C-1-B. Use Cleaner-Fuel Equipment

Photo Credit: TruckPR, April 2017

GHG Mitigation Potential

Potentially small reduction in GHG emissions from construction equipment

Co-Benefits (icon key on pg. 34)

Climate Resilience

Using cleaner fuel equipment allows for fuel redundancy and can reduce sensitivity to price shocks or scarcity in conventional fuels.

Health and Equity Considerations

While most alternative fuels reduce both GHG and criteria pollutants, a few may increase criteria pollutant emissions. The most prominent example of this is biodiesel, which generally results in higher NOx emissions, but lower PM emissions compared to conventional diesel.

Measure Description

This measure requires use of cleaner-fueled construction equipment over conventional diesel- or gasoline-fueled counterparts. Depending on the fuel type, equipment type, and horsepower, equipment may emit fewer GHG for the same amount of work as equivalent diesel- or gasoline-fueled engines. A variation of this measure is described in Measure C-1-A, *Use Electric or Hybrid Powered Equipment*. Compressed natural gas (CNG) is specifically addressed in the quantification method for this measure, although users could expand to cover additional fuel types, such as renewable diesel.

Scale of Application

Project/Site and Plan/Community

Implementation Requirements

Note that while this measure discusses offroad equipment used for construction, this measure can also be implemented for other offroad equipment applications (e.g., agriculture, industrial).

Cost Considerations

Equipment powered by cleaner-fuels tend to be more expensive to purchase and install than less clean models. These costs may be offset by savings in fuel use and maintenance.

Expanded Mitigation Options

Other cleaner fuels available for use in construction equipment include renewable diesel, biodiesel, and hydrogen fuel cells. These fuels are not specifically captured by the current quantitative method for this measure.

GHG Reduction Formula

$$A = ((C \times D \times E2) - (C \times D \times E1)) \times F$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	GHG reduction from using cleaner-fuel equipment	[ ]	MT CO_2e	calculated
User Inputs				
B	Fuel types of existing and cleaner-fuel equipment	[ ]	text	user input
C	Hours of equipment operation	[ ]	hours	user input
E1	Carbon intensity of existing equipment	[ ]	g CO_2e per hp-hour	CARB 2021
E2	Carbon intensity of cleaner-fuel equipment	[ ]	g CO_2e per hp-hour	CARB 2021
Constants, Assumptions, and Available Defaults				
D	Horsepower of equipment (diesel, gasoline, and CNG equipment)	Table C-1-B.1	hp	CARB 2021
F	Conversion from g to MT	1 e^{-6}	MT per g	conversion

Further explanation of key variables:

- (A) – Depending on the fuel type, equipment type, and horsepower, the cleaner-fuel equipment may emit more GHGs than an equivalent gasoline- or diesel-fueled engine. The user should take care to consider the potential criteria pollutant co-benefits against possible GHG increases from the use of a cleaner fuel.
- (B) – The fuel type of the existing and cleaner-fuel equipment is used to obtain the carbon intensity of the equipment (E1 and E2) from CARB's (2021) OFFROAD.
- (D) – Average hp of various construction equipment are provided in Table C-1-B.1 in Appendix C (CARB 2021). If the user can provide an equipment-specific hp, they should replace the default in the GHG calculation formula.
- (E1 and E2) – GHG intensity factors for various construction equipment by fuel type can be obtained from CARB's (2021) OFFROAD model. Note that the OFFROAD emissions rates are inclusive of equipment load. Therefore, the GHG reduction equation does not include a multiplier for load factor.

GHG Calculation Caps or Maximums

None. If the emissions rate for the cleaner-fuel equipment exceeds that of the diesel- or gasoline-powered counterpart, this measure may result in a GHG emissions increase.

Example GHG Reduction Quantification

The user reduces construction equipment emissions by replacing gasoline or diesel combustion with CNG or renewable diesel consumption, which may generate fewer GHG emissions per unit of activity, depending on the piece of equipment and horsepower. In this example, a fleet of 23-hp diesel aerial lifts (D) that are used 40 hours per day (C) in 2022 is replaced by CNG-fueled equivalents. A 23-hp diesel aerial lift has a carbon intensity of 851g CO_2e per hp-hour (E1). The CNG-fueled equivalent has a hp of 19 and carbon intensity of 675g CO_2e per hp-hour (E2).

$$A = \left(\left(40\frac{\text{hours}}{\text{day}} \times 19 \text{ hp} \times 675\frac{\text{g } CO_2e}{\text{hp-hour}}\right) - \left(40\frac{\text{hours}}{\text{day}} \times 23 \text{ hp} \times 851\frac{\text{g } CO_2e}{\text{hp-hour}}\right)\right) \times 1e^{-6}\frac{\text{MT}}{\text{g}} = -0.3\frac{\text{MT } CO_2e}{\text{day}}$$

Quantified Co-Benefits

Improved Air Quality

Depending on the fuel type, equipment type, and horsepower, the cleaner-fuel equipment may emit more criteria pollutants than an equivalent gasoline- or diesel-fueled engine. Emission changes can be calculated using the same formula used to quantify GHG reductions (A). The carbon intensity factors (E1 and E2) should be replaced in the formula with the corresponding criteria pollutant intensity factors, which can be obtained from CARB's OFFROAD model.

Energy and Fuel Savings

This measure would displace use of fossil fuel (gasoline or diesel) with a cleaner fuel type (CNG). Total fuel consumption is a product of the equipment fuel efficiency (gallons consumed per hour) and the equipment operating time (hours). Fuel intensity factors for various construction equipment can be obtained from CARB's OFFROAD model. Users should multiply the fuel intensity factor by the equipment operating hours to quantify fuel changes for the existing and cleaner-fuel equipment.

Sources

- California Air Resources Board (CARB). 2021. OFFROAD2017–ORION. Available: https://arb.ca.gov/emfac/emissions-inventory. Database queried by Ramboll and provided electronically to ICF. September 2021.