CMAQ Emissions Calculator Toolkit: Brief Overview

This calculator is used to assist DOT's, MPOs, and project sponsors in calculating emission reduction estimates for various projects. Emission rates are based on a national-scale run of the EPA MOVES model. This guide will provide a brief overview of how to use the following transportation-related emissions calculators:

For access to the Toolkit downloads, In-depth User Guides, and Training Webinars, visit https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/

For additional help using this tool or to provide feedback, please email: CMAQ_Toolkit_Help@dot.gov

Bicycle, Pedestrian, and Shared Micromobility

This calculator focuses on estimating the emissions reductions created by improving bicycle and pedestrian infrastructure and diverting to bicycle and pedestrian trips. There are two calculators in this toolkit; Bicycle & Pedestrian Improvements and Shared Micromobility Projects.

Bicycle & Pedestrian Improvements

Item	User Input	Units	Description
(1)	Project evaluation year	---	Year the project is fully implemented. For example: a project begins construction in 2023 and concludes in 2025. The evaluation year is 2025.
(2)	Daily individual motorized trips (before & after)	One-way trips	The difference represents the number of diverted trips as a result of the project.
(3a)	One-way trip distance source	---	Select either 'Average' or 'Distribution' as the one-way trip distance type used to derive subsequent VMT estimates.
(3b)	Typical Trip Distance	Miles one way	If you selected 'Average' in (3a), enter the trip distance representing the typical traveler's trip distance for passenger vehicles. If you wish to use default values, click 'Fill National Values'.
(3b)	Distribution of trip distances	---	If you selected 'Distribution' in (3a), enter the percentage of trips according to the ranges provided. This should sum to 100%. Note that these ranges exclude trips greater than 5 miles. If you wish to use default values, click 'Fill National Values'.

Note: When calculating emission reductions of a shared bicycle/pedestrian path, bicycle and pedestrian emission reductions must be calculated separately, then summed.

Also note: This tool calculates emissions based on one-way trips and one-way trip distance of diverted trip distances. To calculate for round trips, multiple the number of trips (2) by two and divide round-trip distances (3b) by two.

For more information, visithttps://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/bikeped_userguide_update.pdf for the complete Bike/Ped User Guide. This includes Tool Methodology, common errors you may encounter, and multiple examples.

For a more in-depth introduction, there is a training webinar with multiple live demonstrations here: https://connectdot.cosocloud.com/p07axgq7mti6/. The Bicycle and Pedestrian Module begins at 26:45.

Shared Micromobility Projects

This calculator focuses on emissions reductions created by the diversion of passenger vehicle trips to shared micromobility devices. Default national averages of mode shifts have been provided, however it is recommended that this is calculated through a travel demand model prior to the use of this emissions calculator.

Item	User Input	Units	Description
(1)	Project evaluation year	---	Year the project is fully implemented. For example: a project begins construction in 2023 and concludes in 2025. The evaluation year is 2025.
(2)	Shared micromobility mode	---	Select either 'bicycle' or 'scooter' as your micromobility mode. If your project includes both types of devices, you will need to calculate separately, then sum the data.
(3)	Docked or undocked	---	Select 'docked' or 'undocked'.
(4)	Device power source	---	Select 'manual power' or 'electric/electric assist'. If "scooter" was selected for (2), "electric/electric assist" will be automatically selected.
(5)	Number of devices	No. of devices	Enter the number of devices that will be deployed at any given time. Note this is not the same as fleet size. If the number of deployed devices fluctuates throughout the year, an average value can be used.
(6a)	One-way trip distance	Miles	If the average one-way trip distance is known, select 'Custom Entry' and input the average distance. If unknown, select " Preset National Average" for default values.
(6b)	Utilization rate	Trips/device /day	If the average number of one-way trips per device per day is known, select 'Custom Entry' and input the utilization rate. If unknown, select " Preset National Average" for default values.
(7)	Mode shift[1]	Percent	Enter the percent of shared micromobility trips that would have otherwise been made using a personal vehicle, taxi, or TNC.

