CMAQ EMISSIONS CALCULATOR TOOLKIT

The purpose of the Congestion Mitigation and Air Quality Improvement Program Emissions Calculator Toolkit (CMAQ Toolkit) is to help a user with limited modeling experience estimate emission reductions associated with implementation of a CMAQ-funded project. The CMAQ Toolkit uses emission rates and activity data based on default-scale (also known as national-scale) runs of the U.S. Environmental Protection Agency's (EPA) Motor Vehicle Emission Simulator (MOVES). This document explains the use and methodology of the Shared Micromobility Tool.

Emission estimates from the CMAQ Toolkit are not intended to meet specific requirements for State Implementation Plans (SIPs) or transportation conformity analyses. For further information regarding the specific setup of MOVES used to generate the emission rates provided in this tool, please refer to the Emissions Data Documentation associated with this tool.

Shared Micromobility Module

The Shared Micromobility Module estimates emissions reductions accomplished by diverting trips from passenger vehicles[1] to shared micromobility devices by establishing a bikeshare or scooter-share program. It is recommended that users calculate related mode shifts through a travel demand model in advance of using this emissions calculator[2], however, a default national average was included in the module and can be used if local data is unavailable. Information on travel demand models can be found in Appendix A. Bikeshare and scooter-share programs increase access to non-motorized or electric shared micromobility vehicles. In addition to improving access, these programs remove the burden of storage and maintenance which may deter potential users. Diverting trips from a personal vehicle, taxi, or transportation network company (TNC) to shared micromobility device(s) improves air quality and reduces congestion by removing motorized vehicles, and their accompanying emissions, from the roadway. Projects covered by this tool include the addition or expansion of shared micromobility programs which make use of docked and undocked bikes and scooters.[3] Note that the tool does not apply to privately owned micromobility devices, and it assumes that transit service miles will remain unchanged, though transit utilization may change.

[1] "Passenger vehicles" refers to MOVES source types Passenger Car (sourceTypeID = 21) and Light Commercial Truck (sourceTypeID = 32).

[2] The most current version of the tool is dated July 2023. To verify the version, check the date on the Introduction page of the tool. Release notes are included in the Change Log tab, which can be viewed by right-clicking on any tab in the tool, selecting "Unhide", and revealing the tab.

[3] CMAQ projects must benefit air quality through demonstrated emission reductions. See the CMAQ guidance at www.fhwa.dot.gov/environment/air_quality/cmaq/ for a full list of projects that may be eligible for CMAQ funds.

This document is divided into four sections – User Guide, Tool Methodology, Examples, and Appendices. The User Guide defines user inputs and tool outputs, assumptions made by the tool, and error messages. The Tool Methodology section outlines the steps taken by the tool to calculate emission reductions and equations used within the tool. The Examples section provides instructive examples of how to use the tool for different types of analysis.

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USER GUIDE

This section describes each user input and tool output, error messages, and other tool assumptions.

User Inputs

The Shared Micromobility Tool's interface contains a series of questions to guide the user through properly inputting information for emission reductions calculations in a step-by-step process. The user-defined inputs for this tool are described in Table 1.

Table 1. User Inputs

Item	User Input	Units	Description
(1)	Project evaluation year*	-----	Year the project is fully implemented. For example: if construction begins in 2023 and concludes in 2025, the evaluation year is 2025. Use the drop-down menu to choose a year between 2018-2040.
(2)	Shared micromobility mode	-----	Use the drop-down menu to select "bicycle" or "scooter". If your project includes both types of devices, you will need to calculate them separately.
(3)	Docked or undocked	-----	Use the radio button to select "docked" or "undocked".
(4)	Device power source	-----	Use the radio button to select whether devices will be manually powered or electrically powered. If "scooter" was selected in question 2, "electric / electric assist" will automatically be selected for question 4.
(5)	Number of devices	No. of devices	Enter the number of devices that will be deployed at any given time. This is different from the size of the fleet, as the fleet likely encompasses spare devices. If the number of devices fluctuates throughout the year, an average value can be used.
(6a)	One-way trip distance	Miles	Enter the average one-way trip distance in miles or select "Preset National Average" to use default values.
(6b)	Utilization rate	Trips/device/day	Enter the average number of one-way trips each device is used per day or select "Preset National Average" to use default values.

Item	User Input	Units	Description
(7)	Mode shift[4]	Percent	Enter the percent of shared micromobility trips that would have otherwise been made using a personal vehicle, taxi, or TNC.

*Note that adjusting evaluation year may not impact results.

