



# **EPA's MOtor Vehicle Emission Simulator (MOVES): Future Plans and Data Needs**

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Analysis Subcommittee  
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# Outline

- Background
- Plans for next official version of MOVES
- Data needs



# What is MOVES?

- EPA's 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.



# What is MOVES? Cont.

- Estimates fuel consumption & emissions of many different pollutants
  - Criteria pollutants and precursors: hydrocarbons (HC), nitrogen oxides (NO<sub>x</sub>), particulate matter (PM), sulfur dioxide (SO<sub>2</sub>), and carbon monoxide
  - GHG pollutants: carbon dioxide (CO<sub>2</sub>), nitrous oxide (N<sub>2</sub>O), methane (CH<sub>4</sub>)
  - >180 air toxics
- Accounts for national emission standards, vehicle populations and activity, 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
- State, regional, and local governments
  - 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:

- National 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
  - Official model for performing SIP and transportation conformity analyses outside of California
- Minor release
  - Often involves more functionality, improved algorithms, and minor bug fixes
  - Onroad 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
- Included only energy and greenhouse gases

## MOVES2009

- Draft release
- Included criteria pollutants

## MOVES2010

- First official major release
- Replaced MOBILE6 for SIPs & conformity

## MOVES2010a\*

- Accounted for LD GHG and fuel economy rules
- Improved performance and usability

## MOVES2010b\*

- Added new features and better performance
- 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 VOCs and toxics from nonroad equipment
- Included new data and features
- Corrected bugs

\* Minor release

# MOVES2014 Evaluation

- Several recent studies suggest that mobile source NO<sub>x</sub> emissions are sometimes too high
- We have compared MOVES2014 emission rates to recent roadside studies
  - We have not yet found evidence that we need to adjust MOVES rates or default inputs
  - Presented the findings at IEIC, CMAS, and AGU
  - We are continuing our investigation
- Understanding the sources of modeled NO<sub>x</sub> bias continues to be a complex problem requiring careful analysis of many potential factors



# MOVES Plans

- Next official version of MOVES to include
  - New data based on latest test programs and analyses
  - Latest vehicle population and activity data
  - Newer rules (e.g. Heavy-Duty Greenhouse Gas Phase 2)
  - Improved functionality and performance
  - Additional features
- Timing of release
  - TBD, but 2019 at the earliest
- Impact on emissions is unclear at this time



# Updated Emissions

- Updated estimates for:
  - Heavy-duty: Criteria pollutant & GHG emissions, CNG for all sourcetypes
  - Light-duty particulate matter
  - Impact of parking time on start emissions
  - Humidity adjustments
  - Temperature adjustments for LD PM running
  - Improved pollutant speciation, including methane



# Updated Fleet & Activity

- Historical and projection data for national VMT and vehicle populations
- National age distributions
- Vehicle starts and idling
- Hotelling activity
- Vehicle weights and other characteristics
- Remove ramps as a separate roadtype
  - Drafting tool to help users model ramps in project mode



# New Vehicle Activity Inputs

- Starts
  - Start emissions are important for onroad vehicles
    - Emission controls not as effective at start
    - “Soak time” matters
  - Telematics data provides improved data on start activity for both light-duty and heavy-duty
  - Updating MOVES to incorporate improved emissions information and activity defaults
  - Improving options for user activity inputs



# New Vehicle Activity Inputs Cont.

- Off-network Idle
  - MOVES2014 accounts for idle activity that is part of the driving cycle
  - Additional idle happens, “off-network”
  - Telematics data provides improved data on idle activity for both light-duty and heavy-duty
  - Updating MOVES to incorporate improved emissions information and activity defaults
  - Improving options for user activity inputs



# Other Planned Changes

- Allow CNG inputs for all HD onroad sourcetypes
- Update nonroad growth factors (and thus equipment populations)
- Update classification and emission rates for Tier 4 nonroad equipment
- Extend model to cover calendar years to 2060
- Reduce model run time





# New Data Needs: MOVES Users

- Option to enter data on “off-network idle”
  - Time spent idling that is not part of onroad driving cycles
- Additional options for entering start activity
- Improved options for entering HD hotelling activity



# Data Needs: EPA

- Historic and projected VMT, vehicle population, activity
- Geographic & temporal resolution
- Nonroad equipment population & activity data



# Summary

- EPA continues work to improve MOVES modeling of mobile source emissions
- Detailed information available on EPA MOVES website:

<https://www.epa.gov/moves>