[1] A default value of 37 percent can be used per NABSA's 2021 State of the Industry Report - https://nabsa.net/2022/08/03/2021industryreport/#:%7E:text=The%202021%20State%20of%20the,economies%2C%20and%20 existing%20 transportation%20 ecosystems

Note: If your project includes bicycles and scooters, emission reductions must be calculated separately, then summed.

For more information, visit https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/cmaq-shared-mm-userguide.pdf for the complete Shared Micromobility User Guide.

Alternative Fuel Vehicles and Infrastructure

This calculator is used to estimate the emission benefits of integrating alternative fuels into our current on-road transportation system. This tool does not consider emissions associated with the production and transmission of fuel or manufacturing, only operating emissions. There are two calculators available for use; Alternative Fuels Fleet Purchase & Restricted Access Fueling Infrastructure and Unrestricted Access Fueling Infrastructure.

Alternative Fuels Fleet Purchase & Restricted Access Fueling Infrastructure

User Inputs for Alternative Fuels Fleet Purchase

Item	User Input	Units	Description
(1)	Project evaluation year	---	Year the project is fully implemented. For example: a project begins construction in 2023 and concludes in 2025. The evaluation year is 2025.
(2)	Project Components	---	Select 'Alt Fuels Fleet Purchase', 'Restricted Access Infrastructure', or both and fill in the corresponding questions.
(3)	Type of vehicle	---	For more information on vehicle classifications, view the Alternative Fuel Vehicle and Infrastructure User Guide.
(6a)	Activity Data	---	Select 'Vehicle Miles Traveled (VMT)', 'Vehicle Population', or both. At least one value is needed for transit bus activity.
---	Additional Information	---	vehicle(s) model year (3), conventional fuel (4), model year of alternative fuel vehicle(s) (6b), model year of alternative fuel vehicle(s) (7), fuel use of new vehicle(s) (8)

User Inputs for Restricted Access Infrastructure

Item	User Input	Units	Description
(12)	Distance to primary fueling facility	---	Select 'Increase' or 'Decrease'.
(13)	Anticipated change in VMT to new fueling infrastructure	Miles	To calculate the change in VMT, multiple (number of vehicles in a fleet) * (distance traveled to old fueling infrastructure) * (total days active in a year). For example, 15 refuse trucks run 330 days out of the year and have to travel 10 miles out of the way to refuel. 15*10*330 = 49,500 additional miles due to old fueling infrastructure.
---	Additional Information	---	type of vehicle(s) (9), model year of alternative vehicle(s) (10), alternative fuel type (11)

For a more in-depth introduction, there is a training webinar with multiple live demonstrations here: https://connectdot.cosocloud.com/pqu4tn4ieqyg/.

Unrestricted Access Fueling Infrastructure

This unrestricted access calculator for public fueling was developed separately from the alternative fuel fleet purchase calculator and should not be combined.

Item	User Input	Units	Description
(1)	Project evaluation year	---	Year the project is fully implemented. For example: a project begins construction in 2023 and concludes in 2025. The evaluation year is 2025.
(2)	Total vehicle count in study area	vehicles	Input the number of vehicles primarily fueled in a specified study area. This may range from one fueling station to a regional corridor. Methods such as vehicle registration or fuel sales and tank size would be appropriate to determine vehicle count.
(3)	Alternative fuel type	---	Use the drop-down menu to select the alternative fuel type.
(4)	Alternative fuel vehicle market share	---	Insert a percentage for the projected market penetration of alternative fuel vehicles out of the total number of vehicles in the study area over the course of the evaluation year.

Note: After clicking "Fill Table", you may get a pop-up about what vehicle sources lack data or emissions given your alternative fuel source. Note the vehicle source types, uncheck these in the table, then refill the table. This will redistribute the data. You can now calculate the output.

For a more in-depth introduction, there is a training webinar with multiple live demonstrations here: https://connectdot.cosocloud.com/pqu4tn4ieqyg/.

