Congestion Mitigation and Air Quality (CMAQ) Improvement Program:

CMAQ Toolkit Overview and Demo

International Emissions Inventory Conference

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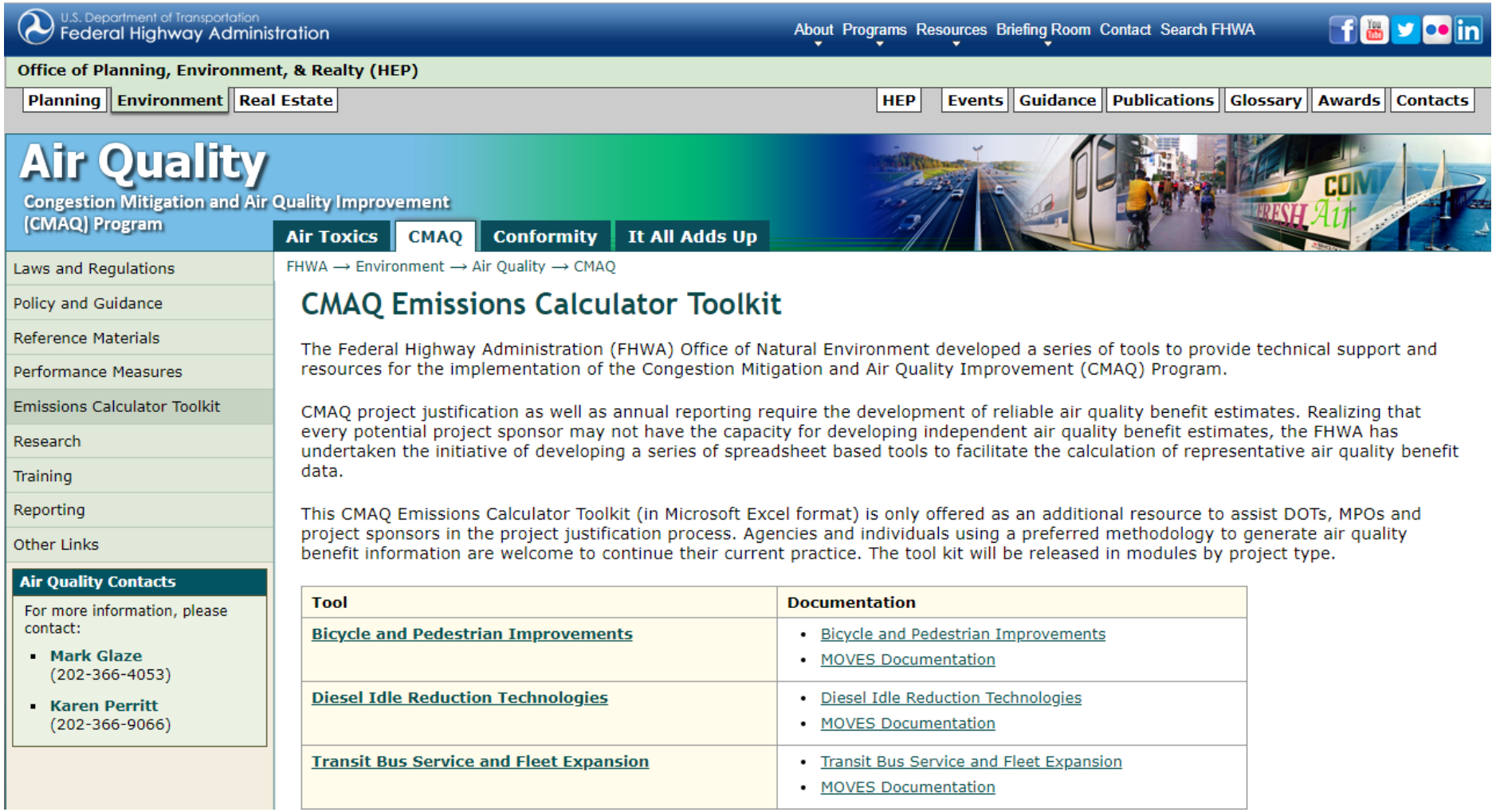
CMAQ Background

- FHWA's CMAQ Program was established in 1991 and most recently reauthorized under the FAST Act of 2015 to fund state and local projects that will improve air quality and reduce congestion
  - Granted more than $2 billion annually over past three years
- CMAQ Toolkit: Suite of simplified, Excel-based tools for estimating emissions benefits



