MOVES3
Introduction & Overview

Public Webinar
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
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MOVES3 Motor Vehicle Emission Simulator
Overview

• Background on MOVES
• What’s new in MOVES3?
• Comparison of MOVES3 and MOVES2014b Results
• MOVES3 Policy Guidance
• MOVES3 Technical Guidance
• Summary and Resources
Background on MOVES

- EPA’s **MOtor Vehicle Emission Simulator**
- Estimates emissions and energy use for
  - Onroad vehicles
  - Nonroad equipment (except airplanes, locomotives, and commercial marine vessels)
- Estimates different types of emissions:
  - Engine running, engine starting, hotelling (extended idle), evaporative, brake and tire wear
- Estimates emissions of criteria pollutants, greenhouse gases (GHGs), and air toxics, and estimates fuel consumption
- Accounts for national emission standards, vehicle populations and activity, state and local rules, fuels, temperatures & humidity
- Used by EPA, states, tribes, local transportation and air agencies and others
  - However, California has its own emissions model, EMFAC
MOVES – Scales of Analysis

**Default**
- **Use:**
  - National estimates of program impacts
  - High-level emission inventory projections
- **Input:**
  - MOVES default national averages (e.g., vehicle counts, VMT, temperature, fuel, etc.)

**County**
- **Use:**
  - SIPs and tribal AQ plans
  - Inputs for air quality modeling
  - Transportation conformity regional analyses
- **Input:**
  - County-specific inputs

**Project**
- **Use:**
  - Estimates for specific transportation projects
  - Inputs for hot-spot analyses
- **Input:**
  - More detailed location-specific inputs
What’s new in MOVES3?
New Naming Convention

• This is the 3rd major MOVES release
  – Follows MOVES2010 and MOVES2014

• Provides clarity on the various versions of the model
  – Future major revisions: MOVES4, MOVES5
  – Future minor revisions: designated by increments of the number after a decimal point (e.g., MOVES3.1)
  – EPA may also designate minor patches with an additional decimal and number (e.g., MOVES3.0.1).
MOVES3

- Based on analyses of millions of emission test results and considerable advances in EPA’s understanding of vehicle emissions
- Incorporates rules not in prior MOVES version
- Includes new data on light-duty and heavy-duty emissions
- Improves user features
- New MOVES3 Policy Guidance and Technical Guidance will help state and local agencies use MOVES for regulatory analyses
Highlights: Light-duty and Fuel Updates

- Updated light-duty (LD) vehicle emission rates for hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOₓ) based on in-use testing data
- Updated LD particulate matter (PM) rates, incorporating data on gasoline direct injection engines
- Added new fuel characteristic data from EPA fuel compliance submissions
- Updated fuel effect calculations to better characterize the base fuel used to develop LD base emission rates
- Incorporated the effects of the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule on light-duty fuel economy
Highlights: Heavy-duty Updates

• Improved heavy-duty (HD) diesel running emission rates based on manufacturer-run in-use testing program data from hundreds of HD trucks
• Updated HD diesel starts and extended idle emission rates
• Updated emission rates for HD gasoline and compressed natural gas (CNG) trucks
• Incorporated the effects of the HD GHG Phase 2 rule
Highlights: Activity Updates

• Includes vehicle start and idling activity patterns based on real-world instrumented vehicle data from Verizon for LD vehicles and the Department of Energy’s (DOE) National Renewable Energy Lab (NREL) for HD vehicles:
  – “Off-network idle” accounts for emissions beyond the idling that is already considered in the MOVES drive cycles;
  – Default hotelling activity substantially reduced from MOVES2014, based on the NREL instrumented truck data;

• Updated national vehicle miles travelled (VMT) and vehicle population defaults with newer historical data from Federal Highway Administration (FHWA) and more recent forecasts from DOE; and

• Updated national onroad vehicle default fuel, regulatory class, and age distributions based on newer vehicle registration data.
Peer Review