For more information, visit the Restricted and Unrestricted Access Alternative Fuel Infrastructure User Guide at:
https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/alt_fuels_veh_purchase_restricted_infra_doc.pdf
https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/alt_fuels_unrestricted_infra_doc.pdf

Congestion Reduction and Traffic Flow Improvements

This toolkit has four calculators to estimate emissions reductions and performance metrics caused by the improvement of traffic flow and the reduction of congestion though single intersection projects. The four calculators include; Intersection Improvements, Traffic Signal Synchronization, Roundabouts, and Two Way Left Turn Lanes.

Intersection Improvements

User Inputs for Existing Conditions

User Input	Units	Description
Project evaluation year	---	Year the project is fully implemented. For example: a project begins construction in 2023 and concludes in 2025. The evaluation year is 2025.
Area type	---	Select 'rural' or 'urban'. All road types refer to MOVES unrestricted roads.
Business district	---	If the intersection is located in a central business district, select 'yes', otherwise select 'no'.
Total peak hours per day (AM+PM)	hours	Input the average number of peak hours the intersection experiences on a typical weekday. The default value is four hours.
Existing Inspection is	---	If the intersection is controlled by a traffic signal, select 'Signalized', otherwise select 'Unsignalized'.
Average Annual Daily Traffic Volume (AADT), Roadway 1 (both directions)	vehicles/day	The annual average daily traffic from both directions and across all lanes.
Peak-hour volume (both directions)	vehicles/hour	Weekday peak average hourly volume of traffic from both directions and across all lanes.
Number of lanes (one direction)	---	The number of existing through lanes for one approach direction.
Truck percentage	---	Percent of traffic that is heavy-duty truck vehicles. The default value is 6% according to the MOVES default activity rates.
Existing delay per vehicle	seconds	Input the existing/no-build delay for one direction of Roadway 1 at the intersection. If field data is available, select the greater delay value of the two directions. If field data is not available, approximate delay value can be found given the intersection's existing level of service. This data and table comes from the Highway Capacity Manual 2010, Exhibit 21-1
Existing left-turn phase	---	If there is an existing protected left-turn signal for Roadway 1, select 'yes'. If the intersection is unsignalized or lacks an existing protected left-turn signal, select 'no'.
Existing right-turn phase	---	If there is an existing protected right-turn signal for Roadway 1, select 'yes'. If the intersection is unsignalized or lacks an existing protected right-turn signal, select 'no'.

User Inputs for Proposed Conditions

User Input	Units	Description
Cycle length	seconds	Input the proposed/new cycle length of the intersection. The default value is 90 seconds.
Number of Left-Turn Lanes to Add (one direction)	---	Input the number of dedicated left-turn lanes for one approach direction for Roadway 1 and 2.
Left-turn phase	---	If the proposed project will have a protected left-turn signal for Roadway 1 and 2, select 'yes', otherwise choose 'no'.
Right-turn phase	---	If the proposed project will have a protected right-turn signal for Roadway 1 and 2, select 'yes', otherwise choose 'no'.

For a more in-depth introduction, there is a Training Webinar with multiple live demonstrations here:https://connectdot.cosocloud.com/p6fgojv9f4kp/.

For more information on understanding output meanings, common errors, and tool methodology, visit the Intersection Improvements User Guide at https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/crtf_intersection_improvements.pdf.

Traffic Signal Synchronization

This calculator estimates the benefits of coordinating traffic signal timing along a corridor. This is not intended to calculate the benefits of new signals, only the synchronization of existing traffic signals.