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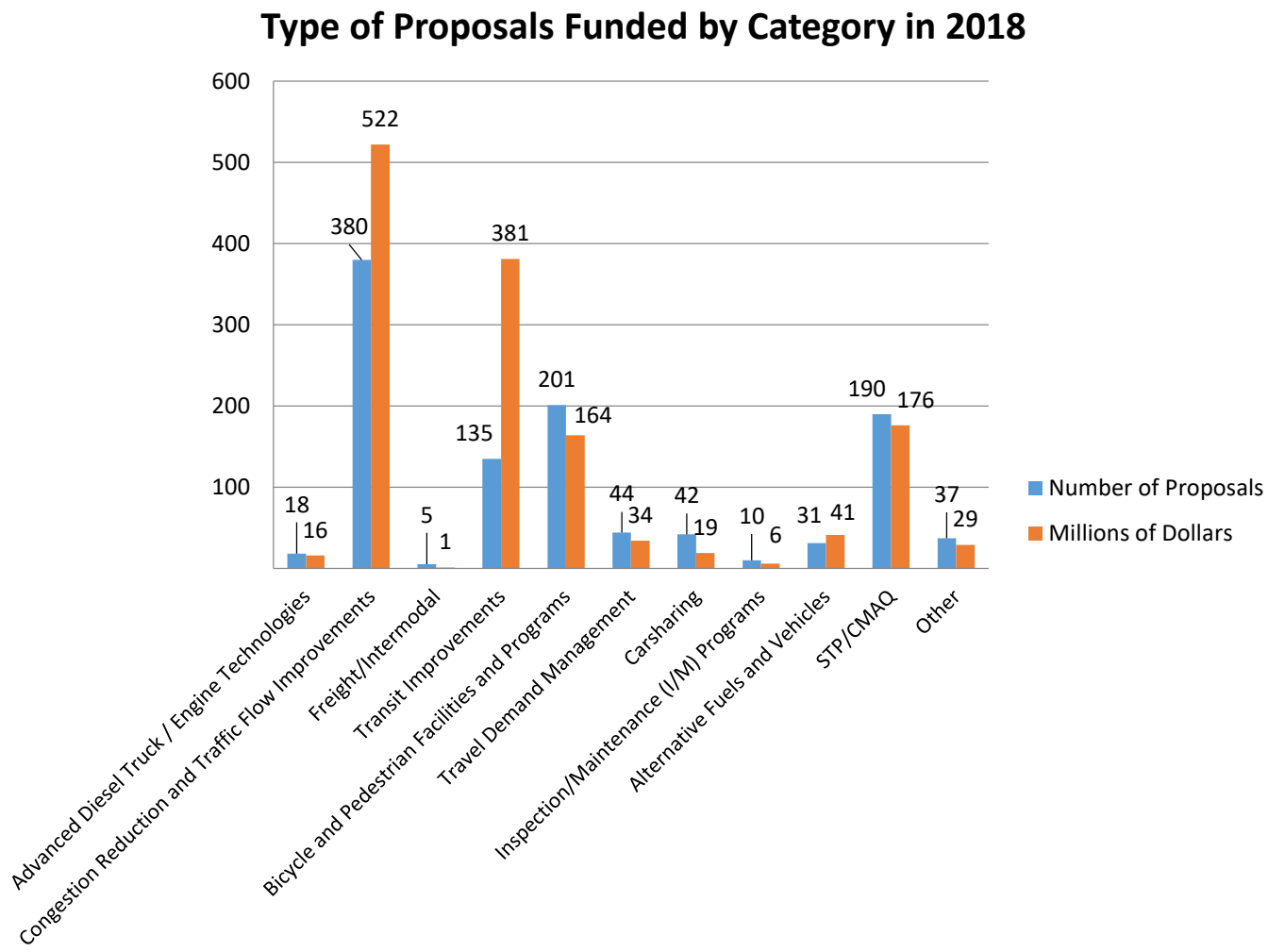
Project Distribution



