Energy

The GHG emissions from energy use come from power generation that provides the energy used to operate a building or source. Power is typically generated by either a remote, central electricity generating plant, onsite generation by fuel combustion, or onsite solar, wind, or other renewable power. Because the emissions from central electricity generation are not emitted where the electricity is being used, these types of emissions are referred to as *indirect* emissions. As such, measures that reduce electricity consumption result in reductions of criteria pollutants where the electricity is generated (i.e., power plants). Electricity-reducing measures are, therefore, not considered to result in local air quality co-benefits at the project site, although they could contribute to regional air quality improvements.

Because the emissions from onsite fuel combustion are emitted where the fuel is being consumed, these types of emissions are referred to as *direct* emission. Measures that reduce residential natural gas use (e.g., from cooktops and for space and water heating) reduce onsite fuel combustion and improve local air quality. Direct use of onsite solar or wind power generated electricity does not result in emissions.

Energy sector emissions can be reduced through energy efficiency improvements, renewable energy generation, building electrification, and CH_4 recovery and reuse at industrial facilities (landfills and wastewater treatment plants). These types of measures are discussed below. This section also provides guidance for combining emission reductions from energy measures and accounting for statewide legislation that may reduce future emissions reductions achieved by energy measures. The measure factsheets and quantification methods for individual measures follow. Use the graphic on the following page to click on an individual measure to navigate directly to the measure's factsheet.

Measures to Improve Efficiency

Energy sector emissions can be reduced by lowering the amount of electricity and natural gas required for building operations. This can be achieved by designing a more energy-efficient building structure and/or installing energy-efficient appliances.[14] Emissions reductions from energy efficiency improvements are quantified based on the amount of expected energy savings that would be achieved over existing energy codes and regulations. Existing consumption values are determined using California-specific energy end use databases, such as the California Commercial End-Use Survey and Residential Appliance Saturation Study (RASS), and other literature sources

[14] This Handbook does not account for potential "rebound effects" of energy efficiency measures. *Rebound effect* is the phenomenon that an increase in energy efficiency may lead to fewer energy savings because energy use will increase due to consumer and market responses. While rebound effects have been documented in literature, they are difficult to precisely and reliably quantify.

(e.g., ENERGY STAR program). Quantified measures that target energy efficiency improvements described in this section include Measures E-1 through E-9.

Energy

ENERGY EFFICIENCY IMPROVEMENTS

- ○ E-1. Buildings Exceed 2019 Title 24 Building Envelope Energy Efficiency Standards
- ○ E-2. Require Energy Efficient Appliances
- ○ E-3-A. Require Energy Efficient Residential Boilers
- ○ E-3-B. Require Energy Efficient Commercial Packaged Boilers
- ○ E-4. Install Cool Roofs and/or Cool Walls in Residential Development
- ○ E-5. Install Green Roofs in Place of Dark Roofs
- ○ E-6. Encourage Residential Participation in Existing Demand Response Program(s)
- ○ E-7. Require Higher Efficacy Public Street and Area Lighting
- ○ E-8. Replace Incandescent Traffic Lights with LED Traffic Lights
- ○ E-9. Utilize a Combined Heat and Power System

RENEWABLE ENERGY GENERATION

- ○ E-10-A. Establish Onsite Renewable Energy Systems—Generic
- ○ E-10-B. Establish Onsite Renewable Energy Systems—Solar Power
- ○ E-10-C. Establish Onsite Renewable Energy Systems—Wind Power
- ○ E-11. Procure Electricity from Lower Carbon Intensity Power Supply

BUILDING DECARBONIZATION

- ○ E-12. Install Alternative Type of Water Heater in Place of Gas Storage Tank Heater in Residences
- ○ E-13. Install Electric Ranges in Place of Gas Ranges
- ○ E-14. Limit Wood Burning Devices and Natural Gas/Propane Fireplaces in Residential Development
- ○ E-15. Require All-Electric Development
- ○ E-16. Require Zero Net Energy Buildings
- ○ E-17. Require Renewable-Surplus Buildings

METHANE RECOVERY

- ○ E-18. Establish Methane Recovery in Landfills
- ○ E-19. Establish Methane Recovery in Wastewater Treatment Plants

Measures to Increase Renewable Energy Generation

Different modes of electricity generation have different GHG emission intensities. Fossil fuel-based generation emits GHGs from fuel combustion, with the emissions quantity depending on the quantity and type of fuel used. Renewable energy generation, on the other hand, typically has significantly fewer emissions, and most types of renewable sources—such as solar photovoltaic (PV) systems—have zero associated GHG emissions. Renewable energy generation reduces emissions by avoiding an equivalent amount of grid energy. To calculate this, the amount of energy generated by the renewable system(s) must be quantified and then multiplied by the electricity provider-specific emission factor for the type of energy (e.g., electricity, natural gas) being replaced.[15] Quantified measures that target renewable energy generation described in this section include Measures E-10-A through E-11.

