Introduction to MOVES3 for Non-Modelers
Course Outline

• MOVES overview
• MOVES3
  • Data updates
  • Functionality updates
  • Guidance updates
• Policy updates
• What’s in MOVES?
• Modeling options and uses
What is MOVES?

• The **MOtor Vehicle Emission Simulator** (MOVES) is a state-of-the-art modeling framework for onroad and nonroad emissions inventory development

• EPA’s official model for state implementation plans (SIPs) and transportation conformity analyses

• Current version is MOVES3
  • Previous version (MOVES2014b) can still be used for conformity analyses until January 9, 2023 – EPA has allowed a two-year grace period for transition
MOVES3

- Major release (11/2020)
- Increased LD fuel consumption and CO₂ emissions to account for the Safer Affordable Fuel-Efficient (SAFE) rule
- HD GHG emissions reflect the effects of the HD Phase 2 GHG rule
- Updated default fuel properties
- Updated HD diesel and CNG running rates, LD emission rates, start emission rates
- Activity updates based on updated DOE and FHWA forecasts
- Updates to MOVES graphical user interface (GUI)
When do I use MOVES?

- **EPA Federal Register** notice of January 7, 2021 (86 FR 1106) approved MOVES3 and any subsequent minor revisions for:
  
  - **New State Implementation Plans (SIPs)**
    - Use MOVES3 now for any new SIPs
    - If significant work on a SIP with MOVES2014b has already been completed, you can continue
  
  - **Transportation conformity analyses, including**
    - Regional conformity analyses
    - Project-level conformity analysis (PM & CO Hotspot)
    - *FR* notice established a two-year conformity grace period
      - Until January 9, 2023, could use a version of MOVES2014
      - After that, must use a version of MOVES3
EPA MOVES Guidance

- MOVES3 SIP and Conformity Policy Guidance
  - Published November 2020
  - [https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1010LXH.pdf](https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1010LXH.pdf)
  - Guidance on when MOVES should be used in SIPs and transportation conformity analyses

- MOVES3 Q&A document
  - Published November 2020
  - [https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1010M06.pdf](https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1010M06.pdf)

- MOVES3 Technical Guidance
  - Published November 2020
  - [https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1010LY2.pdf](https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1010LY2.pdf)
  - Detailed guidance on appropriate inputs for MOVES in SIPs and regional conformity analyses
  - Defaults vs. local information
  - Developing appropriate local inputs
MOVES Policy and Guidance Documents

• Technical Guidance on MOVES for On-Road GHG Emissions and Energy Consumption

• Transportation Conformity Guidance for Quantitative Hot-spot Analyses in PM$_{2.5}$ and PM$_{10}$ Nonattainment and Maintenance Areas
  www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses#pmguidance

• Using MOVES in Project-Level CO Analyses
  www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses#coguidance
What’s Inside MOVES?

• The following section covers the *onroad* portion of MOVES
  • Information on the *nonroad* model in MOVES is covered in EPA’s MOVES2014b training (Module 10): [https://www.epa.gov/moves/moves-training-sessions](https://www.epa.gov/moves/moves-training-sessions)

• Next few slides will cover:
  • Processes that yield emissions
  • Pollutants
  • Vehicle types
  • Emission rate components
Emissions Processes in MOVES

• Running
• Start
• Extended Idle (trucks “hoteling” under load)
• Evaporative
  • Permeation, Vapor Venting, Liquid Leaks
• Refueling
  • Vapor loss, Spillage
• Crankcase
• Tire Wear
• Brake Wear
Pollutants in MOVES

- HC (THC, NMHC, NMOG, TOG, VOC)
- CO
- NO\textsubscript{x} (NO, NO\textsubscript{2})
- NH\textsubscript{3}
- SO\textsubscript{2}
- PM\textsubscript{10,2.5} (multiple exhaust species plus brake and tire)
- GHG (CO\textsubscript{2}, CH\textsubscript{4}, N\textsubscript{2}O)
- Toxics (over 50 different exhaust and evap species)
- Energy (total, petroleum, fossil)
Fuel and Vehicles in MOVES

- Compressed Natural Gas
- Diesel
- Ethanol (E-85)
- Gasoline
- Electricity

+ Passenger Car
+ Passenger Truck
+ Motorcycle
+ Light Commercial Truck
+ Other Buses
+ Transit Bus
+ School Bus
+ Refuse Truck
+ Single Unit Short-haul Truck
+ Single Unit Long-haul Truck
+ Motor Home
+ Combination Short-haul Truck
+ Combination Long-haul Truck
MOVES Emission Rates

• MOVES includes different emission rates for each combination of...