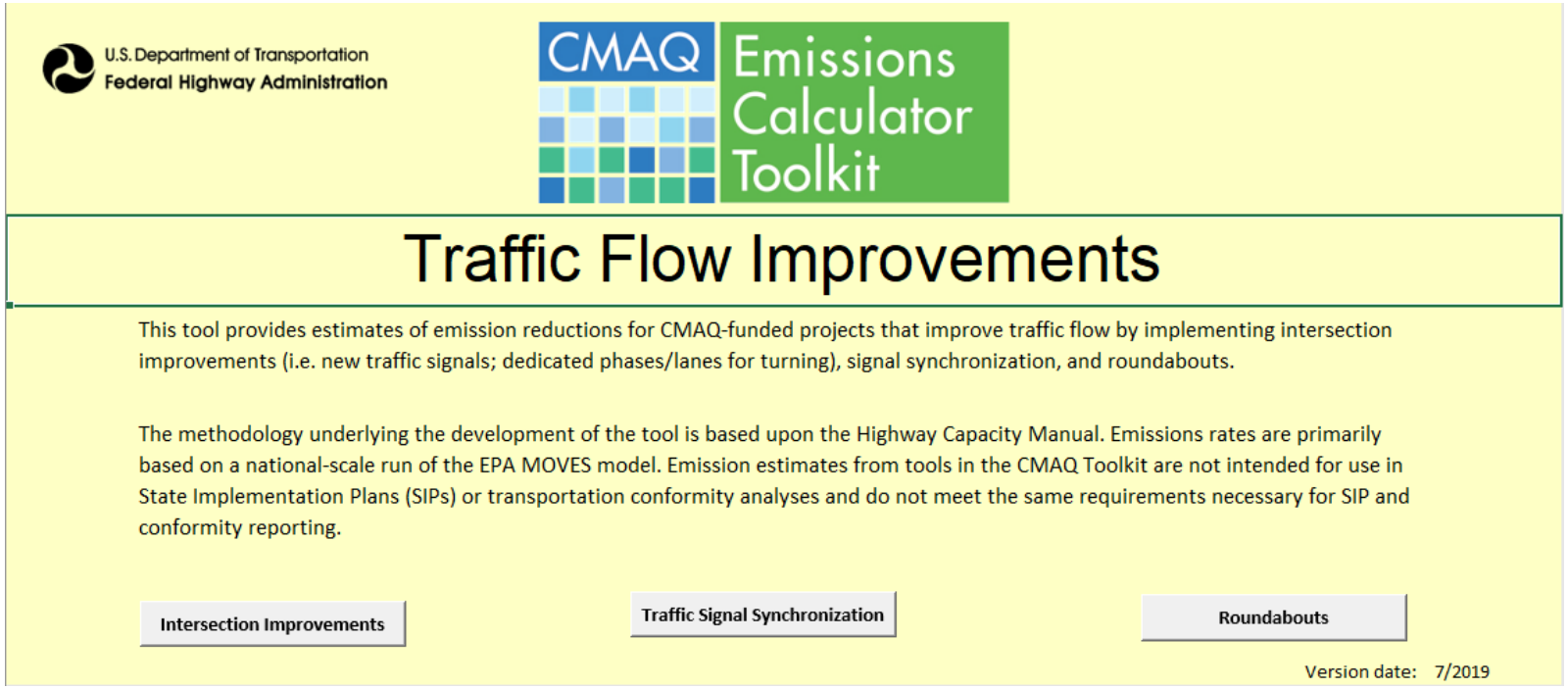
- FHWA maintains the [CMAQ Public Access System] with many thousands of funded projects dating back to 1992
- Most common project types:
  - Traffic flow improvements
  - Transit improvements
  - Bicycle-pedestrian facilities & programs

Tool Release Schedule

- Volpe has assisted FHWA in CMAQ Toolkit development since 2015:
  - 8 tools have been publicly released
  - 2 tools are pending release this year
  - All tools are currently being updated to extend through analysis year 2030
  - Nonroad tools are under development
    - Similar methodology to existing onroad tools