Default Typical Trip Distance, Utilization Rate, and Mode Shift

If users cannot provide an average trip distance or utilization rate, the Shared Micromobility Tool includes default values from the North American Bikeshare and Scootershare Association (NABSA)'s 2021 State of the Industry Report[5]. Since non-motorized trips are assumed to have zero emissions, the tool asks users for the length of the diverted motorized trips and frequency with which the devices are used to calculate the change in emissions due to the project.

NABSA's 2021 State of the Industry Report also reports that 37 percent of micromobility trips replace a personal vehicle trip. Selecting "Preset National Average" for question 7 in the tool will populate the tool with a value per the calculation in Equation 1.

$$mode\ shift = number\ of\ devices * utilizatoin\ rate * 0.37 \quad (1)$$

Travel Demand Modeling

As previously described, the Shared Micromobility Tool derives emissions benefits from motorized passenger vehicle trips diverted to non-motorized modes. In addition to direct modal substitutions, some CMAQ-eligible projects will enable multimodal trip chaining, such as beginning or completing a transit journey using shared micromobility devices. However, the Shared Micromobility Tool does not account for changes to any transit service activity, adhering to the assumption that primarily passenger vehicle trips are diverted to non-motorized modes. Moreover, the tool assumes that, regardless of travel behavior shifts toward or away from transit, transit service itself does not change in conjunction with a shared micromobility project, and therefore transit-based emissions do not change. Users should separately model emissions impacts from new or modified transit service, such as through other tools in the CMAQ Toolkit.[6]

Successful use of this CMAQ calculator relies on credible travel demand modeling (TDM) to provide mode shifts as activity inputs. TDM can be a complex computational process. However, there are several simplified methodologies that enable agencies to conduct robust TDM analyses with fewer resources. Several of these methodologies are provided in Appendix A, including links to primers on travel behavior and travel modeling, as well as some simplified tools.

[4] 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/#:~:text=The%202021%20State%20of%20the,economies%2C%20and%20existing%20transportation%20ecosystems

[5] NABSA's 2021 State of the Industry Report - https://nabsa.net/2022/08/03/2021industryreport/#:~:text=The%202021%20State%20of%20the,economies%2C%20and%20existing%20transportation%20ecosystems.

[6] https://www.fhwa.dot.gov/environment/air_quality/cmaq/toolkit/

Rebalancing Activities

Many shared micromobility service providers "rebalance" their vehicles throughout the day. Rebalancing refers to redistributing devices throughout the service area to better accommodate the needs of users. Rebalancing may be used to achieve equity goals, or to make sure that ample devices are available at high traffic locations. Rebalancing activities are often conducted by a truck, vehicle with a trailer, or cargo van; however, these activities result in minimal changes to emissions benefits and are therefore not considered in the Shared Micromobility Tool.

Tool Outputs

Emission reductions are calculated for five pollutants – carbon monoxide (CO), particulate matter with aerodynamic diameter of 2.5 microns or less ($PM_{2.5}$), particulate matter with aerodynamic diameter of 10 microns or less (PM_{10}), nitrogen oxides (NOx), volatile organic compounds (VOC), as well as greenhouse gases in terms of carbon dioxide (CO_2) and carbon dioxide equivalent (CO_2e) – in kilograms per day, and total energy consumed (TEC) in million British Thermal Units (BTU). Note that positive results indicate emissions reductions (benefits); negative numbers indicate emissions increases (disbenefits).

Error Messages

Table 2 lists error messages the user may encounter, the reason for the error message, and the solution. Once errors are corrected, press 'Calculate Output' to recalculate the results.

Table 2. Error Messages

Error Message	Reason for Error	Solution
Please enter a valid evaluation year in Question 1.	Invalid input for project evaluation year.	Input a year between 2018 and 2040 by using the drop-down menu.
Please select a mode in Question 2.	No mode selected.	Use the radio button to select a mode for evaluation.
Please select an option for Question 3.	No option selected.	Use the radio button to select whether the shared micromobility device will be docked or undocked.
Please select an option for Question 4.	No option selected.	Use the radio button to select whether the shared micromobility devices will be manually or electrically powered.
Manually powered scooters are not supported by this tool. Please select a different combination.	Invalid combination selected.	Use questions 2 and 4 to select a valid combination of device and power source.
Please enter the number of devices that are part of the project. Tool accepts values between 1 and 10,000.	No value entered or value entered is outside of the acceptable range.	Enter a value between 1 and 10,000.