Peer Review materials on EPA Science Inventory page: [https://cfpub.epa.gov/si/](https://cfpub.epa.gov/si/)

- **2017**
  - Exhaust Emission Rates for Heavy-Duty On road Vehicles in MOVES201X
  - Fuel Supply Defaults for Regional Fuels and Fuel Wizard Tool in MOVES201X
  - Population and Activity of On-road Vehicles in MOVES201X
  - Speciation and Toxic Emissions from On road Vehicles, and Particulate Matter Emissions from Light-Duty Gasoline Vehicles in MOVES201X

- **2019**
  - Exhaust Emission Rates for Heavy-Duty Onroad Vehicles in MOVES CTI NPRM
  - Population and Activity of On-road Vehicles in MOVES CTI NPRM

- **2020**
  - On road Emission Rate Updates to MOVES3
  - Fuel Supply Defaults: Regional Fuels and the Fuel Wizard in MOVES3.0
Comparison of MOVES3 and MOVES2014b
Changes in Emission Estimates

• In general, MOVES3 national emission estimates in MOVES3 are:
  • lower for most criteria pollutants in future years compared to MOVES2014b
  • higher for greenhouse gases in near future years compared to MOVES2014b

• Results will vary based on local inputs in a given area
  • Urban areas may see NOx increases
National Comparisons

• National annual results based on U.S. “average” activity, fuels, etc.
  – Results will vary based on local inputs in a given area
• Graphs compare MOVES2014b and MOVES3
• Nonroad changes (not shown) are limited to SO₂ and PM, which decrease with the decrease in diesel fuel sulfur levels.
  • Other nonroad results are virtually unchanged.
### National: Onroad VMT

- Small changes due to new historical data & AEO forecast
- Predicted VMT continues to increase across onroad sectors

*Percentage label indicates change from MOVES2014b to MOVES3.*
National: Onroad GHGs

- LDGHG and HDGHG rules reduce future CO₂
- SAFE rule impacts seen in MOVES3 gasoline values
- Increase in CH₄
  - Updates to CNG population increase HD emissions
  - Updates to speciation (CH₄/THC ratios) change gasoline and diesel emissions
  - But still only a small fraction of a percent of GHG emissions.
National: Onroad NOx

- Continue to see large drop in gasoline (LD) NOx with Tier 3
- At national scale, increase in diesel running NOx is outweighed by reduced extended idle from HD hotelling
National: Onroad PM$_{2.5}$

- MOVES3 has less exhaust PM$_{2.5}$ due to decreased extended idle activity and lower HD emission rates
- Brake and tire wear constitute a growing fraction of PM emissions
National: Onroad VOC

- Continue to see large drop in gasoline (LD) VOC with Tier 3
- Diesel declines in MOVES3 with extended idle
- Evaporative emissions are a growing fraction of future onroad VOC
Comparisons for Sample Counties

• Next slides show results for two sample counties for selected years
  • Two core urban counties with different local travel patterns and ambient conditions
Sample Counties: Onroad NOx

In these counties, compared to MOVES2014b:

1. Lower gasoline NOx
2. Higher diesel NOx
   • Urban diesel is dominated by running NOx (which increased) rather than extended idle (which decreased)
Sample Counties: Onroad PM$_{2.5}$

In these counties, compared to MOVES2014b:

1. Lower PM from gasoline
2. Lower PM from diesel
   - Dominated by running emissions & sensitive to local fleet mix
3. Brake and tire wear emissions are unchanged, but contribute a significant fraction of future year PM
Sample Counties: Onroad VOC

In these counties, compared to MOVES2014b:

1. Less gasoline VOC; driven by reduced start emissions
2. Similar or less diesel VOC; dominated by running emissions
MOVES3 Policy Guidance

When to use MOVES3?
State Implementation Plans

• MOVES3 must be used in new SIPs after its release – there is no grace period

• However, if a state has done significant work on a SIP using MOVES2014b, it may continue with that model

• In general, incorporating MOVES3 into the SIP now could be useful in some areas; MOVES3 will have to be used for transportation conformity at the end of the grace period
Transportation Conformity