User Input	Units	Description
Project evaluation year	---	Year the project is fully implemented. For example: a project begins construction in 2023 and concludes in 2025. The evaluation year is 2025.
Road type	---	Based on the road type for the coordinated signalized corridor, select 'rural' or 'urban'. All road types refer to MOVES unrestricted roads.
Corridor Length	miles	Input the length of the project corridor in which the lights will be synchronized. The default value is 1 mile.
Number of signalized intersections	---	Input the total number of traffic signals along the project corridor. Note: There must be at least two intersections/traffic signals. The default value is two signals.
Number of lanes, one direction	---	Average number of through lanes along the length of the project corridor in one direction. The default value is 1 lane.
Posted speed limit	mph	Average speed limit posted along the length of the project corridor. The upper limit is 75 mph.
Average cycle length	seconds	Average cycle length of the traffic signals included in the signal synchronization project. Per the Highway Capacity Manual, the default value is 90 seconds.
Truck percentage	---	Percent of traffic that is heavy-duty truck vehicles along the corridor. The default value is 6% according to the MOVES default activity rates.
Annual Average Daily Traffic (AADT), both directions	vehicles/day	Input the annual average daily traffic from both directions and all lanes along the length of the corridor.
Peak-hour volume, both directions	vehicles/hour	Input average volume of traffic from both directions and all lanes along the corridor during a typical weekday, peak travel hours.
Existing corridor travel time	minutes	Input the average time in minutes it takes for a vehicle to travel the length of the project corridor.
Total peak hours per day (AM+PM)	hours	Input the total number of peak hours the project corridor experiences on a typical weekday. The default value is 4 hours.

For more information on understanding output meanings, common errors, and tool methodology, view the Traffic Signal Synchronization User Guide at https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/crtf_signal_sync.pdf.

Roundabouts

This is intended to calculate emission reductions following the insulation of a single or double lane roundabout with three to four approaches during peak and off-peak hours.

User Input	Units	Description
Project evaluation year	---	Year the project is fully implemented. For example: a project begins construction in 2023 and concludes in 2025. The evaluation year is 2025.
Area type	---	Indicate either a rural or urban unrestricted intersection.
Business district	---	If the intersection is located in a central business district, select 'yes', otherwise select 'no'.
Total peak hours per day (AM+PM)	hours	Input the average number of peak hours the intersection experiences on a typical weekday. The default value is four hours.
Existing Intersection is	---	Select if traffic control at the existing intersection is 'Signalized' or 'Un-signalized'.
Average Annual Daily Traffic (AADT) volume, each day	vehicles/day	The AADT volume of traffic across all lanes of travel from all approaches.
Peak-hour volume, each approach	vehicles/hour	Average hourly volume of traffic across all lanes during weekday peak hours from each approach.
Truck percentage, each approach	---	Percent of heavy-duty traffic from each approach. Per MOVES activity rates, the default value is 6%.
Existing delay per vehicle, each approach	seconds	Input the existing/no-build build delay for each approach of the existing intersection. If field data is not available, approximate values can be found from the table given the intersection's existing level of service[1]. **Note**: For the most accurate results, use field data.
Number of lanes, each approach	---	Indicate the number of lanes for each approach.
Percent left/right turns, each approach	---	Input the percent of traffic in each approach that takes a left and right turn at the existing intersection.
Number of circulating roundabouts (proposed)	---	Indicate the proposed number of circulating lanes the roundabout will have. The default value is 1 lane.

[1]Exhibit 21-1, Highway Capacity Manual, Transportation Research Board National Academy of Sciences, Washington DC, 2010.

Note: A “0” value for emissions reductions indicates no change in emissions associated with the proposed project. A negative value indicates an increase in emissions due to the implementation of the given project.

Two Way Left Turn Lanes

This calculator estimates the benefits of adding two way left turn lanes. By removing left-turning vehicles from through lanes, through traffic delay and left-turning vehicle delay is expected to decrease, resulting in improved travel time and reduced emissions.