Error Message	Reason for Error	Solution
Please select an option for the radio button on Question 6.	No option selected.	Use the radio button to select manual entry or national default values.
Please enter the typical one-way trip distance between 0 and 5 miles.	No value entered or the value entered is outside of the acceptable range.	Enter a value between 0 and 5.
Please enter the number of times the average device is used per day. Tool accepts values between 0 and 10.	No value entered or the value entered is outside of the acceptable range.	Enter a value between 0 and 10.
Please enter the expected mode shift. Value must be less than the product of 'number of devices' and 'utilization rate'	No value entered or the value entered is outside of the acceptable range.	Enter a value between 0 and the product of 'number of devices' and 'utilization rate'.
This tool does not accept negative values.	A negative number has been entered in one or more of the questions.	Replace the negative number(s) with positive number(s) within the acceptable range for the question.

TOOL METHODOLOGY

Emissions Equations

Equations 2 through 4 detail how the tool calculates emissions changes, i.e., the difference between the emissions from baseline travel behavior and the emissions after the implementation of the project. Emission reductions, reported in kilograms per day, are calculated for a given pollutant as follows:

$$E_{i,p} = \left[\left(DMT * e_{i,p,c}\right) + \left(Starts * e_{i,p,c}\right)\right] \quad (2)$$

NABSA'S State of the Industry Report explains that over 50 percent of micromobility trips replace trips using a sustainable mode of transportation (e.g., walking, biking, transit) or are newly generated trips as opposed to mode shift from a personal vehicle, taxi, or TNC[7]. As such, tool users will only receive emissions benefits from a portion of the total number of trips taken via shared micromobility (via the mode shift percent). While mode shift is entered into the tool as a value of trips, it is calculated as a percent of total trips as seen in Equation 3 and Equation 4.

$$E_{i,p,m} = E_{i,p} * m \quad (3)$$

$$m = \frac{trips\ diverted\ from\ vehicles}{number\ of\ devices * utilization\ rate} \quad (4)$$

[7] NABSA's 2021 State of the Industry Report - https://nabsa.net/2022/08/03/2021industryreport/#:~:text=The%202021%20State%20of%20the,economies%2C%20and%20existing%20transportation%20ecosystems

For all i and p where:

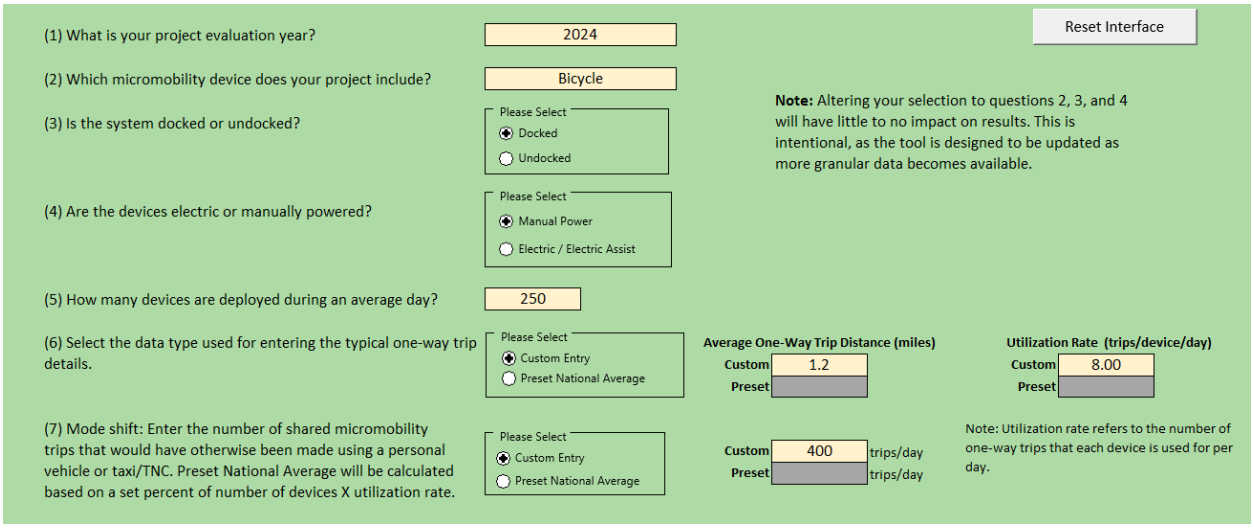
$E_{i,p}$	emissions by mode *i*, and pollutant *p*;
$E_{i,p,m}$	emissions by mode *i* and pollutant *p,* reduced by mode shift *m*;
m	mode shift percent;
p	pollutant, including the five criteria pollutant above (CO, $PM_{2.5}$, PM_{10}, NOx, VOC) as well as CO_2, CO_2e, and total energy consumption;
$e_{i,p,c}$	emission rate by mode *i*, pollutant *p*, and process *c;*
$Starts$	device starts;
DMT	device miles traveled.