Tool	Eligible Project Types	Status
Congestion Reduction and Traffic Flow Improvements	• Intersection Improvements • Traffic Signal Synchronization • Roundabouts	Available since September 2016
Advanced Diesel Truck / Engine Technologies	• Vehicle / Engine Replacement • Heavy Duty Vehicle Retirement • Engine Rebuilding / Exhaust Retrofit • After Treatment Hardware/Devices • On-Board Emissions Control Devices	Available since January 2017
Alternative Fuels and Vehicles	• Fueling Facilities • Vehicle Purchase • Fleet Conversion • Engine Replacement • Hybrid Vehicles	Available since May 2017
Carpooling and Vanpooling	• Carpooling • Vanpooling	Available since September 2017
Transit Bus Retrofit and Replacement	• Diesel Engine Retrofits • Diesel Bus Replacement • Alternative Fuel Bus Replacement	Available since December 2017
Transit Bus Service and Fleet Expansion	• New Transit Service • System or Service Expansion • New Vehicle Procurement • Fare Subsidies	Available since September 2018
Diesel Idle Reduction Technologies	• Auxiliary Power Units • Direct-Fired Heaters • Truck Stop Electrification	**Released in January 2019!**
Bicycle/Pedestrian Improvements	• New Bicycle Lanes/Trails • New Sidewalks/Paved Shoulders • Bicycle Parking/Transit Storage • Maps for Bicyclists/Pedestrians • Lighting/Signs/Signal Improvements	**Released in January 2019!**
Dust Mitigation	• Street Sweeping • Chemical or Water Treatments • Paving	**Coming Soon!**
Managed Lanes	• New HOV or HOT Lane • Conversion of HOV to HOT Lane	**Coming Soon!**