• EPA will be publishing a *Federal Register* notice to announce the availability of MOVES and establish:
  – A two-year grace period before MOVES needs to be used in regional emissions analyses
    • Unless MOVES3-based SIP budgets become applicable sooner
  – A two-year grace period before MOVES needs to be used in project-level conformity hot-spot analyses
• Analyses that are started during the grace period may use either MOVES3 or MOVES2014
• Analyses started after the grace period must use MOVES3
MOVES Technical Guidance

Provides guidance on

• Using MOVES at the County Scale for onroad emission inventory development in SIPs and conformity (in states other than California)
  – Section 2, planning an onroad emissions analysis with MOVES
  – Section 3, creating a MOVES Run Specification
  – Section 4, entering local data using the County Data Manager

• Developing nonroad inventories – Section 5

• Other guidance covers MOVES at the Project Scale (used for hot-spot analyses), using MOVES to model specific control programs (e.g., diesel retrofits/replacements), and using MOVES to estimate GHGs
  – Until updated, existing guidance generally applicable to MOVES3
MOVES Technical Guidance (cont’d)

• Covers main changes in MOVES3 from MOVES2014, e.g.,
  – New input options for start activity
  – New input options for entering local hotelling activity data, for long-haul combination trucks
  – New input option for off-network idling: vehicle engine is running, but not on the road (not hotelling), e.g.:
    • LD vehicles idling while waiting to pick up children at school or passengers at airport or train station,
    • Single unit and combination trucks idling while loading/unloading cargo or making deliveries
    • Vehicles idling at drive-through restaurants
  – Automatic selection of all fuel types in the Onroad Vehicles Panel, and other instances where model ensures consistency of user choices
MOVES Technical Guidance (cont’d)

• Discusses use of tools provided within MOVES, such as:
  – Input database converters: if a MOVES2014 input database has the latest information, it can be converted to work with MOVES3
  – Off-network idling tool: provides hours of off-network idling needed for Emission Rates runs

• Includes new appendix with a script to reduce the size of a nonroad output database
  – Will speed up other nonroad post-processing
MOVES Webpage

[www.epa.gov/moves](https://www.epa.gov/moves) is the starting point for all MOVES information, with links to:

- Latest model (MOVES3)
- Limited use models (MOVES2014)
- Tools
- Training
- Background Information
  - Technical Reports
  - Software Information
MOVES3 Webpage

https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves has links and documents for MOVES3, including:

- EPA Releases MOVES3 Mobile Source Emissions Model: Questions and Answers
- Policy and Technical Guidance
- MOVES3 Installation File (Instructions and trouble shooting guide are included)
- Links to training materials and additional user materials
MOVES GitHub Site

- [https://github.com/USEPA/EPA_MOVES_Model](https://github.com/USEPA/EPA_MOVES_Model) has links to the MOVES source code
- [https://github.com/USEPA/EPA_MOVES_Model/tree/master/docs](https://github.com/USEPA/EPA_MOVES_Model/tree/master/docs) has links to additional user support documents, including:
  - Anatomy of a Runspec
  - Command Line MOVES
  - Input DB changes in MOVES3
  - Tips for faster MOVES runs
  - Onroad Cheat Sheet
  - Nonroad Cheat Sheet
Additional Resources

• MOVES3 Policy Guidance and Technical Guidance are also available at: www.epa.gov/state-and-local-transportation/policy-and-technical-guidance-state-and-local-transportation#emission

• Coming soon: Federal Register notice, other guidance updates, webinar for experienced users, and information about training

• Join EPA’s MOVES listserv to receive MOVES announcements, including training: www.epa.gov/moves/forms/epa-mobilenews-listserv
Questions?

Please submit questions via the “Live Event Q & A” box and we will answer as many as we can.
Thank you!

The webinar has ended. For more information on MOVES, see the MOVES web site:  
[https://www.epa.gov/moves](https://www.epa.gov/moves)