EXAMPLES

Example 1: Docked Bike Share

A college campus is considering adding a docked bikeshare system for the 2024 school year. The initial fleet of 250 devices will be manually powered. The school estimates the average one-way trip distance will be 1.2 miles (the distance between the dorms and student center). Since students will be commuting back and forth throughout the day, the school estimates that each bike will be used for 8 trips per day. Most students on campus currently walk or take the student shuttle, so the mode shift is expected to be relatively low, with only 20 percent of shared micromobility trips replacing car trips.

Using this information, the user would enter the following inputs into the tool to analyze the scenario:



Evaluation year:	2024	Number of vehicles:	250 vehicles
Mode:	Bicycle	One-way trip distance:	1.2 miles
Docked or undocked:	Docked	Utilization rate:	8 trips/device/day
Power source:	Manual power	Mode shift:	400 trips

Pressing the "Calculate Output" button produces the following results:

Pollutant	Total
Carbon Monoxide (CO)	1.854
Particulate Matter ≤2.5 µm ($PM_{2.5}$)	0.006
Particulate Matter ≤10 µm (PM_{10})	0.023
Nitrogen Oxides (NOx)	0.103
Volatile Organic Compounds (VOC)	0.080
Carbon Dioxide (CO_2)	182.219
Carbon Dioxide Equivalent (CO_2e)	183.669
Total Energy Consumption (MMBTU/day)	2.464

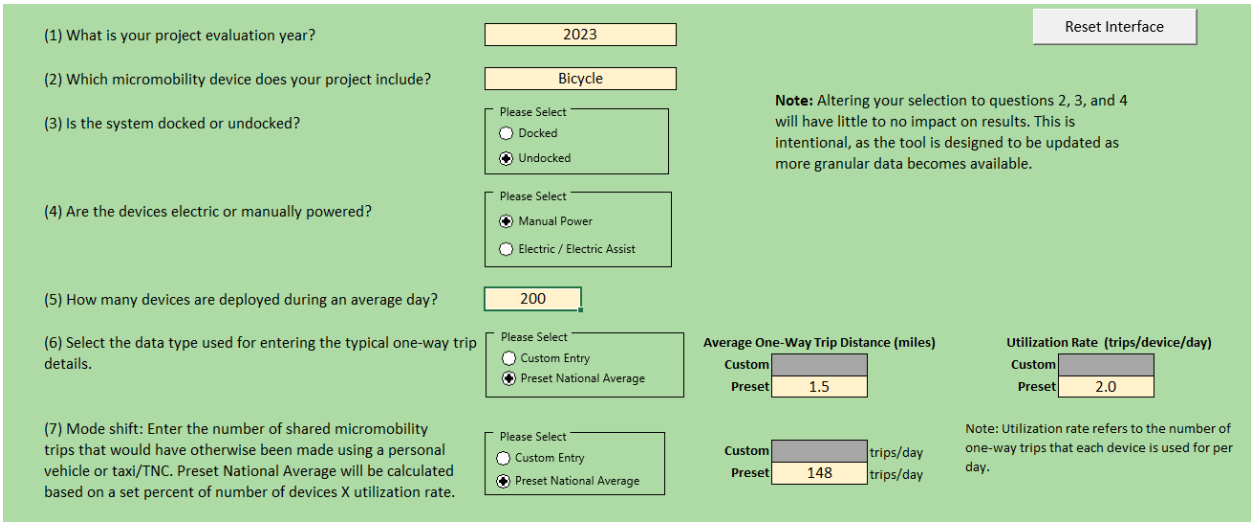
The emission reductions in kg/day and TEC reductions in millions of British Thermal Units (MMBTU) are:

Carbon Monoxide (CO): 1.854
Particulate Matter ($PM_{2.5}$): 0.006
Particulate Matter (PM_{10}): 0.023
Nitrogen Oxides (NOx): 0.103
Volatile Organic Compounds (VOC): 0.080
Carbon Dioxide (CO_2): 182.219
Carbon Dioxide Equivalent (CO_2e): 183.669
Total Energy Consumption (TEC): 2.464

Example 2: Dockless Bikeshare and Scooter-Share

A municipality decides to host a bikeshare and scooter-share program beginning in 2023. The program will include 200 manually powered, undocked bikes and 400 undocked electric scooters. Since the municipality has never hosted a shared micromobility program before, they opt to use the preset national average values for trip distance and utilization rate. It is expected that the bikes will be used primarily for commuting, while the scooters will be used for leisure. Since the program is new, the municipality decides to use the national average default value for mode shift.