User Input	Units	Description
Project evaluation year	---	Year the project is fully implemented. For example: a project begins construction in 2023 and concludes in 2025. The evaluation year is 2025.
Area type	---	Indicate either a rural or urban unrestricted intersection.
Segment length	miles	The length of the project segment in which the unseparated median will be converted. The default value is a quarter of a mile (0.25).
Number of lanes (both directions)	---	Input the number of through lanes in both directions in the project segment. Options are; 2, 4, and 6 lanes.
Free flow speed (speed limit)	mph	Input the average speed limit along the project corridor. The tool's upper limit is 75 mph.
Total peak hours per day (AM+PM)	hours	Input the average number of peak hours the project segment experiences on a typical weekday. The default value is four hours.
Number of access points (outside/right side of direction)	---	Input the number of driveways, parking lot entrances, or minor streets that intersect the major street on the right side or outside of the subject travel direction within the study segment.
Average percent of right turning vehicles per access point	---	The percentage of vehicles approaching each access point intersection that turn right, averaged over the entire major road segment.
Truck percentage	---	Enter the percent of traffic across the segment that is heavy-duty truck vehicles.
Peak hour traffic volume (each direction)	vehicles/hour	Input the average peak hour traffic volume or demand across the segment.
Annual average daily traffic (AADT, each direction)	vehicles	Input the AADT of the study segment.

For more information on understanding output meanings, common errors, and tool methodology, view the Two Way Left Turn Lanes User Guide at https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/crtf_two_way_left_turn_lane.pdf.

To view the Training Webinar for Congestion Reduction and Traffic Flow Improvements and its calculators, visit https://connectdot.cosocloud.com/p6fgojv9f4kp/. This covers the general inputs, possible errors, and walks through multiple examples.

Electric Vehicles and EV Charging Infrastructure

These two calculators estimate the emission reductions of replacing conventional fuel fleets and developing EV charging infrastructure, with restricted and unrestricted access. This tool uses emission rates from the US Environmental Protection Agency's Motor Vehicle Emission Simulator (MOVES).

Restricted Access EV Charging Infrastructure

Note: This tool does not consider emissions associated with the production and transmission of fuel or the manufacturing of the vehicle.

Item	User Input	Units	Description
(1)	Project evaluation year	---	Year the project is fully implemented. For example: a project begins construction in 2023 and concludes in 2025. The evaluation year is 2025.
(2)	Project component: Electric Vehicle Fleet Replacement	---	Select if your project involves the purchase or replacement component.
(2)	Project component: Restricted Access Infrastructure	---	Select if your project involves new restricted access infrastructure.

User Inputs for EV Fleet Purchase

Item	User Input	Units	Description
(3)	Replacement vehicle type	---	For more information on vehicle classifications, visit the Restricted Access EV Charging Infrastructure User Guide.
(4)	Model year of conventional fuel vehicle	---	Input the model year of vehicles to be replaced. If there is a range of years, input and calculate the years separately, then sum, OR input a representative number.
(5)	Conventional fuel type	---	Select 'Gasoline' or 'Diesel Fuel'.
(6a)	Vehicle miles traveled to be replaced (check box)	---	Check the box if you know the annual vehicle miles traveled for the vehicles to be replaced. This can be checked concurrently with the vehicle population option.
(6a)	Replacement vehicle population (check box)	---	Check the box if you know the number of vehicles to be replaced. This can be checked concurrently with the vehicle miles traveled option.
(7)	Model year of electric vehicle population	---	Input the model year of the vehicles to be purchased. If you have a range of years, input and calculate the years separately or input a representative purchase year for the vehicles.

Note: If you have a range of model years for the conventional fuel vehicle and EV populations, input and calculate the years separately, then sum. You can also input a representative purchase year for the range of model years.

Also note: If both VMT and Vehicle Population is provided, emissions benefits are calculated off VMT. The only population is entered, the emissions benefits will be calculated by multiplying the supplied population by the default annual miles traveled per vehicle in MOVES. For more information on this equation, view the Restricted Access EV Charging Infrastructure User Guide at https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/.

User Inputs for Restricted Access Infrastructure

Item	User Input	Units	Description
(8)	Vehicle type to be charged at the facility	---	For more information on vehicle classifications, visit the Restricted Access EV Charging Infrastructure User Guide.
(9)	Model year of vehicles to be fueled at the facility	---	Input the model year of vehicles to be replaced. If there is a range of years, input and calculate the years separately, then sum, OR input a representative number.
(10)	Increase or decrease in distance to facility	---	Select "Increase" or "Decrease". Note that this tool only provides results if there is a change in distance traveled.
(11)	Change in total annual fleet VMT	miles	Enter the expected change in annual vehicle miles traveled for fueling of the electric fleet after construction of the restricted-access infrastructure.