Measures for Building Decarbonization

Building decarbonization, also termed *beneficial electrification* or *building electrification*, involves shifting from fossil fuels (e.g., natural gas) to electricity as the power source for heating, cooking, and appliances. In a fully electrified building, gas-powered water heaters, gas-powered ovens and cooktops, gas-powered clothes washers and dryers, and space heating that normally uses natural gas, propane, or heating oil are all replaced by electric alternatives, which are usually 2 to 3 times more efficient than traditional appliances. Displacing emissions-intensive fossil fuel energy with less emissions-intensive electricity results in a net emission reduction. Further, the emission reduction increases if the electricity for these end uses is generated by solar, wind, or other sources of zero-carbon electricity. These zero-carbon sources can be provided on a project site or integrated into the local electricity providers' renewable energy mix. In future years, building decarbonization measures will become increasingly effective at reducing GHG emissions because electricity provided by retail sellers of electricity will be procured from increasing amounts of renewable energy sources.

Emissions reductions achieved through building electrification are quantified based on the direct emissions avoided by the displaced fuel plus the indirect emissions added by the increased use of electricity. To calculate this, the avoided energy (i.e., negative value) generated by the fossil-fueled appliance(s) must be quantified and then multiplied by the appropriate fuel emission factor. The additional energy (i.e., positive value) generated by the electric alternative appliance(s) must be quantified and then multiplied by the electricity provider-specific emission factor.[16] The sum of these two emissions represents the net emission reduction. Quantified

[15] The quantification methods do not account for potential future renewable energy curtailment (i.e., the deliberate reduction in power output below what could have been generated to balance supply and demand), which could reduce expected emissions savings from certain renewable energy measures.

[16] One method for determining energy consumption for an electric alternative appliance is to convert the natural gas consumption, typically measured in therms, into British thermal units, which can then be converted into the electricity energy consumption metric of kWh. However, this method does not account for the differing energy efficiencies of natural gas versus electricity or potential differences in the technical specifications of the associated appliances. Accordingly, the Handbook does not use this basic conversion method. Instead, the Handbook recommends using actual reported energy consumption for electric alternative appliances.

measures that target building decarbonization described in this section include Measures E-12 through E-17.

Measures for Methane Recovery

Decomposition of waste and organic material in landfills and at wastewater treatment facilities generates CH_4. Capturing CH_4 through recovery systems directly reduces GHG emissions. Additional reductions can be achieved if the captured CH_4 is combusted to generate electricity for onsite energy needs, which displaces the associated indirect GHG emissions from electricity production. Emissions reductions from CH_4 recovery systems that include electricity generation are quantified using similar methods as described above for measures to increase renewable energy generation. Quantified measures that target CH_4 recovery described in this section include Measures E-18 and E-19.

Combining Emissions Reductions from Energy Measures

The total reductions claimed by a user for energy measures should not exceed 100 percent of project energy emissions, unless a measure would result in additional excess energy capacity that would be sold to an electricity provider or other project. This may include renewable energy generation systems tied into the grid. These additional emission reductions may be used to offset other categories of emissions, with approval of the agency reviewing the project. In these cases of excess capacity, the quantified excess emissions must be carefully verified to ensure that any credit allowed for these additional reductions is truly additional.[17]

Reduced Effectiveness of Energy Measures in Future Years

Senate Bill 100 requires that 100 percent of electricity supplied to California end-use customers be from eligible renewable energy resources and zero-carbon resources by 2045. As retail sellers of electricity procure increasing amounts of renewable energy to displace fossil fuels in their energy generation mix, the emission factors of local electricity providers will decrease over time. Because some energy measures reduce electricity consumption or displace grid energy, the annual GHG reduction from these measures will be less in future years. As noted above, however, the shift to a larger portfolio of renewable energy will make building decarbonization measures more effective. Further, if the local electricity provider for a project already has carbon-free electricity, then energy reduction measures would not reduce electricity emissions as they would already be zero or near zero.[18] Users should take care to appropriately account for this possibility by using the electricity provider-specific, year-specific emission factors presented in Tables E-4.3 and E-4.4 in Appendix C, *Emissions Factors and Data Tables*.[19]

Similarly, measures that reduce building energy consumption may become less effective over time because of increasingly stringent Title 24, California Building Standards Code, standards.

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[17] For more detailed information on offset verification protocols visit https://www.climateactionreserve.org/how/future-protocol-development/criteria/.

[18] Senate Bill 100 requires 100 percent renewable for retail sales but not for all power generation/supply (e.g., grid balancing or in-facility usage). Thus, emission factors may not be exactly zero by 2045.

[19] The default electricity provider emission factors reflect the annual average emissions intensity of delivered electricity. Depending on the time of day and load, measures that reduce electricity consumption may offset emissions from marginal power sources, yielding greater emissions reductions than estimated when using average annual emission factors.

Strengthening of Title 24 requirements, including provisions for zero net energy (ZNE) buildings (i.e., energy efficiency improvements and onsite renewable energy), will improve energy efficiency and reduce energy consumption in new construction. The quantification methods presented in this report include measures that exceed minimum regulatory requirements of the 2019 Title 24 standards. Some measures in this Handbook may become obsolete if they are made mandatory for all new buildings as part of future Title 24 standards. As such, users should take care to determine whether the measures in this Handbook still exceed the Title 24 requirements at the time of project implementation. If the user's project exceeds the requirements of Title 24, then they can take credit for the resulting reductions.