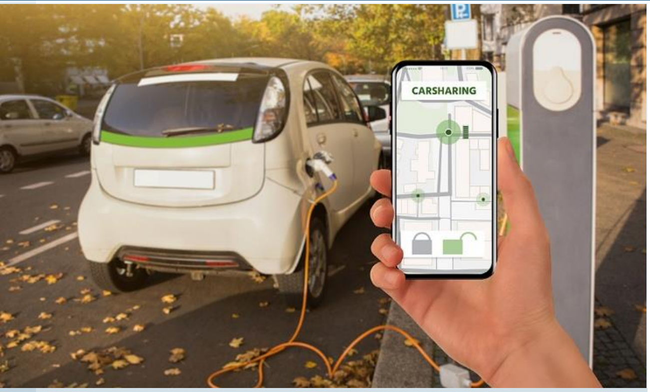
T-21-B. Implement Electric Carshare Program



GHG Mitigation Potential

0.18%

Up to 0.18% of GHG emissions from vehicle travel in the plan/community

Co-Benefits (icon key on pg. 34)

Climate Resilience

Electric carshare programs can increase accessibility and provide redundancy to vehicles that can be used to evacuate or obtain resources during an extreme weather event. Electric vehicles also provide fuel redundancy by allowing an alternative fuel source if an extreme event disrupts other fuel sources; however, they may decrease resilience if they are the only option available during a power outage.

Health and Equity Considerations

Provide inclusive mechanisms so people without bank accounts, credit cards, or smart phones can access the system.

Measure Description

This measure will increase carshare access in the user's community by deploying electric carshare vehicles. Carsharing offers people convenient access to a vehicle for personal or commuting purposes. This helps encourage transportation alternatives and reduces vehicle ownership, thereby avoiding VMT and associated GHG emissions. This also encourages a mode shift from internal combustion engine vehicles to electric vehicles, displacing the emissions-intensive fossil fuel energy with less emissions-intensive electricity. Electric carshare vehicles require more staffing support compared to conventional carshare programs for shuttling electric vehicles to and from charging points. A variation of this measure, conventional carsharing, is described in Measure T-21-A, *Implement Conventional Carshare Program*.

Subsector

Neighborhood Design

Locational Context

Urban, suburban

Scale of Application

Plan/Community

Implementation Requirements

The GHG mitigation potential is based, in part, on literature analyzing one-way carsharing service with a free-floating operational model. This measure should be applied with caution if using a different form of carsharing (e.g., roundtrip, peer-to-peer, fractional).

Cost Considerations

Costs incurred by the service manager (e.g., municipality, carshare company) may include the capital costs of purchasing vehicles; costs of storing, maintaining, and replacing the fleet; and costs for marketing and administration. Some of these costs may be offset by income generated through program use. Participants' recurring costs of renting a carshare vehicle may be offset by the cost savings from access to cheaper transportation.

Expanded Mitigation Options

When implementing a carshare program, best practice is to discount carshare membership and provide priority parking for carshare vehicles to encourage use of the service.

GHG Reduction Formula

$$A = -1 \times \frac{B \times ((E \times G \times H \times I \times J) - (D \times F))}{C \times F}$$

GHG Calculation Variables

ID	Variable	Value	Unit	Source
Output				
A	Percent reduction in GHG emissions from vehicle travel in plan/community	0–0.18	%	calculated
User Inputs				
B	Number of electric vehicles deployed in plan/community	[ ]	integer	user input
C	VMT in plan/community without measure	[ ]	VMT per day	user input
Constants, Assumptions, and Available Defaults				
D	Conventional VMT avoided with measure	54.8	VMT per day per EV	Martin and Shaheen 2016
E	Electric VMT added with measure	13.7	VMT per day per EV	Martin and Shaheen 2016
F	Emission factor of non-electric light duty fleet mix	307.5	g CO_2e per mile	CARB 2020a
G	Energy efficiency of carshare electric vehicle	0.327	kWh per mile	CARB 2020b; U.S. DOE 2021
H	Carbon intensity of local electricity provider	Tables E-4.3 and E-4.4	lb CO_2e per MWh	CA Utilities 2021
I	Conversion from lb to g	454	g per lb	conversion
J	Conversion from kWh to MWh	0.001	MWh per kWh	conversion

Further explanation of key variables:

- (B) – The number of cars in the carshare program is selected by the carshare provider, but its magnitude is relative to the size of the service area. A study of several carsharing programs (Martin and Shaheen 2016) documented a range of carshare fleet sizes for different North American cities: Calgary (590), San Diego (406), Seattle (640), Vancouver (920), Washington, D.C. (626).
- (C) – The total plan/community VMT should represent the expected total VMT generated by all land use in that area. The most appropriate source for this data is from a local travel demand forecasting model.
- (D) – Conventional VMT avoided per deployed carshare vehicle was derived based on a study of an electric vehicle carshare program in San Diego. It accounts for VMT avoided from carshare users who sold their personal vehicles and carshare users who decided not to purchase a personal vehicle, both directly because of the availability of carshare (Martin and Shaheen 2016).