Note: This tool only provides results if there is a change in distance traveled.

Also note: A representative year indicates the model year of the majority of transit buses to be replaced. To get a more accurate representative year, take a weighted average of the model years and number of buses of each model year. For example, given five 2010 buses and ten 2014 buses, the weighted average can be calculated by: (5*2010+10*2014)/(5+10) = 2012.7. Users can then round to get the nearest representative year, 2013.

For access to the in-depth User Guide, view the Restricted Access EV Charging Infrastructure User Guide at https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/.

Unrestricted Access Electric Vehicle Charging Infrastructure

Item	User Input	Units	Description
(1)	Project evaluation year	---	Year the project is fully implemented. For example: a project begins construction in 2023 and concludes in 2025. The evaluation year is 2025.
(2)	Total vehicle count in study area	vehicles	Input the number of vehicles primarily fueled in a specified study area. This may range from one fueling station to a regional corridor. Methods such as vehicle registration or fuel sales and tank size would be appropriate to determine vehicle count.
(3)	Electric vehicle market share	---	Insert a percentage for the projected market penetration of electric vehicles out of the total number of vehicles in the study area over the course of the evaluation year.
(4)	Source type distributions for vehicle activity and populations	---	By selecting 'Fill Table', the table is populated with the average annual miles traveled per vehicle from the MOVES national default activity, number of existing conventional fuel vehicles using scaled MOVES default counts, and the subsequent number of electric vehicles based on the input market share to replace the existing conventional fuel vehicles in the given evaluation year. Results are presented by source type and any source type can be un/selected using the checkboxes. Users can also optionally override any specific value in the table.

To view the Unrestricted Access Electric Vehicle Charging Infrastructure User Guide, visit https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/ev_unrestricted_infra_doc.pdf.

Transit Bus Upgrades & System Improvements

This is an updated toolkit that includes the electric repowering of conventionally fueled transit buses. It can be used to calculate the emission reductions from retrofitting diesel transit buses, replacing diesel and compressed natural gas buses, and replacing conventional buses with emission reduction technologies and alternative fuel. It includes three calculators; Electric Transit Bus Replacement, Non-EV Transit Bus Replacement, and Transit Bus Diesel Retrofit.

Transit Bus Diesel Retrofit

This calculator estimates the emission reductions for retrofitting diesel transit buses. Emission reductions are calculated based on the change in running, start, and crankcase emissions of the pro- and post-retrofit transit buses.

Item	User Input	Units	Description
(1)	Project evaluation year	---	Select a year from the drop-down menu.
(2a)	Activity Data	---	If you know the annual vehicle miles traveled for the vehicles to be replaced, select 'VMT'. If you know the number of buses to be replaced, select 'vehicle population'. Both options may be selected concurrently.
(2b)	Annual activity (input value)	miles	Input the total annual vehicle miles traveled for the entire fleet of transit buses to be replaced. For example, a fleet of 10 buses each driving 60,000 miles annually equals 600,000 miles.
(2b)	Annual activity (input value)	vehicles	Input the number of buses to be replaced. The default value is one bus.
(3)	Retrofit type	---	Select the appropriate retrofit type from the drop-down menu. For more details on retrofit types, visit the Transit Bus Diesel Retrofit User Guide.
(4)	Model year of transit buses to be retrofit	---	Input the model year of vehicles to be retrofitted. If there is a range of years, input and calculate the years separately, then sum, OR input a representative year.

For access to more information on this toolkit, visit the Transit Bus Diesel Retrofit Module at https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/transit_bus_retrofit_user_guide.pdf.

Electric (EV) Transit Bus Replacement

This calculator estimates the emissions reduction of replacing conventional fuel transit buses with electric buses. This calculator only applies to transit buses, and the emission rates, activity, and population assumptions are based on MOVES.

