clothes washers, dishwashers, and ceiling fans were evaluated for all residential housing types.
- (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 Table E-2.2 and Table E-2.3.

- (E) – See Table E-2.1 for the percent reduction in ENERGY STAR appliance electricity use compared to conventional appliances that meet the minimum federal efficiency standards (ENERGY STAR 2014; 2016; 2017; 2018a; 2018b).
- (F) – See Table E-2.2 and Table E-2.3 for the percent of total building electricity by appliance. There is one table for residential land uses and another for non-residential land uses. This information, excluding ceiling fans, is primarily based on data from the CEC (2020, 2021). RASS does not specify a ceiling fan end-use; rather, electricity use from ceiling fans is accounted for in the Miscellaneous category, which includes interior lighting, attic fans, and other miscellaneous plug-in loads. Because the electricity usage of ceiling fans alone is not specified, a value from a National Renewable Energy Laboratory (NREL) study is used. The study reports that the average energy use per ceiling fan is 84.1 kWh per year (NREL 2008). In this measure, it is assumed that each multi-family, single-family, and townhome residence has one ceiling fan. The electricity savings shown here are based on installing an ENERGY STAR ceiling fan and do not account for an occupant's decreased use of cooling devices such as air conditioners.

GHG Calculation Caps or Maximums

It is assumed that the electricity demand of the project's appliances is currently being met by grid electricity that requires *some* amount of fossil fuel–based energy generation, which emits GHGs from fuel combustion. In other words, the local electricity provider has an energy intensity factor (lb of CO_2e per MWh) greater than zero. For projects that are served by electricity providers already with a renewable portfolio of 100 percent, this measure could have no reduction in GHG emissions. If the electricity provider is using REC to meet a 100 percent renewable portfolio goal, then some emissions reductions may be achieved. This measure would still result in the co-benefits of reduced electricity use and enhanced energy security.

Example GHG Reduction Quantification

The user reduces building energy by requiring the builder supply appliances that exceed the energy efficiency of conventional appliances. In this example, the user's project includes Building 1, a supermarket, and Building 2, single-family home (B) located in EDFZ 1 (D). The user would commit to ENERGY STAR commercial refrigerators in the grocery store and ENERGY STAR residential refrigerators, clothes washers, dishwashers, and ceiling fans in the single-family housing (C). GHG emissions from the supermarket and single-family home from electricity would be reduced by 4.6 percent and 2.8 percent, respectively.

$A_{electricity\_1} = -20\% \times 23\% = -4.6\%$ supermarket electricity emissions

$A_{electricity\_2} = (-9\% \times 18\%) + (-25\% \times 1.1\%) + (-12\% \times 1.1\%) + (-60\% \times 1.3\%) = -2.8\%$ housing electricity emissions

The percent reduction in GHG emissions from building energy (i.e., electricity plus natural gas) per building can also be calculated if the user knows the percent of total GHG emissions from each energy source. In this example, 60 percent of the supermarket's energy emissions come from electricity and 50 percent of the single-family home's energy emissions come from electricity. GHG emissions from the supermarket and single-family home would be reduced by 2.8 percent and 1.4 percent, respectively.

$A_{energy\_1} = (60\% \times -4.6\%) = -2.8\%$ supermarket energy emissions

$A_{energy\_2} = (50\% \times -2.8\%) = -1.4\%$ housing energy emissions

Further, the percent reduction in GHG emissions for the project can be calculated if the user knows the percent of total building energy emissions from each building. In this example, 67 percent of building energy emissions come from the supermarket and 33 percent come from the single-family home. The percent reduction in GHG emissions from all building energy would be 2.3 percent.

$A_{energy\_total} = (67\% \times -2.8\%) + (33\% \times -1.4\%) = -2.3\%$ building energy emissions

Quantified Co-Benefits

Energy and Fuel Savings

The percent reduction in electricity use achieved by the measure is the same as the percent reduction in GHG emissions from electricity ($A_{electricity}$).

Sources

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