LL-1. Replace Gas-Powered Landscape Equipment with Zero-Emission Landscape Equipment

GHG Mitigation Potential

Large

Potentially large reduction in GHG emissions from landscaping equipment

Co-Benefits (icon key on pg. 34)

Climate Resilience

Replacing gas-powered landscape equipment with zero-emission landscape equipment can reduce sensitivity to fuel price shocks or scarcity.

Health and Equity Considerations

Consider implementing programs to help disadvantaged business enterprises convert to electric equipment. Reduction or replacement of gasoline-powered equipment reduces localized air pollution.

Measure Description

This measure requires use of zero-emission landscaping equipment over conventional gasoline-fueled counterparts. Equipment types historically powered by gasoline engines covered by this measure include chainsaws, chippers, lawn mowers, leaf blowers/vacuums, riding mowers, tillers, and trimmers (CARB 2020). Replacing gasoline-powered equipment with zero-emission equipment reduces fossil fuel combustion and thus GHG emissions. However, electric equipment results in GHG emissions from the electricity used to charge the equipment. The indirect GHG emissions increase from electricity must be calculated in addition to the GHG emissions reduction from displaced fossil fuel combustion to estimate the total net GHG emissions reduction achieved by this measure.

Scale of Application

Project/Site

Implementation Requirements

For this measure to be successfully implemented, it is helpful for electrical outlets on the exterior of buildings to be accessible so that the corded electric landscaping equipment can be more easily used in different areas, and batteries can be charged if indoor charging is not available. Measure LL-3, *Electric Yard Equipment Compatibility,* in Table 3-2 should, therefore, be considered as a supporting action to this measure.

Cost Considerations

Although the environmental benefits of replacing gas powered landscape equipment are high, so too are the costs. Zero-emission equipment is usually more expensive than conventional gasoline-powered equipment. Once the equipment is purchased, however, there are long-term cost savings in avoided fuel inputs and maintenance.

Expanded Mitigation Options

Users may consider an exchange program to expand penetration of this measure, as outlined in Measure LL-2, *Implement Yard Equipment Exchange Program*, in Table 3-2.

GHG Reduction Formula

A = [**B** × C × (D × E) × F1 × G] – [**B** × C × D × **F2** × H]

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	GHG reduction from using plug-in or battery electric equipment	[ ]	MT CO_2e	calculated
User Inputs				
B	Hours of equipment operation	[ ]	hours	user input
F2	Carbon intensity of gasoline equipment	[ ]	g CO_2e per hp-hour	CARB 2020
Constants, Assumptions, and Available Defaults				
C	Load factor of equipment	Table LL-1.1	unitless	CARB 2020
D	Horsepower (hp) of equipment	Table LL-1.1	hp	CARB 2020
E	Conversion from horsepower to MW	0.0007457	MW per hp	conversion
F1	Carbon intensity of local electricity provider	Tables E-4.3 and E-4.4	lb CO_2e per MWh	CA Utilities 2021
G	Conversion from lb to MT	0.000454	MT per lb	conversion
H	Conversion from grams (g) to MT	1×10^{-6}	MT per g	conversion

Further explanation of key variables:

- (C) – The load factor is the average operational level of an engine as a fraction or percentage of the engine manufacturer's maximum rated horsepower (hp). Average load factors of various landscaping equipment are provided in Table LL-1.1 in Appendix C, *Emission Factors and Data Tables* (CARB 2020). If the user can provide an equipment-specific load factor, they should replace the default in the GHG calculation formula.
- (D) – Average hp of various landscaping equipment are provided in Table LL-1.1 in Appendix C (CARB 2020). If the user can provide an equipment-specific hp, the user should replace the default in the GHG calculation formula.
- (E) – Conversion factor assumes that energy requirements and losses are the same for both a fuel-powered engine and a piece of electric equipment.
- (F1) – 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.
- (F2) – GHG intensity factors for various landscaping equipment can be obtained from CARB's (2020) SORE2020 model.

GHG Calculation Caps or Maximums

None.

Example GHG Reduction Quantification

The user reduces lawn and landscaping emissions by replacing fossil fuel combustion with electricity consumption, which generates fewer GHG emissions per unit of activity. In this example, a 5-hp residential gasoline 4-stroke leaf blower (D) that is used 8 hours per day (B) is replaced by an electric-powered equivalent. The average load factor for a 5-hp leaf blower is 0.94 (C). The electricity provider for the project area is CleanPower SF and the analysis year is 2025. The carbon intensity of electricity is, therefore, 80 lb CO_2e per MWh (F1).

$$A = \left(8\ \frac{\text{hours}}{\text{day}} \times 0.94 \times \left[5\ \text{hp} \times 0.0007457\ \frac{\text{MW}}{\text{hp}}\right] \times 80\ \frac{\text{lb } CO_2e}{\text{MWh}} \times 0.000454\ \frac{\text{MT}}{\text{lb}}\right) - \left(8\ \frac{\text{hours}}{\text{day}} \times 0.94 \times 5\ \text{hp} \times 635\ \frac{\text{g } CO_2e}{\text{hp-hour}} \times 1e^{-6}\ \frac{\text{MT}}{\text{g}}\right) = -0.02\ \frac{\text{MT } CO_2e}{\text{day}}$$

Measure Co-Benefits

Improved Air Quality

Reducing gasoline combustion will also reduce local criteria pollutants. Emission savings can be calculated using the same formula used to quantify GHG reductions (A). Criteria pollutant intensity factors for various landscaping equipment can be obtained from CARB's (2020) SORE2020 model.

Electricity supplied by statewide fossil-fueled or bioenergy power plants will generate criteria pollutants. However, because these power plants are located throughout the state, electricity consumption from equipment charging will not generate localized criteria pollutant emissions. Consequently, for the quantification of criteria pollutant emission reductions, either the electricity portion of the equation can be removed, or the electricity intensity (F1) can be set to zero.

Energy and Fuel Savings

Fossil fuel (gasoline) savings are a product of the equipment fuel efficiency (gal consumed per hour) and the equipment operating time (hours). Fuel intensity factors for various landscaping equipment can be obtained from CARB's (2020) SORE2020 model . Users should multiply the fuel intensity by the equipment operating hours to quantify fuel savings. Increased electricity consumption is calculated as part of the GHG reduction formula. The abbreviated formula is also shown below.

$$\text{MWh} = [B \times C \times (D \times E)]$$

Sources

- California Air Resources Board (CARB). 2020. 2020 Emissions Model for Small Off-Road Engines—SORE2020. Version 1.1. September. Available: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-announcements. Database queried by Ramboll and provided electronically to ICF. September 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.