Item	User Input	Units	Description
(1)	Project evaluation year	---	Select a year from the drop-down menu.
(2)	Project component: EV Transit Bus Replacement & Restricted Access Infrastructure	---	Check one or both of the project component options.

User Inputs for Non-EV Transit Bus Replacement

Item	User Input	Units	Description
(3)	Model year of current transit buses (buses to be replaced)	---	Input the model year of buses to be replaced. If there is a range of years, input and calculate the years separately, then sum, OR input a representative year.
(4)	Fuel type of transit buses to be replaced	---	Select either 'diesel' or 'CNG' for the fuel types of the buses that will be replaced.
(5a)	Activity data	---	If you know the annual vehicle miles traveled for the vehicles to be replaced, select 'VMT'. If you know the number of buses to be replaced, select 'vehicle population'. Both options may be selected concurrently.
(5b)	Annual activity (input value)	miles	Input the total annual vehicle miles traveled for the entire fleet of transit buses to be replaced. For example, a fleet of 10 buses each driving 60,000 miles annually equals 600,000 miles.
(5b)	Annual activity (input value)	vehicles	Input the number of buses to be replaced. The default value is one bus.
(6)	Model year of replacement transit buses	---	Input the model year of the replacement vehicle. If there is a range of years, input and calculate the years separately, then sum, OR input a representative year.

User Inputs for Restricted Access Infrastructure

Item	User Input	Units	Description
(7)	Model year of current transit buses (buses to be replaced)	---	Input the model year of vehicles to be replaced. If there is a range of years, input and calculate the years separately, then sum, OR input a representative year.
(8)	Change in fueling distance	---	Select "Increase" or "Decrease". Note that this tool only provides results if there is a change in distance traveled.
(11)	Anticipated change in annual VMT	miles	Enter the expected change in annual vehicle miles traveled for fueling of the alternative fleet after construction of the restricted-access infrastructure.

For more information on how to understand and analyze the outputs, visit the Electric Transit Bus Replacement User Guide at https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/transit_bus_ev_replacement_user_guide.pdf.

For additional information and live demonstrations for the module, visit https://connectdot.cosocloud.com/p3u0vad3q6ei/.

Non-EV Transit Bus Replacement

This module specifically focuses on calculating the change in emissions when replacing diesel and compressed natural gas transit buses with CNG, newer diesel, or alternative fuel buses.

Item	User Input	Units	Description
(1)	Project evaluation year	---	Select a year from the drop-down menu.
(2)	Project component: Non-EV Transit Bus Replacement & Restricted Access Infrastructure	---	Check one or both of the project component options.

User Inputs for Non-EV Transit Bus Replacement

Item	User Input	Units	Description
(3)	Model year of current transit buses (buses to be replaced)	---	Input the model year of vehicles to be replaced. If there is a range of years, input and calculate the years separately, then sum, OR input a representative year.
(4)	Fuel type of transit buses to be replaced	---	Select either 'diesel' or 'CNG' for the fuel types of the buses that will be replaced.
(5a)	Activity data	---	If you know the annual vehicle miles traveled for the vehicles to be replaced, select 'VMT'. If you know the number of buses to be replaced, select 'vehicle population'. Both options may be selected concurrently.
(5b)	Annual activity (input value)	miles	Input the total annual vehicle miles traveled for the entire fleet of transit buses to be replaced. For example, a fleet of 10 buses each driving 60,000 miles annually equals 600,000 miles.
(5b)	Annual activity (input value)	vehicles	Input the number of buses to be replaced. The default value is one bus.
(6)	Model year of replacement transit buses	---	Input the model year of the replacement vehicle. If there is a range of years, input and calculate the years separately, then sum, OR input a representative year.
(7)	Fuel type of replacement transit buses	---	Select an alternative fuel type of the replacement buses in the drop-down menu. Note that not all vehicle fuel type combinations are allowable and may produce an error.

Note: A representative year indicates the model year of the majority of transit buses to be replaced. To get a more accurate representative year, take a weighted average of the model years and number of buses of each model year. For example, given five 2010 buses and ten 2014 buses, the weighted average can be calculated by: (5*2010+10*2014)/(5+10) = 2012.7. Users can then round to get the nearest representative year, 2013.

