CMAQ Cost-Effectiveness Tables and Emissions Calculator Toolkit

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WILMAPCO Air Quality Subcommittee
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CMAQ: A Quick Overview

- Congestion Mitigation and Air Quality Improvement (CMAQ) Program
- Established in 1991 under ISTEA (23 U.S.C. Section 149)

The CMAQ program is established for transportation projects that contribute to the attainment or maintenance of the national ambient air quality standards for ozone, carbon monoxide, or particulate matter.

- Reauthorized in all subsequent transportation reauthorization Acts, most recently the FAST Act
  - Annual funding level at about $2.3-$2.5 billion (FY 2016-2020)
Basic CMAQ Project Eligibility

- Each CMAQ project must
  - be a transportation project
  - generate emission reductions
  - be located in or benefit a nonattainment or maintenance area

- Emission Reduction
  - Must reduce emissions from transportation sources
    - CO
    - Ozone precursors (VOC and NOx)
    - PM$_{2.5}$ and PM$_{10}$ (both direct and applicable precursors)
  - Reductions must contribute to the area's overall clean air strategy and should be demonstrated by the emissions analysis required by FHWA.
Expanded Project Eligibility under FAST Act

- Diesel emission control technology for non-road diesel vehicles and engines used in construction projects or port-related freight operations
  - located in ozone and PM areas, and
  - Funded under Titles 23 or 49

- Port related landside non-road or on road equipment
  - In PM2.5 areas

- Installation of vehicle to infrastructure communications equipment
General Requirements for the Cost Effectiveness Tables as Prescribed under MAP-21

23 USC 149(i):

IN GENERAL - The Secretary in consultation with the Administrator of the Environmental Protection Agency shall evaluate projects on a periodic basis and develop a table or other similar medium that illustrates cost effectiveness of a range of project types for funding under this section as to how the projects mitigate congestion and improve air quality.

USE OF TABLE - States and metropolitan planning organizations shall consider the information in the table when selecting projects or developing performance plans under subsection (l)
FHWA Objectives

- Provide representative cost-effectiveness (C-E) estimates to guide project selection and funding request processes at the State and local level
- Promoting ownership of a role in achieving high environmental impact returns on project funds
Scope of Analysis

Within scope:
- C-E estimates of criteria pollutants and precursors (PM2.5, PM10, NOx, CO, VOCs)
  - CMAQ mandate is to reduce emissions of these pollutants
- All project types either receiving CMAQ funding or that may receive CMAQ funding in the near future
- Congestion impacts, where applicable
Key Data Sources

- CMAQ assessment studies
- CMAQ project tracking system
- State and local project summaries
- *Multi-Pollutant Emissions Benefits of Transportation Strategies*
- MOVES
- Diesel Emissions Quantifier
- DERA
- Academic and industry literature and contacts
Project Types Selected for Analysis

- Bikesharing
- Bicycle / Pedestrian Projects
- Carsharing
- Dust Mitigation
- Electric Vehicle Charging Stations
- Employee Transit Benefits
- Extreme Cold Temperature Cold-Start Technologies
- Heavy Duty Vehicle Engine Replacements
- Heavy Duty Vehicle Retrofits
- Incident Management
- Intermodal Freight Facilities
- Natural Gas Re-Fueling Infrastructure
- Park and Ride
- Ride Share Programs
- Roundabouts
- Signalization and Intersection Improvements
- Subsidized Transit Fares
- Transit Amenity Improvements
- Transit Service Expansion
- Truck Stop Electrification
Analytical Scenarios

- C-E estimates represent lifetime emission mitigation for a single pollutant, divided by project cost
- A range of individual cases (scenarios) was analyzed for each project type, in order to generate C-E estimates at the project-type level.
- When required information was not available for an eligible project, representative values from related projects or the literature were substituted
- More complex cases required accounting for increased emissions associated with new, alternative travel behavior (e.g., new bus routes)
Median C-E estimates have been reported to represent C-E because medians are:

- Not distorted by abnormally-performing outliers;
- Likely to be more representative within project types than best-case scenarios; and
- Likely to be more comparable across project types than best-case scenarios.
Median Cost-Effectiveness (Cost per Ton Reduced) of PM$_{2.5}$

- Diesel Retrofits: $60K, $101K
- Truck Stop Electrification: $76K, $470K
- Heavy Vehicle Engine Replacements (Diesel): $77K, $5.8K
- Park and Ride: $2.1M, $6.8K
- Transit Service Expansion: $2.7M
- Extreme-Temperature Cold Start Technologies: $2.0K, $3.0M
- Incident Management: $3.0M
- Bike-Pedestrian Paths: $3.2M
- Intermodal Freight: $740K, $4.2M
- Natural Gas Fueling Infrastructure: $370K, $4.6M
- Transit Amenity Improvements: $342K, $6.7M
- Employee Transit Benefits: $58K, $6.1M
- Carsharing: $1.2M, $7.7M
- Ridesharing: $3K, $8.8M
- Intersection Improvements: $422K, $13M
- Roundabouts: $478K, $17M
- Bikesharing: $662K, $25M
- Subsidized Transit Fares: $1.5M, $28M
- Electric Charging Stations: $4.4M, $33M
Findings: PM2.5