Based on this information, the user would enter the following inputs into the tool in two separate runs:



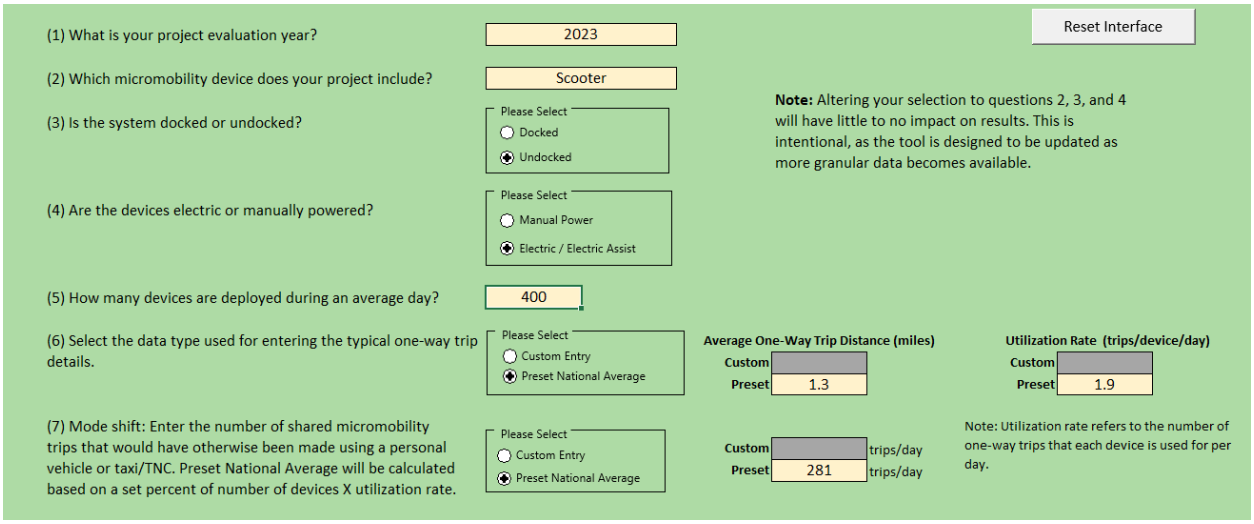
Evaluation year:	2023	Number of vehicles:	200 vehicles
Mode:	Bicycle	One-way trip distance:	1.5 miles (default)
Docked or undocked:	Undocked	Utilization rate:	2 trips/device/day (default)
Power source:	Manual power	Mode shift:	148 trips/day (default)

Pollutant	Total
Carbon Monoxide (CO)	0.905
Particulate Matter ≤2.5 µm ($PM_{2.5}$)	0.003
Particulate Matter ≤10 µm (PM_{10})	0.011
Nitrogen Oxides (NOx)	0.056
Volatile Organic Compounds (VOC)	0.040

Carbon Dioxide (CO_2)	86.184
Carbon Dioxide Equivalent (CO_2e)	86.900
Total Energy Consumption (MMBTU/day)	1.165

The emission reductions in kg/day and TEC reductions in MMBTU are:

Carbon Monoxide (CO):	0.905
Particulate Matter ($PM_{2.5}$):	0.003
Particulate Matter (PM_{10}):	0.011
Nitrogen Oxides (NOx):	0.056
Volatile Organic Compounds (VOC):	0.040
Carbon Dioxide (CO_2):	86.184
Carbon Dioxide Equivalent (CO_2e):	86.900
Total Energy Consumption (TEC):	1.165



Evaluation year:	2023	Number of vehicles:	400 vehicles
Mode:	Scooter	One-way trip distance:	1.3 miles (default)
Docked or undocked:	Undocked	Utilization rate:	1.9 trips/device/day (default)
Power source:	Electric/Electric Assist	Mode shift:	281 trips/day (default)

Pollutant	Total
Carbon Monoxide (CO)	1.490
Particulate Matter ≤2.5 µm ($PM_{2.5}$)	0.004
Particulate Matter ≤10 µm (PM_{10})	0.017
Nitrogen Oxides (NOx)	0.092
Volatile Organic Compounds (VOC)	0.067

Carbon Dioxide (CO_2)	141.917
Carbon Dioxide Equivalent (CO_2e)	143.095
Total Energy Consumption (MMBTU/day)	1.919

The emission reductions in kg/day and TEC reductions in MMBTU are:

Carbon Monoxide (CO):	1.490
Particulate Matter ($PM_{2.5}$):	0.004
Particulate Matter (PM_{10}):	0.017
Nitrogen Oxides (NOx):	0.092
Volatile Organic Compounds (VOC):	0.067
Carbon Dioxide (CO_2):	141.917
Carbon Dioxide Equivalent (CO_2e):	143.095
Total Energy Consumption (TEC):	1.919

To calculate the total emissions benefits from this shared micromobility project, the results from the two tool runs must be added together (Table 3).