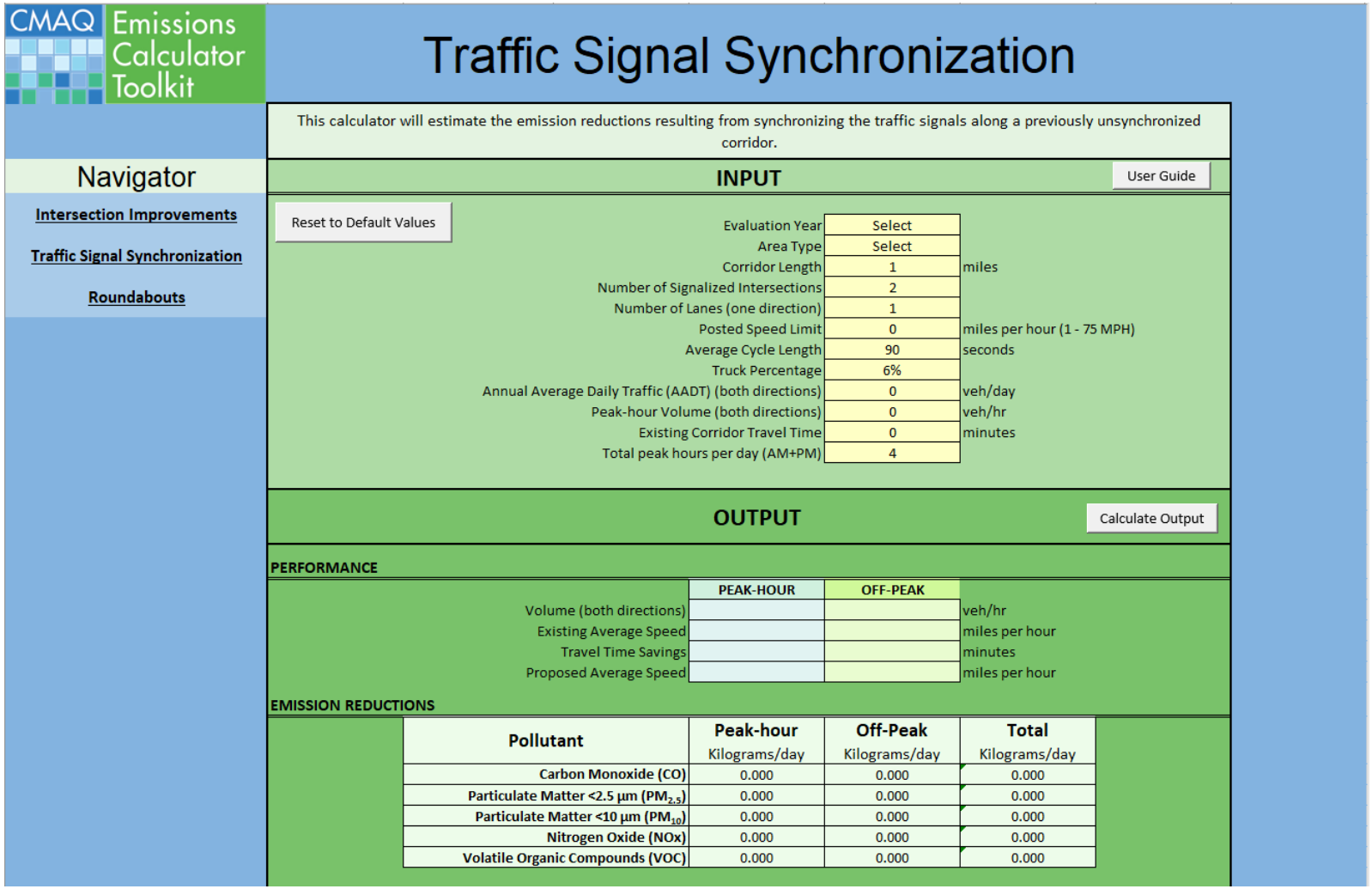
Tool and Documentation Files



- Each CMAQ tool consists of:
  - Excel macro file (.xlsm) with modules for related but distinct eligible projects
  - User guide documentation that lays out tool inputs, emission calculations, and example projects
  - Document of emissions data and its sources
    - Most tools utilize MOVES for onroad emission estimates

Example 1: Synchronizing Traffic Signals

- The Traffic Flow Improvements tool has a module for estimating the benefits of adopting synchronized traffic signals:
  - Increase average speeds
  - Decrease travel time & idling
  - Reduce emissions
  - Alleviate congestion



Example 1: Signal Synchronization Methodology

Off-Peak Existing Average Speed Calculation Methodology

Assuming that the mid-segment (roadway between signals) travel speed is the free-flow speed along the corridor, the corridor travel time, t_R, in seconds, is expressed in the following equation from the Highway Capacity Manual, 2010[9]:

$$t_R = N_s \frac{6.0 - l_1}{(0.0025L)5280} f_x + \frac{3600L}{S_{PL}} f_v + N_s d_1 \quad (6)$$

where:

l_1 = start-up lost time = 2.0 for signalized intersections,

L = corridor length (miles),

f_x = 1.00 for signalized through movement,

S_{PL} = posted speed limit (miles per hour),

f_v = traffic volume proximity factor, defined previously,

N_s = number of signals along project corridor,

d_1 = calculated delay (seconds), defined previously.

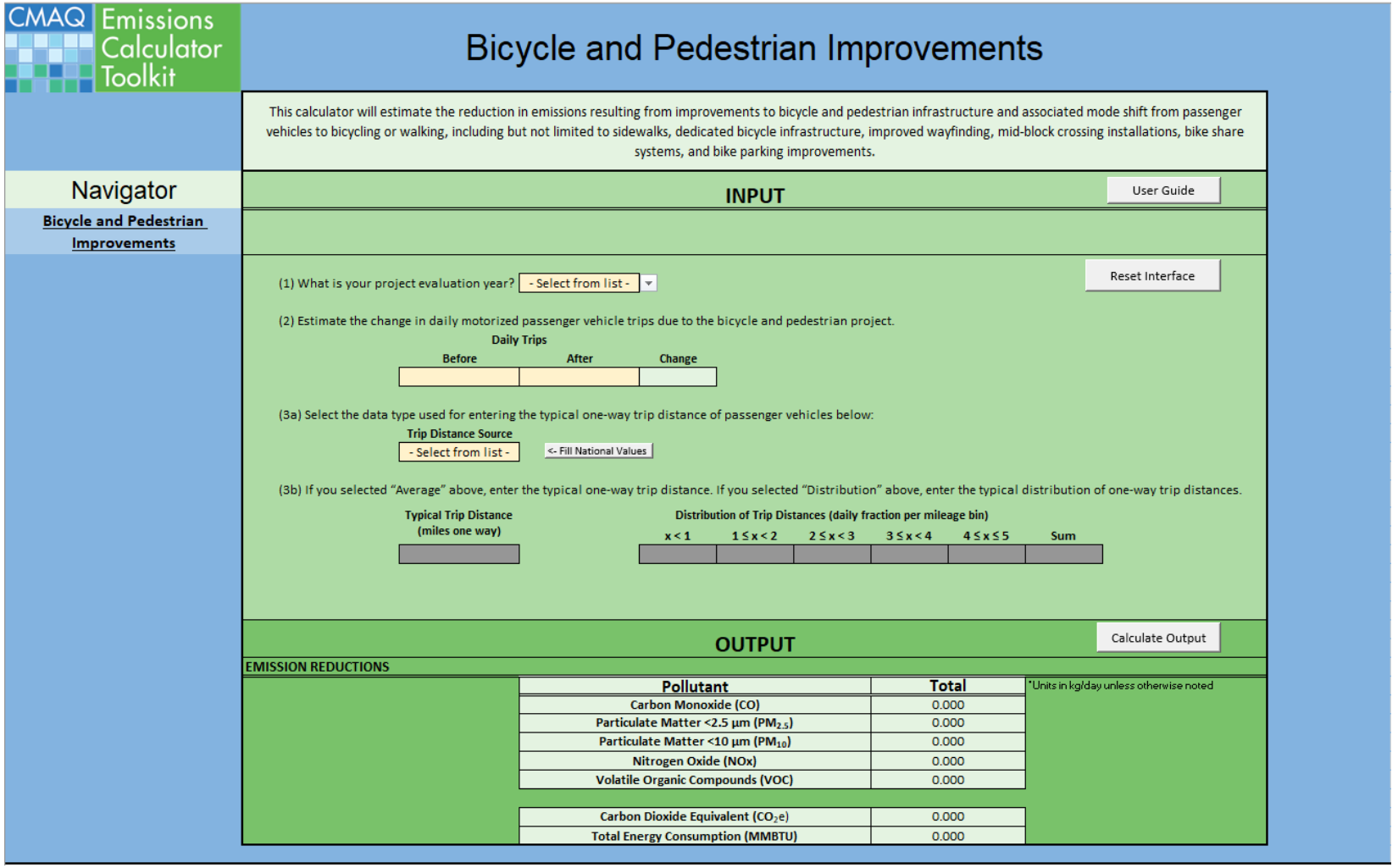
The existing travel speed along the corridor, S_1, is then given by the equation:

$$S_1 = \frac{3600L}{t_R} \quad (7)$$

- Users calculate average speeds before and after signal synchronization based on the Highway Capacity Manual
- Project-level MOVES emission rates are generated and then queried according to speed
- Tool estimates delta of emissions for:
  - Existing average speed, and
  - Average speed achieved after synchronization

Example 2: Striping New Bicycle Lane

- Users can estimate benefits from installing bicycle infrastructure:
  - Divert passenger vehicle trips to non-motorized trips
  - Reduce emissions and energy consumption
  - Mitigate roadway congestion



Example 2: Trip Diversion Methodology

$$VMT_{before_i} = N_{before_i} * D_i \quad (3)$$

$$VMT_{after_i} = N_{after_i} * D_i \quad (4)$$

$$D_i = \sum_{j \in J} \left(d_{midpoint_j} * k_{i,j} \right) = \sum_{j \in J} \left(\left(\frac{d_{max_j} + d_{min_j}}{2} \right) * k_{i,j} \right) \quad (5)$$

For all i and j where:

N_{before_i}	number of trips before project completion for mode i,
N_{after_i}	number of trips after project completion for mode i,
D_i	weighted average commute distance for mode i,
$j \in J$	bin j in the group of all bins of the trip distance distribution J, bins in one-mile intervals,
$d_{midpoint_j}$	midpoint distance of each bin j in the trip distance distribution, i.e. 0.5, 1.5, 2.5, 3.5, 4.5
d_{max_j}	maximum value of distance bin j in the distance distribution, i.e., 1, 2, 3, 4, 5
d_{max_j}	maximum value of distance bin j in the distance distribution, i.e., 0, 1, 2, 3, 4, and
$k_{i,j}$	proportion of trips that fall in distance bin j for all trip distances of given mode i. trip distance distributions must sum to one for each mode.

- Using the National Household Travel Survey, the distribution of average trip distances is calculated by mode
- The number of trips by mode is projected before and after the bicycle lane is created
- Average trip distance and number of trips per day multiplied to find the vehicle miles travelled (VMT)
- Difference in passenger vehicle emissions is estimated for before and after project completion

Stakeholder Outreach

- Seeking partners at federal agencies, state DOTs, and MPOs to participate in CMAQ tool beta testing
- Regularly provide updates on Toolkit to various stakeholder groups, such as the Transportation Research Board (TRB) Air Quality Committee Webinars to introduce tools to potential users
  - FHWA plans to provide more webinars later this year
- Investigating tool adoption and usage for better support and outreach