- Most effective – diesel engine technologies, all under $100,000/ton:
  - Heavy-duty vehicle diesel engine replacements
  - Diesel retrofits
  - Idle reduction

- Least effective, all over $13 million/ton:
  - Electric vehicle charging stations
  - Subsidized transit fares
  - Bikesharing
  - Roundabouts, intersection improvements
Congestion Impacts
(Dollars per Vehicle-Hour of Delay Reduced)

- Intersection Improvements - Median: $1.26
- Intersection Improvements - Mean: $1.87
- Incident Management - Mean: $2.85
- Incident Management - Median: $2.98
- Roundabouts - Median: $11.99
- Roundabouts - Mean: $16.87
Median C-E for All Pollutants

<table>
<thead>
<tr>
<th>Project Type</th>
<th>CO</th>
<th>NOx</th>
<th>VOC</th>
<th>PM10</th>
<th>PM2.5</th>
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<td>Dust Mitigation</td>
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<td>Employee Transit Benefits</td>
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<td>Carsharing</td>
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<td>Employer Rideshare Support</td>
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<td>Park and Ride</td>
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<td>Intermodal Freight</td>
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<td>Electric Charging Stations</td>
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Legend:
- $0 - $10,000.00
- $10,000 - $249,999
- $250,000 - $999,999
- $500,000 - $1,999,999
- $1,000,000 - $9,999,999
- $2,000,000 - $19,999,999
- $5,000,000 - $20,000,000
General Findings

-high general effectiveness:
  - Idle reduction
  - Heavy vehicle diesel engine replacements (except CO)
  - Diesel retrofits (except NOx)
  - Transit service expansion (NOx, VOCs, CO)
  - Park and ride (NOx, VOCs, CO)
CMAQ Emissions Calculator Toolkit
CMAQ Emissions Calculator: Purpose

- Develop tools to assist the estimation of emission benefits of CMAQ projects, and to support reporting activities:
  - Annual CMAQ report
  - Proposed CMAQ on-road mobile source performance measure
- Respond to request from project sponsors who may have limited technical and analytical capabilities to estimate emission benefits
CMAQ Emissions Calculator: Purpose (Cont.)

- Provide analysis methodologies for most encountered CMAQ projects
- Provide a common set of methodologies using consistent assumptions, available data sources
- Serve as a resource only; areas are not required to replace methodologies already in practice
Approach to Tool Development

- Research Reviewed
  - Air Quality and Congestion Mitigation Measure Outcomes Assessment Study*
  - Highway Capacity Manual
  - Emissions quantification tools
    - EPA MOVES – primary source for emissions rates
    - EPA’s Diesel Emissions Quantifier
    - MPO methods, including ARC’s CMAQ Calculator
Approach to Tool Development (Cont.)

- Identified 80 project types
- Grouped Project Types
  - Available methodology (fully-, partially-, un-developed)
  - Projects based on changes in: emission rates, speed, idling, VMT, etc.
  - Priority project types
- Prioritized 20 Project Types in 5 CMAQ categories
Coordination

- MPO beta testers provide excellent feedback – thank you!
- Gathered feedback and data from EPA on diesel retrofits and replacements modules
- Coordinated with DOE Clean Cities and Argonne National Laboratory on alternative fuels tool
- Working closely with FTA in the development of Transit 1 & 2 tools.
Tool Methodology

- Years: 2016-2021
- MOVES National default data
- Inputs readily-available
- Outputs by pollutant in kg/day
# Project Tools Now Available

<table>
<thead>
<tr>
<th>CMAQ Project Category</th>
<th>Eligible Project Types</th>
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</table>
| Congestion Reduction and Traffic Flow Improvements | • Intersection Improvements  
• Traffic Signal Synchronization  
• Roundabouts                                               |
| Advanced Diesel Truck / Engine Technologies      | • Diesel Retrofits                                          
• Diesel Replacements                                      |
| Alternative Fuels                                | • Vehicle Purchase                                          
• Fueling Facilities (Restricted and Unrestricted Access Infrastructure) |

## Project Tools Planned in 2017

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<tr>
<th>CMAQ Project Category</th>
<th>Eligible Project Types</th>
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<tr>
<td>Carpooling and Vanpooling</td>
<td>• Carpooling</td>
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<td>• Vanpooling</td>
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<tr>
<td>Transit Bus Retrofit and Replacement</td>
<td>• Diesel Engine Retrofits</td>
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<tr>
<td></td>
<td>• Diesel or CNG Bus Replacement</td>
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<td></td>
<td>• Alternative Fuel Bus Replacement</td>
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Tool Kit Summary

- Easy to use –
  - Excel-based
  - Readily available inputs

- Consistent methods

- Customizable with local data

www fhwa dot gov environment air_quality cmaq toolkit/
Thank you!

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