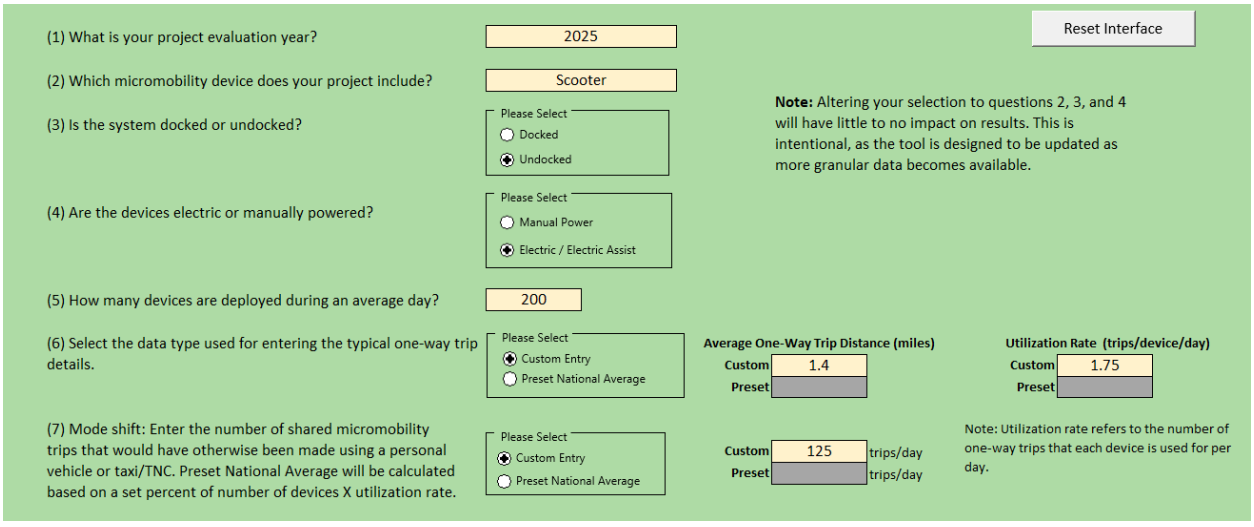
Table 3: Combined Results from Example 2

Pollutant	**Bike**	**Scooter**	**Sum**
Carbon Monoxide (CO):	0.905	1.490	*2.395*
Particulate Matter ($PM_{2.5}$):	0.003	0.004	*0.007*
Particulate Matter (PM_{10}):	0.011	0.017	*0.028*
Nitrogen Oxides (NOx):	0.056	0.092	*0.148*
Volatile Organic Compounds (VOC):	0.040	0.067	*0.107*
Carbon Dioxide (CO_2):	86.184	141.917	*228.101*
Carbon Dioxide Equivalent (CO_2e):	86.900	143.095	*229.995*
Total Energy Consumption (TEC):	1.165	1.919	*3.084*

Example 3: Increasing Capacity of Existing Scooter Share System

Following the success of the first year of their shared micromobility program, a municipality decides to expand their scooter share system by deploying an additional 200 dockless, electric scooters by the year 2025. The municipality predicts the new devices would not impact the current average trip distance of 1.4 miles but will decrease the utility rate from 2 trips per device per day to 1.75 trips per device per day. The additional scooters are expected to divert 125 trips from personal vehicles per day.