<table>
<thead>
<tr>
<th>Source</th>
<th>Age Group</th>
<th>Operating Mode</th>
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<tbody>
<tr>
<td>Gas-LDV-MY2001</td>
<td>8-9 years</td>
<td>low speed coast; 20 mph, VSP 0-3 kW/tonne</td>
</tr>
<tr>
<td>Gas-LDT-MY2005</td>
<td>4-5 years</td>
<td>accelerating; 55 mph, VSP 12-15 kW/tonne</td>
</tr>
</tbody>
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What output does MOVES provide?

• MOVES can:
  • provide emission rates which users can multiply by appropriate activity factors outside of MOVES, or
  • calculate an emission inventory internally using fleet and activity inputs
Files and Databases

- To run MOVES, users must provide or create
  - A run specification, a.k.a. a “RunSpec” and
  - Input databases (county and project scales)

- MOVES creates an output database
## Summary: MOVES Three Scales

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<tr>
<th></th>
<th>Default</th>
<th>County</th>
<th>Project</th>
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| **Geographic area covered** | - Entire nation  
- One or more states  
- One or more counties | - One county  
- A multi-county area | An individual transportation project (e.g., a highway, intersection, or transit project) |
| **Purpose**   | Non-regulatory only                                                     | Required for SIP and regional conformity analyses | Required for project-level conformity analyses |
| **Input database** | User does not need to create, use of Data Importer is optional* | User creates with local data, through the County Data Manager | User creates with local data, through the Project Data Manager |
| **Default data** | Used unless overridden                                                  | Access to default data is limited         | Access to default data is limited                |

* User cannot provide information for certain inputs at the Default scale
MOVES Project Scale

- Project scale is appropriate for:
  - CO and PM “Hot-spot” analyses for project conformity
  - National Environmental Policy Act (NEPA) Environmental Impact Statements (EISs)
  - Roadway/Intersection level energy and greenhouse gas analysis
This figure illustrates a set of links for a realistic project scenario.
MOVES Graphical User Interface (GUI)
County Data Manager

MOVES County Data Manager

RunSpec Summary

Output Database Server Name: [using default]

Output Database Name: Denver_2021_training_out

Time Spans:

Aggregate By: Hour
Years:
2021

Months: July

Days: Weekdays

Hours:
Begin Hour: 00:00 - 00:59
End Hour: 23:00 - 23:59

Geographic Bounds:
COUNTY geography
Selection: Denver County, CO (08031)

On Road Vehicles:
Passenger Car - Diesel Fuel
Passenger Car - Electricity
Passenger Car - Ethanol (E-85)
Passenger Car - Gasoline

Road Types:

RunSpec Summary
MOVES3 Regional Emissions Changes

• FHWA analyzed the potential impacts of MOVES3 to regional inventories by modeling an example urban county
  • This analysis used local data (fuels, I/M program, activity, and meteorology) to assess the potential inventory impacts from MOVES3 (vs. MOVES2014b)

• The results presented are not necessarily representative of every area as local inputs have a significant impact on the emissions changes
  • It is recommended for areas concerned about the changes, that they complete an analysis with their local inputs
MOVES3 Regional Emissions Changes – Example City
Local inputs are critical to the magnitude of difference between models!
MOVES3 Project-level (“hot-spot”) Emissions Changes

• FHWA analyzed the potential impacts of MOVES3 to project-level application (e.g., “hot-spot” analyses) by running several realistic scenarios common to NEPA or project-level conformity

• For 2020 and 2040, PM emissions are generally lower between 3% and 15%
  • There will be variability depending on local traffic activity, fleet mix, fuels, meteorology, etc.
  • Off-network PM may increase up to 20% due to MOVES3 start rate updates

• In MOVES3, carbon monoxide emissions increase ~20% in 2020, and increase up to 30-40% in 2040
  • Though trend in CO still shows significant decrease in emissions for future years

• Project-level run-time is slower by about 2-3x verses MOVES2014b
What are the impacts of these changes?

• Higher NOx emissions mean mobile sources have bigger role in attainment

• For conformity analysis with budgets developed using previous versions of MOVES, the change in emissions may be important
  • States may consider redoing vehicle emissions budgets to meet conformity requirements with MOVES3

• Percent reduction from base year is key to attainment analysis

• Given the changes to project-level carbon monoxide, FHWA is planning on updating the categorical hot-spot finding
Other MOVES Information

• To join the MOVES listserv, send a blank email to www.epa.gov/moves/forms/epa-mobilenews-listserv

MOVES Questions?
• Chris Dresser (FHWA Resource Center) christopher.dresser@dot.gov
• Contact EPA: mobile@epa.gov