For More Information

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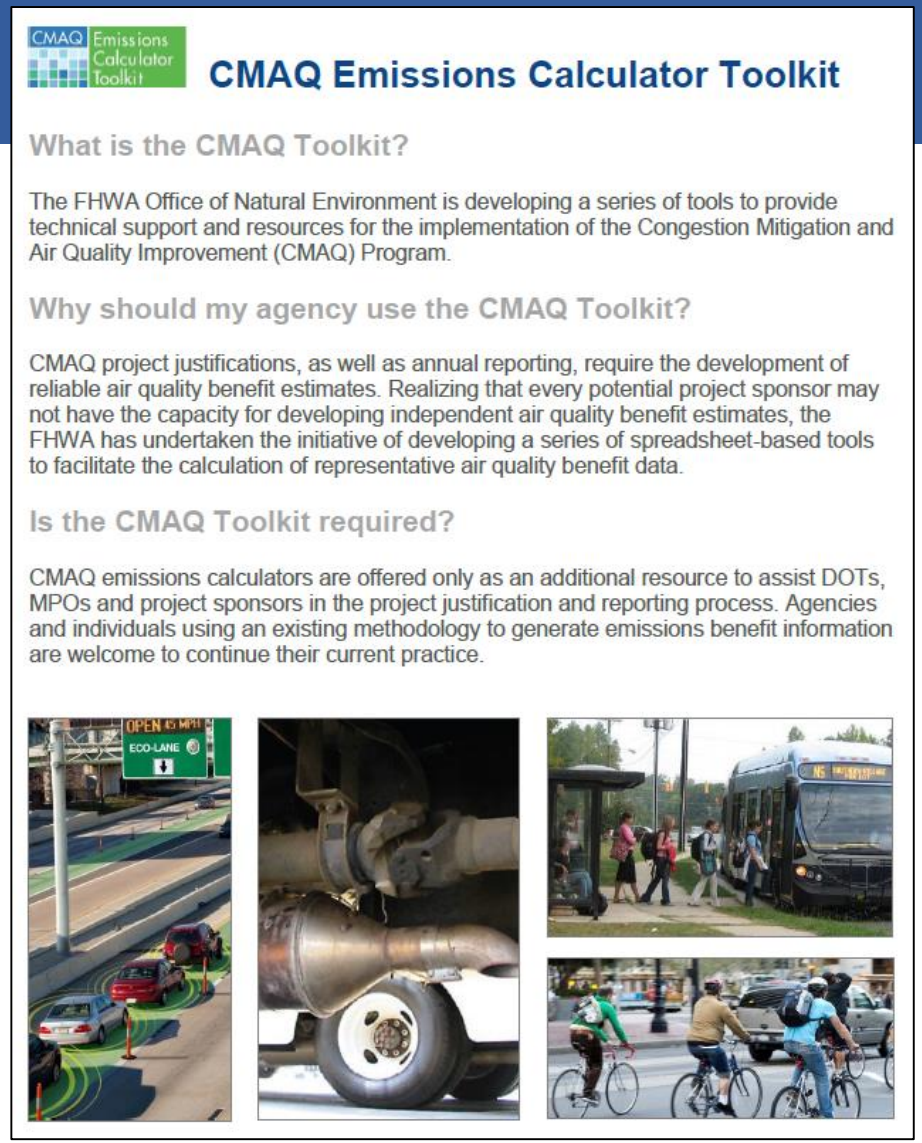

CMAQ Emissions Calculator Toolkit

What is the CMAQ Toolkit?

The FHWA Office of Natural Environment is developing a series of tools to provide technical support and resources for the implementation of the Congestion Mitigation and Air Quality Improvement (CMAQ) Program.

Why should my agency use the CMAQ Toolkit?

CMAQ project justifications, as well as annual reporting, require the development of reliable air quality benefit estimates. Realizing that every potential project sponsor may not have the capacity for developing independent air quality benefit estimates, the FHWA has undertaken the initiative of developing a series of spreadsheet-based tools to facilitate the calculation of representative air quality benefit data.

Is the CMAQ Toolkit required?

CMAQ emissions calculators are offered only as an additional resource to assist DOTs, MPOs and project sponsors in the project justification and reporting process. Agencies and individuals using an existing methodology to generate emissions benefit information are welcome to continue their current practice.

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

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