- (E) – Electric VMT added per deployed carshare vehicle was derived based on a study of an electric vehicle carshare program in San Diego. It accounts for the VMT of the carshare vehicles and includes staff-driven VMT needed to bring the vehicles to charging points (Martin and Shaheen 2016).
- (F) – The average GHG emission factor for non-electric vehicles was calculated in terms of CO_2e per mile using EMFAC2017 (v1.0.3). The model was run for a 2020 statewide average of LDA, LDT1, and LDT2 vehicles using diesel and gasoline fuel. The running emission factors for CO_2, CH_4, and N_2O (CARB 2020a) were multiplied by the corresponding 100-year GWP values from the IPCC's Fourth Assessment Report (IPCC 2007). If the user can provide a project-specific value (i.e., for a future year and project location), the user should run EMFAC to replace the default in the GHG reduction formula.
- (G) – Scaled from light-duty automobile gasoline equivalent fuel economy (G from Measure T-14) based on energy efficiency ratio (EER) of 2.5 (CARB 2020b) and an assumption of 33.7 kWh electricity per gallon of gasoline (U.S. DOE 2021).
- (H) – 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, the user may elect to use the statewide grid average carbon intensity.

GHG Calculation Caps or Maximums

Measure Maximum

(A_{max}) The maximum GHG reduction from this measure is 0.18 percent. This maximum scenario is presented in the below example quantification.

Subsector Maximum

($\sum A_{max_{T\text{-}18\ through\ T\text{-}22\text{-}C}} \leq 10\%$) This measure is in the Neighborhood Design subsector. This subcategory includes Measures T-18 through T-22-C. The VMT reduction from the combined implementation of all measures within this subsector is capped at 10 percent.

Example GHG Reduction Quantification

The user reduces plan/community VMT by deploying carshare vehicles. In this example, the project would be in the city of San Diego, which in 2017 had a VMT per day of 24,101,089 miles (C) (SANDAG 2019). Assuming twice the number of vehicles used in the Car2go San Diego program (B), and a commitment by the carshare service provider to purchase zero-carbon electricity for all carshare charging stations (H), the GHG emissions from plan/community VMT would be reduced by 0.18 percent.

A =

$$-1 \times \frac{812 \times \left(\left(13.7\,\frac{\text{eVMT}}{\text{day·vehicle}} \times 0.327\,\frac{\text{kWh}}{\text{mile}} \times 0\,\frac{\text{lb }CO_2e}{\text{MWh}} \times 454\,\frac{\text{g}}{\text{lb}} \times 0.001\,\frac{\text{MWh}}{\text{kWh}}\right) - \left(54.8\,\frac{\text{cVMT}}{\text{day·vehicle}} \times 307.5\,\frac{\text{g }CO_2e}{\text{mile}}\right)\right)}{24{,}101{,}089\,\frac{\text{VMT}}{\text{day}} \times 307.5\,\frac{\text{g }CO_2e}{\text{mile}}} = -0.18\%$$

Quantified Co-Benefits

Improved Local Air Quality

Local criteria pollutants will be reduced by the reduction in vehicle fuel consumption. 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 electric vehicles will not generate localized criteria pollutant emissions. Accordingly, the percent reduction in NO_X, CO, NO_2, SO_2, and PM (K) is calculated using a simplified version of the GHG reduction formula, as follows:

$$K = -1 \times \frac{B \times -D}{C}$$

Reductions in ROG emissions can be calculated by multiplying the percent reduction in other criteria pollutant emissions (K) by an adjustment factor of 87 percent. See *Adjusting VMT Reductions to Emission Reductions* above for further discussion.

Fuel Savings (Increased Electricity)

The percent reduction in vehicle fuel consumption would be the same as the percent reduction in criteria pollutant emissions (K). The percent increase in electricity use (L) from this measure can be calculated using a variation of the GHG reduction formula, as follows.

Electricity Use Increase Formula

$$L = \frac{B \times E \times G \times N}{M}$$

Electricity Use Increase Calculation Variables

ID	Variable	Value	Unit	Source
Output				
L	Increase in electricity from electric vehicles	[ ]	%	calculated
User Inputs				
M	Existing electricity consumption of plan/community	[ ]	kWh per year	user input
Constants, Assumptions, and Available Defaults				
N	Days per year carshare program operational	365	days per year	assumed

Further explanation of key variables:

- (M) – The user should take care to properly quantify building electricity using accepted methodologies (such as CalEEMod).
- Please refer to the GHG Calculation Variables table above for definitions of variables that have been previously defined.

VMT Reductions

The percent reduction in VMT (O) is calculated using a simplified version of the GHG reduction formula that excludes the variables related to emission factors, as follows.

$$O = -1 \times \frac{B \times (E - D)}{C}$$

Sources

- California Air Resources Board (CARB). 2020a. *EMFAC2017 v1.0.3*. August. Available: https://arb.ca.gov/emfac/emissions-inventory. Accessed: January 2021.
- California Air Resources Board (CARB). 2020b. Unofficial electronic version of the Low Carbon Fuel Stproved_unofficial_06302020.pdf
- 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.
- Intergovernmental Panel on Climate Change (IPCC). 2007. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor and H.L. Miller (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 996 pp. Available: https://www.ipcc.ch/report/ar4/wg1/. Accessed: January 2021.
- Martin, E. and Shaheen, S. 2016. *The Impacts of Car2go on Vehicle Ownership, Modal Shift, Vehicle Miles Traveled, and Greenhouse Gas Emissions: An Analysis of Five North American Cities*. July. Available: https://tsrc.berkeley.edu/publications/impacts-car2go-vehicle-ownership-modal-shift-vehicle-miles-traveled-and-greenhouse-gas. Accessed: March 2021.
- San Diego Association of Governments (SANDAG). 2019. *Mobility Management VMT Reduction Calculator Tool – Design Document*. June. Available: https://www.icommutesd.com/docs/default-source/planning/tool-design-document_final_7-17-19.pdf?sfvrsn=ec39eb3b_2. Accessed: January 2021.
- U.S. Department of Energy (U.S. DOE). 2021. Download Fuel Economy Data. January. Available: https://www.fueleconomy.gov/feg/download.shtml. Accessed: January 2021.