T-40. Establish a School Bus Program

GHG Mitigation Potential

57%

Up to 57% of GHG emissions from school commute vehicle travel

Co-Benefits (icon key on pg. 34)

Climate Resilience

Establishing a school bus program can take more cars off the road, resulting in less traffic and better allowing emergency responders to access a hazard site during an extreme weather event.

Health and Equity Considerations

Shifting children's trips to school from private car trips to bus, bicycling or walking trips promotes consistent physical activity. Prioritize service for students who live further away from schools with limited access to sustainable modes of transportation.

Measure Description

This measure requires establishing or expanding a school bus program. Busing provides a practical way to transport students to school while also offering reductions in GHG emissions when there is high enough ridership. When districts establish busing programs, they directly replace automobile trips to take students to and from school.

Subsector

School Programs

Locational Context

Urban, suburban

Scale of Application

Project/Site

Implementation Requirements

See measure description.

Cost Considerations

Establishing or expanding a school bus program requires capital investment to purchase school buses or operating expenses associated with using contracted transportation service, along with increased staffing to direct the program. Total costs vary depending on the type and capacity of buses, as well as on the routes and frequency of service. Electric school buses can cost more initially but offer long-term cost benefits through lower maintenance costs and fuel efficiency. Familes of students who may more easily be able to travel without a car may also observe cost savings from reduced vehicle usage or ownership.

Expanded Mitigation Options

Use electric buses to achieve greater emissions reductions compared to conventional diesel buses with the same number of passengers. Because diesel school buses have much higher emissions per mile than a typical light-duty vehicle and take a much longer route than a direct drive to school, they need to transport a high number of students to make up for the bus emissions. The circumstances change, however, with the introduction of electric buses; even a small capacity electric bus of five students leads to emission reductions relative to the average passenger vehicle.

GHG Reduction Formula

$$A = -\frac{B \times C \times D \times \left(\frac{H}{E} - \frac{G \times I}{F}\right)}{\frac{H}{E}}$$

GHG Calculation Variables

ID	Parameter	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicle travel among students	0–57	%	calculated
User Inputs				
B	Percent of students across the school who begin riding the bus as a result of the program	0–100	%	user input
C	Percent of students served by bus system (regardless of whether they ride)	0–100	%	user input
Constants, Assumptions, and Available Defaults				
D	Percent of new bus riders who drove or were driven beforehand	79	%	FHWA 2023
E	Average student occupancy of cars driving to school	1.58	students/car	FHWA 2023
F	Average student occupancy of school buses	Table T-40.1	students/bus	Wang 2019
G	Adjustment for ratio of bus touring distance to driving distance	3.42	unitless	FHWA 2023; Duran 2013
H	Light-duty emission factor	Table T-30.2	grams CO_2e/mile	CARB 2019, 2020a, 2020b, 2020c; U.S. DOE 2021
I	School bus emission factor	Table T-40.2	grams CO_2e/mile	CARB 2021

Further explanation of key variables:

- (B) – This is the percentage of students at the school who can ride the bus and who begin riding the bus after the implementation of the program. For a new program, this is equal to the percentage of all students who ride. For a program change, this is equal to the difference in percentage of students who ride before and after program implementation.
- (C) – This is the percentage of students for whom the bus program provides service. If one neighborhood is served, then this is the percentage of students at the school who live in that neighborhood.

- (D) – If a district is conducting surveys as part of their California's Safe Routes to Schools (SR2S) or bus program expansion, it is recommended to include a question that assesses what fraction of new riders were driving before bus service was introduced. This eliminates any over counting from riders who biked, walked or took some other form of transit prior to the service's introduction.
- (E) – This constant is from NHTS and represents the average occupancy of school trips taken by car in the Pacific division. NHTS does not consider the driver an occupant if they are dropping someone off; however, students driving themselves to school are included in this occupancy value.
- (F) – This constant represents an estimate of the average occupancy of school buses based on research from Wang 2019.
- (G) – This constant was derived from NHTS data and school bus drive cycle data from Duran 2013. The average school trip taken in a private vehicle is 9.3 miles long in the Pacific Census division, while the average school bus tour is 31.7 miles. Thus, the ratio of bus touring distance to driving distance is 3.42.
- (H) – These light duty emissions factors are used throughout the Handbook and represent the emissions of cars taking students to school. The emission factors for light-duty autos or light-duty trucks is most appropriate.
- (I) – The school bus emission factor is taken from the most recent version of EMFAC and is used to determine the new emissions from the school buses added in this program. If a different type of vehicle is used for the program (such as a van or other light-duty vehicle), users should select the appropriate emission factor for that vehicle type as found in Table T-30.2 in Appendix C.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The percent reduction in GHG emissions (A) is capped at 57 percent. The benefits are unlikely to be this high; this level assumes that buses have an occupancy of 17.3 students, all buses are electric, and all students ride the bus.

Subsector Maximum

($\sum A_{max_{T\text{-}40\ \&\ T\text{-}56}} \leq 57\%$) This measure is in the School Programs subsector. This subcategory includes Measures T-40 and T-56 at the Project/Site scale of application. The school trip VMT reduction from the combined implementation of all measures within this subsector is capped at 57 percent. The reduction percentage for this measure is applicable to the School Programs subsector, which includes school commute trips. If users would like to apply the reduction percentage to community-wide emissions, the reductions can be converted to community-scale reductions by multiplying the reduction percentage by 1.64 percent (FHWA 2023).

Example GHG Reduction Quantification

A school district in the San Diego area starts a new busing program that serves all students but only 50 percent (B) of eligible students ride. The buses run on compressed natural gas, and the average parent drives their child to school in an SUV. This would lead to a reduction in GHG emissions from school-based trips of 5.8 percent.

$$A = -\frac{50\% \times 100\% \times 79\% \times \left(\dfrac{416.9\,\frac{g}{mi}}{1.58\,\frac{riders}{veh}} - \dfrac{3.42 \times 981\,\frac{g}{mi}}{14.9\,\frac{riders}{veh}} \right)}{\dfrac{417\ g/mi}{1.58\,\frac{riders}{veh}}} = -5.8\%$$

Quantified Co-Benefits

Improved Air Quality

The percent reduction in GHG emissions (A) would be the same as the percent reduction in NOx, CO, NO_2, SO_2, and PM. Reductions in ROG emissions can be calculated by multiplying the percent reduction in GHG emissions (A) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* for further discussion.

Energy and Fuel Savings

The percent reduction in vehicle fuel consumption achieved by the measure would be the same as the percent reduction in GHG emissions (A).

VMT Reductions

The percent reduction in VMT achieved by the measure would be the same as the percent reduction in GHG emissions (A).

Sources

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