User Inputs for Restricted Access Infrastructure

Item	User Input	Units	Description
(8)	Model year of current transit buses (buses to be replaced)	---	Input the model year of vehicles to be replaced. If there is a range of years, input and calculate the years separately, then sum, OR input a representative year.
(9)	Fuel type of transit buses to be replaced	---	Select either 'diesel' or 'CNG' for the fuel types of the buses that will be replaced. Note: Questions 8 and 9 are not needed if you selected both project components in question 2.
(10)	Change in fueling distance	---	Select "Increase" or "Decrease". Note that this tool only provides results if there is a change in distance traveled.
(11)	Anticipated change in annual VMT	miles	Enter the expected change in annual vehicle miles traveled for fueling of the alternative fleet after construction of the restricted-access infrastructure.

For access to the in-depth guide, view the Non-EV Transit Bus Replacement User Guide at https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/transit_bus_non-ev_replacement_user_guide.pdf.

To view the training webinar for Transit Bus Upgrades & System Improvement and its calculators, visit https://connectdot.cosocloud.com/p3u0vad3q6ei/. This covers the general inputs, possible errors, and walks through multiple examples.

Transit Bus Service and Fleet Expansion

This tool estimates emission reductions created by diverting passenger vehicle usage to transit buses. Any project that demonstrates an increased transit use and decreased passenger vehicle use can be modeled using this tool.

Item	User Input	Units	Description
(1)	Project evaluation year	---	Select a year from the drop-down menu.
(2)	Annual bus service operating days	number of days	Input the total number of days per year that the bus service operates. For weekdays only, input 260 days per year. For weekends only, enter 105 days per year. The default operating days are 365 days per year.
(3a)	Transit bus vehicle miles traveled before and after project completion	miles	Enter the estimated vehicle miles traveled annually by transit buses before and after project completion.
(3b)	Allocation of model years (button)	Model Year VMT / Total Fleet VMT	Users will be redirected to Model Year Activity Allocations to modify the fleet vehicle model year distribution. Input the distribution of the fleet's activity by model year before and after project completion. For default values, click 'Set to National Default Values'. Note all allocations must sum to 1.
	Allocation of fuel (button)	Fuel Type VMT / Total Fleet VMT	Users will be redirected to Fuel Type Activity Allocations to modify the fuel type distribution. Input the distribution of the fleet's activity using given conventional and alternative fuel types before and after project completion. For default values, click 'Set to National Default Values'. Note all allocations must sum to 1.
	Allocation of road types (button)	Road Type VMT / Total Fleet VMT	Users will be redirected to Road Type Activity Allocations to modify the fuel type distribution. Input the distribution of the fleet's activity on the given road types before and after project completion. For default values, click 'Set to National Default Values'. Note all allocations must sum to 1.
(4a)	Passenger Vehicle Activity Type	---	Select 'Passenger Vehicle Miles Traveled' or 'Passenger Vehicle Trips'.
	Passenger Activity	trips or miles	Enter the miles or trips of passenger vehicle activity in the service area before and after project completion according to what was selected in the previous question. These activity inputs are required.
	Average One-Way Trip Distance	miles	Enter the average trip distance for passenger vehicles in the service area. The default value is 4.52 miles.

(4b)	Do you expect most passenger vehicle trips to be linked with bus trips as a result of service or fleet expansion?	---	Select whether services users will drive to the transit hub to use the bus service or not. If trips are linked, emissions for passenger vehicles will not be reduced as a result of the transit project. If the project will reduce full passenger trips, start activity, and thus emissions, start emissions will be reduced.

For more information, visit https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/transit_bus_expansion_userguide.pdf for the complete Transit Bus Service and Fleet Expansion Tool Guide. This includes tool methodology, common errors you may encounter, and multiple examples.

For a more in-depth introduction, there is a training webinar with multiple live demonstrations here: https://connectdot.cosocloud.com/p3u0vad3q6ei/.