MOVES
Motor Vehicle Emission Simulator

# MOVES2014 Overview and Plans for the Future

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# Outline

- What is MOVES?
- MOVES history
- MOVES2014 overview
- Plans for next official version of MOVES
- MOVES development process
- Work currently underway

# What is MOVES?

- Motor Vehicle Emission Simulator
- Estimates emissions & energy use from
  - Onroad vehicles: passenger cars, light-trucks, heavy-duty trucks, buses, motorcycles
  - Nonroad equipment: construction, industrial, agricultural, lawn & garden, commercial, logging, airport, oil & gas, mining, railroad service, recreational vehicles
- Estimates different types of emissions:
  - Engine running/working, engine starting, idling, evaporative, etc.
- Estimates fuel consumption & emissions of many different pollutants
  - Criteria pollutants and precursors: hydrocarbons (HC), nitrogen oxides (NOx), particulate matter (PM), sulfur dioxide ($SO_2$), and carbon monoxide
  - GHG pollutants: carbon dioxide ($CO_2$), nitrous oxide ($N_2O$), methane ($CH_4$)
  - >180 air toxics
- Accounts for national emission standards, vehicle populations and activity, local rules, fuels and meteorology

# Uses of MOVES

- U.S. EPA
  - Uses MOVES to estimate emission impacts of mobile source emissions regulations and policies
  - Uses MOVES when generating national inventories of air pollutants
- States and cities
  - Use MOVES to develop State Implementation Plans (SIPs) and to show conformity of transportation activities with the SIP
- Others
  - Use MOVES to model the effects of policy choices
  - Use MOVES in academic research on vehicle emissions

# MOVES – Scales of Analysis

## National

Input:

- MOVES default national averages (e.g. vehicle counts, VMT, temperature, fuel, etc)

Use:

- Rough estimates of program impacts
- High-level emission inventory projections

## County

Input:

- County-specific inputs

Use:

- Required state and local agency modeling
- Inputs for air quality modeling

## Project

Input:

- More detailed location-specific inputs

Use:

- Estimates for specific transportation projects

# Types of MOVES Release

- Major release
  - Typically includes new regulations, up-to-date emissions data, improved functionality, and others
  - Involves changes in emissions
  - Approved model for performing SIP and transportation conformity analyses outside of California
- Minor release
  - Often involves more functionality, improved algorithms, and minor bug fixes
  - Criteria pollutant emissions are not significantly changed from the major version
  - Not considered a new model for SIP and transportation conformity purposes

# MOVES History

| | |
|---|---|
| **MOVES2004** | • First model release<br>• Included only energy and greenhouse gases |
| **MOVES2009** | • Draft release<br>• Included criteria pollutants |
| **MOVES2010** | • First official major release<br>• Replaced MOBILE6 for SIPs & conformity |
| **MOVES2010a*** | • Accounts for LD GHG and fuel economy rules<br>• Improvements in performance and usability |
| **MOVES2010b*** | • New features and better performance<br>• Improved modeling of air toxics |

* Minor release

# MOVES2014 Overview

**MOVES2014**

- Second official major release (Oct. 2014)
- Replaced MOVES2010 for use in SIPs & conformity
- Included new EPA regulations:
  - LD GHG 2017-2025, HD GHG Phase 1, and Tier 3
- Updated with the latest data on fuel effects, emission rates and activity for onroad vehicles
- Incorporated NONROAD model into MOVES

**MOVES2014a***

- Released in November 2015
- No significant change in criteria pollutant emissions
- Added the capability to estimate VOC and toxics from nonroad equipment
- Included new data and features
- Corrected bugs

* Minor release

# What's Next for the Next MOVES?

- Next official version of MOVES to include
  - New data based on latest test programs and analyses
  - Latest vehicle population and activity data
  - New rules (e.g. Heavy-Duty Greenhouse Gas Phase 2)
  - Improved functionality and performance
  - Additional features
- Timing of release
  - 2018 at the earliest

# MOVES PROCESS

# Process for Updating MOVES

# MOVES Process – Collect

- Data from new research programs
  - e.g. heavy-duty in-use program, ACES Phase II, EPA and California test programs
- Latest vehicle population and activity data
  - e.g. Annual Energy Outlook (AEO) projections
- User concerns, recommendations, suggestions
  - FACA workgroup
  - MOVES training courses
  - Research conferences/journals/publications
  - Input from other air quality and transportation agencies
  - Input from EPA staff
- Problems, potential errors, inaccuracies
  - MOVES inbox, EPA use of MOVES, feedback from evaluation work

# MOVES Process – Prioritize & Analyze

- Prioritize based on:
  - User needs
  - Quality of data
  - Data availability
  - Impact on total inventory
  - Relevance for policy decisions
  - Budget and staffing
- Analyze
  - Improve current data with new analyses and updated algorithms
  - Reduce data gaps/uncertainties
  - Confirm issue and/or evaluate recommendations

# MOVES Process – Develop & Test/Document/Peer Review

- Develop codes and databases
  - Incorporate the results from analyses based on latest science and data
  - Add features and improve user interface
- Test
  - Perform extensive testing and debugging in-house
  - Beta release
    - Limited confidential testing prior to the public release
- Document/Peer Review
  - Prepare user guide, software design reference manual
  - Peer review MOVES technical reports
  - Review underlying assumptions and analyses in MOVES as a part of FACA process

# MOVES Process – Release & Evaluate

- Release
  - Timing of release depends on many factors (e.g. SIP schedule, regulatory agenda)
- Evaluate
  - Compare results to newest data
  - Serves to guide future work and research needs
  - By EPA and by others
    - e.g. CRC E-101 MOVES2014 Review

# MOVES2014 Evaluation

- Several recent studies suggest that mobile source NOx emissions are sometimes too high
- We are comparing MOVES2014 emission rates to recent roadside studies
  - tunnel/remote-sensing and inspection/maintenance data
- We are examining air quality results for specific times and grid cells to better understand discrepancies.
- To be presented at future FACA meetings

# PROPOSED UPDATES

# Potential Onroad Updates

- 2007+ heavy-duty diesel emission rates
  - New emission data from multiple studies
  - Running, starts, extended idle rates
  - Revisit real-world effectiveness of emission control technologies (SCR and DPF)
  - To be presented at future FACA meetings
- Incorporate the impact of Heavy-duty Greenhouse Gas Phase 2 Program (2018-2027)

# Potential Onroad Updates (cont'd)

- Tier 2 light-duty PM emission rates
  - Using data from EPA and California test programs
  - Incorporate gasoline direct injection (GDI) PM emission rates
  - To be presented at future FACA meetings
- Minor Updates
  - Incorporate additional chemical mechanism (SAPRC07), and update CB05 (CB05e51 update)
  - Update methane emission rates
  - Others

# Potential Onroad Updates (cont'd)

- Population and activity
  - Remove freeway ramps from county-scale and national MOVES runs
  - Consolidate MOVES source types
  - Update VMT and vehicle population projections using the latest estimates from Federal Highway Administration (FHWA) and Annual Energy Outlook (AEO)
  - Update default vehicle populations using inputs into the 2014 National Emissions Inventory (NEI)
  - Allow emission projections to 2060
  - Change allocation of hoteling to be consistent with the NEI
  - To be presented at future FACA meetings

# Potential "Functional" Improvements

- Improve performance
- Upgrade ant and GO language
- Simplify pollutants and processes panel
- Remove fuel choices from equipment panel
- Etc…

# THANK YOU!

For questions, email mobile@epa.gov