Using this information, the user would enter the following inputs into the tool to analyze the scenario:



Evaluation year:	2025	Number of vehicles:	200 vehicles
Mode:	Scooter	One-way trip distance:	1.4 miles
Docked or undocked:	Undocked	Utilization rate:	1.75 trips/device/day
Power source:	Electric/Electric Assist	Mode shift:	125 trips/day

Pollutant	Total
Carbon Monoxide (CO)	0.638
Particulate Matter ≤2.5 µm ($PM_{2.5}$)	0.002
Particulate Matter ≤10 µm (PM_{10})	0.008
Nitrogen Oxides (NOx)	0.033
Volatile Organic Compounds (VOC)	0.027
Carbon Dioxide (CO_2)	64.974
Carbon Dioxide Equivalent (CO_2e)	65.472
Total Energy Consumption (MMBTU/day)	0.879

The emission reductions in kg/day and TEC reductions in MMBTU are:

Carbon Monoxide (CO):	0.638
Particulate Matter ($PM_{2.5}$):	0.002
Particulate Matter (PM_{10}):	0.008
Nitrogen Oxides (NOx):	0.033
Volatile Organic Compounds (VOC):	0.027
Carbon Dioxide (CO_2):	64.974
Carbon Dioxide Equivalent (CO_2e):	65.472
Total Energy Consumption (TEC):	0.879

Appendix A: Travel Demand Modeling Resources

Successful use of this CMAQ calculator relies on credible travel demand modeling (TDM) to provide mode shifts as activity inputs. TDM can be a complex computational process involving a great deal of effort. However, there are several simplified methodologies that enable agencies to conduct robust TDM analyses with fewer resources. A few of these methodologies are described in the next section, and include primers on travel behavior and travel modeling, as well as links to some simplified tools.[8] Questions about individual resources should be directed to their respective authors.

TDM Concepts

The following provide an overview of travel demand analysis core concepts, both theoretical and practical.

Integrating Demand Management into the Transportation Planning Process: A Desk Reference (FHWA 2012) was prepared to assist transportation officials' incorporation of TDM into policy and implementation. It characterizes several ways TDM relates to policies regularly considered by state and local governments, including air quality and environment. It also includes a chapter on TDM strategies and tools available to the transportation community. [9]

Transportation Research Board Special Report 288 (TRB 2007) is the product of several years' dedicated research to evaluate the state of TDM practice among American Metropolitan Planning Organizations (MPOs) and State Departments of Transportation (DOTs). The report includes the history and statutory origins of travel modeling in the United States and gives a plain language overview of the economic principles informing its applications to planning a transportation system. It also discusses the technical and resource considerations for various modeling scales, i.e., Federal, state, and local.[10]

Understanding Transport Demands and Elasticities (Litman 2017) describes the relationship between travel behavior and the demographic, geographic, and economic factors that lead to mode choice. The paper gives an assessment of theoretical bases for travel behavior and emphasizes the role of total cost pricing when modeling transportation scenarios. In addition, the author describes a computationally light modeling strategy involving demand elasticities, which are provided in tables summarizing other economic research.[11]

[8] Note that the CMAQ program does not endorse the use of any particular tool and provides this list as a starting point for agencies without their own preferred modeling approach. Each of the simplified tools described here can be used to produce the necessary inputs for CMAQ tools relatively quickly.
[9] Federal Highway Administration, https://ops.fhwa.dot.gov/publications/fhwahop12035/index.htm
[10] Transportation Research Board (TRB), http://onlinepubs.trb.org/onlinepubs/sr/sr288.pdf
[11] Victoria Transportation Policy Institute, www.vtpi.org/elasticities.pdf

Example Simplified Tools

The three tools listed below provide simplified methodologies for estimating shifts in travel demand for various modes as a result of level of service, land use, pricing, and infrastructure changes; each account for non-motorized as well as motorized changes.

Trip Reduction Impacts of Mobility Management Strategies (TRIMMS) is a spreadsheet tool developed by the Center for Urban Transportation Research (CUTR) at the University of South Florida that evaluates transportation and land-use impacts of policy scenarios. TRIMMS[12] has a built-in TDM calculator, which uses a demand elasticity methodology to calculate shifts in trips by mode resulting from changes in the time/money costs of each mode.[13] Note that users must convert these outputs into distance-based units using known typical trip distances.[14] TRIMMS comes pre-loaded with default values that the user may modify at their discretion. Depending on input data availability, a simple run of the tool might take less than one day.

Rapid Policy Analysis Tool (RPAT) is a graphical user interface (GUI)-based transportation scenario planning software package developed by the American Association of State Highway and Transportation Officials (AASHTO) in partnership with FHWA and the second Strategic Highway Research Program (SHRP2).[15] RPAT's six internal models use inputs on local household dynamics, economics, urban form, and transportation characteristics to evaluate regional land use and transportation policy scenarios; this includes a TDM whose outputs are in vehicle-miles traveled. RPAT provides modifiable default input data, and its user guide provides step-by-step instructions for obtaining data and constructing scenarios. RPAT is expressly designed to be accessible for users with no prior modeling experience. However, due to its comprehensiveness and ability to consider multiple scenarios at once, using RPAT with local data may require 1-2 days if the needed inputs are not readily available.

Simplified Trips-on-Project Software (STOPS) is a standalone software package developed by the Federal Transit Administration (FTA).[16] STOPS applies a set of travel models to predict detailed transit travel patterns using a modified approach to the conventional "four-step" method. STOPS uses the Census Transportation Planning Package (CTPP) to describe the local travel market, and replaces the traditional coded transit network with transit services in the General Transit Feed Specification (GTFS) framework. STOPS outputs include a prediction of changes in the automobile mode person-miles of travel (automobile mode trips plus auto access to transit trips) that can be converted into a VMT change. Note that using the software requires a meaningful knowledge base of applying travel models to project-specific forecasts, as well as familiarity with GIS and the other data required for the analysis, including GTFS and zonal

[12] TRIMMS is available at www.trimms.com/download/
[13] Florida Department of Transportation hosts the TRIMMS user manual at www.fdot.gov/research/Completed_Proj/Summary_PTO/FDOT_BDK85_977-27_UserManual.pdf
[14] For an example of a simplified methodology extracting typical commute distances, see www.brookings.edu/wp-content/uploads/2016/07/Srvy_JobsProximity.pdf
[15] RPAT is available at www.planningtools.transportation.org/551/rapid-policy-analysis-tool.html
[16] For the latest information about STOPS, and to obtain the latest software and documentation, please visit www.transit.dot.gov/funding/grant-programs/capital-investments/stops

transportation characteristics. Depending on the availability of data and skilled personnel, successful use of STOPS for project analysis may take several weeks.

TDM Best Practices and Practitioner Forums

Resources on TDM abound, and many are internet-accessible including some useful items here:

The Transportation Modeling Improvement Portal is the long-term home for the Travel and Freight Modeling Improvement Programs (TMIP/FMIP) that came out of SHRP2. Supported by TRB and FHWA, their website includes a library of hundreds of documents, datasets, and an archive of webinar presentations by private and public transportation professionals over the course of the programs (2007-2016).[17]

Travel Forecasting Resource (TFR) is the long-term home of the community that produced the aforementioned TRB Special Report 288. TFR's website includes a curated resource library with documents and webinar recordings, an active user forum, and information on their annual Innovations in Travel Modeling Conference.[18]

The Victoria Transport Policy Institute (VTPI) is an independent think tank in Victoria, British Columbia, Canada. VTPI regularly publishes white papers, topical policy analyses, and evaluation references for free. Their website houses the Online TDM Encyclopedia, a comprehensive resource for travel modeling information.[19]

Advanced TDM Resources

For those interested in expanding their modeling capacity beyond trip-based and simplified methods, the following documents provide guidance and instruction in activity-based modeling.

Activity-Based Travel Models: A Primer (FHWA 2015) is a report prepared by FHWA and AASHTO to serve as a practical guide for understanding activity-based travel modeling, and considerations applying this kind of modeling to transportation system planning.[20]

A Self Instructing Course in Mode Choice Modeling: Multinomial and Nested Logit Models (Koppelman and Bhat, 2006) is a manual written for the FTA. It instructs the reader in the fundamentals of discrete choice probabilistic modeling, as well as model construction using recommended software.[21]

Appendix B: Tool Updates

Table 4 provides the full list of tool updates from the Shared Micromobility Tool and its companion Bicycle and Pedestrian Improvements Tool – now as separate modules within a single tool.

[17] Transportation Modeling Improvement Portal, https://tmip.org
[18] Travel Forecasting Resource (TFR), https://tfresource.org
[19] VTPI, Online TDM Encyclopedia, www.vtpi.org
[20] FHWA, https://planningtools.transportation.org/files/108.pdf
[21] Koppelman and Bhat (2006): www.caee.utexas.edu/prof/bhat/COURSES/LM_Draft_060131Final-060630.pdf

Table 4. Tool Updates Log

Date	Update
12/2018	Initial release
6/2019	Updated rates to MOVES2014b, updated years to range 2019-2030.
8/2019	Updated calculation methodology to include starts independently of running.
4/2022	MOVES3 Data integrated
5/2022	NHTS 2017 Data Added
6/2022	CO_2 Emissions Added
1/2023	Shared Micromobility Module Added
1/2023	Corrected a data error in Bike/Ped Module
7/2023	Shared Micromobility Module Finalized after beta testing
7/2023	Tool Renamed "Bicycle, Pedestrian, and Shared Micromobility Projects"