Questions and Answers

EPA Releases MOVES4 Mobile Source Emissions Model

1. What is MOVES, and why is the EPA releasing MOVES4?

EPA's MOtor Vehicle Emission Simulator (MOVES) is a state-of-the-science emission modeling system that estimates emissions for mobile sources at the national, county, and project level for criteria air pollutants, greenhouse gases, and air toxics. MOVES4 allows users to model the benefits from new regulations promulgated since MOVES3 was released, incorporates the latest emissions data, and has improved functionality.

2. What has changed from MOVES3 to MOVES4?

MOVES4 incorporates several important updates, including:

- The emission impacts of the EPA heavy-duty (HD) low NOx rule for model years 2027 and later (HD2027 rule) and the light-duty (LD) greenhouse gas rule for model years 2023 and later (LD GHG 2023 rule).
- The ability to model HD battery-electric and fuel-cell vehicles, as well as compressed natural gas (CNG) long-haul combination trucks.
- Improved modeling of LD electric vehicles.
- New tools to make the model easier to use and updates for compatibility with newer software.
- Updated data and forecasts on vehicle populations (including electric vehicle fractions), travel activity, and emission rates, as well as updated fuel supply information at the county level.
- The latest data on ammonia emission rates for light-duty and heavy-duty vehicles.
- A number of other limited-impact updates to specific emissions rates and adjustments.

The structure of MOVES4 is fundamentally the same as MOVES3, but to take advantage of new capabilities, modelers will need to modify their inputs.

EPA United States Environmental Protection Agency

Office of Transportation and Air Quality
EPA-420-F-23-019
August 2023

As for emissions, EPA performed a comparison of MOVES3 to MOVES4 using default information in MOVES at the national level, and for two sample urban counties with different local travel patterns and ambient conditions. MOVES4 national and local onroad vehicle emission estimates are generally lower in future years:

- Future year NOx and PM emissions are notably lower due to the HD2027 rule.
- Future year GHG estimates are lower due to the LD GHG 2023 rule and electric vehicles expected with the Inflation Reduction Act.

There are some increases:

- National emissions estimates are often higher in recent years because MOVES4 incorporates updated vehicle registration data that shows vehicles are older than in MOVES3 defaults.
- Evaporative hydrocarbon emissions from refueling increase in the near-term due to algorithm improvements and new data. HD gasoline vehicle refueling emissions decrease in later years because of HD2027 rule requirements.
- While national-scale ammonia emissions continue to be dominated by agricultural sources, on-road ammonia emissions increase significantly because real-world measurements show ammonia emissions from both gasoline and diesel vehicles are much higher than MOVES3 predicted.
- Similarly, nitrous oxide (N2O) emissions have increased due to new data for HD diesel vehicles. This increase is small compared to the expected decrease in other greenhouse gases, namely carbon dioxide and methane.

In practice, the results from using MOVES4 will depend upon the unique circumstances and local information that is used for a given area. For more information, including a detailed list of changes to the MOVES interface, see Overview of EPA's MOtor Vehicle Emission Simulator (MOVES4).

3. What needs to be done to switch to MOVES4?

The MOVES4 installer will automatically install all of the prerequisite software, including Java and MariaDB, along with the MOVES code and database. The installer includes a troubleshooting guide. MOVES3 can remain installed.

When switching to MOVES4, new run specifications should be constructed using the improved MOVES4 Graphical User Interface. For user input databases that still contain the latest data, MOVES4 contains a database conversion tool that may be used to help convert a MOVES3 database to the MOVES4 format. The tool contains detailed instructions on performing this task.

4. How has EPA reviewed the new model?

Technical reports that describe the new MOVES4 inputs and algorithms have been reviewed by independent experts under EPA's peer review policies and procedures. The MOVES development team performs rigorous testing throughout the model development life cycle. This includes unit testing to ensure that every change to MOVES affects emissions and activity as expected, and systematic integrated testing to ensure changes do not have unintended side

effects. A draft version of MOVES4 was tested by a small group of experienced MOVES users who alerted EPA to potential errors and provided comments on the MOVES4 documentation. We also publicly shared the MOVES4-RC2 "release candidate" version of MOVES4 for modelers who wanted to become familiar with MOVES4 prior to release.

5. What changed between the MOVES-RC2 "release candidate" posted in June 2023 and the current model?

We have updated the model with more recent forecasts of future EV populations, and we have fixed a few errors in the model. We have also added tools and documentation.

While results generated with MOVES4-RC2 are generally similar to official MOVES4 results, they will not be identical. MOVES4-RC2 cannot be used for regulatory purposes.

6. When should MOVES4 be used for state implementation plans (SIPs) and transportation conformity?

EPA will be publishing a Federal Register notice to announce the availability of MOVES4 for official purposes. Details on when and how MOVES4 should be used for regulatory purposes are provided in EPA's MOVES4 Policy Guidance: Use of MOVES for State Implementation Plan Development, Transportation Conformity, General Conformity, and Other Purposes, which EPA issued with MOVES4. All states other than California should use MOVES4 for future SIPs to meet applicable requirements and to take full advantage of the improvements incorporated in this version.[1] However, state and local agencies that have already completed significant SIP work with a version of MOVES3 may continue to rely on that MOVES version. In addition, EPA intends to include in the upcoming Federal Register notice a two-year grace period for using MOVES4 for transportation conformity determinations, both in new regional emissions analyses and in new hot-spot analyses.

Questions about the application of MOVES4 guidance to specific SIPs or transportation conformity analyses should be addressed to the EPA Regional Office SIP or transportation conformity contact. Regional contacts for transportation conformity can be found at www.epa.gov/state-and-local-transportation/epa-regional-contacts-regarding-state-and-local-transportation. A list of EPA Regional mobile source contacts can be found in Section 16.2 of the Office of Transportation and Air Quality Contacts by Topic.

7. Is additional training required to use MOVES4?

Users who are familiar with MOVES3 will find MOVES4 easy to use, but we plan to offer a webinar in mid-September, 2023, to demonstrate new features of the model and answer questions about changing from MOVES3 to MOVES4. Slides from this webinar will be posted on the MOVES training page.

[1] In California, a different onroad emissions model, EMFAC, is used for regulatory purposes instead of MOVES. MOVES can also model emissions in the District of Columbia, Puerto Rico, and the U.S. Virgin Islands.

Modelers new to MOVES should review the MOVES training materials available on the web since most of this information is still relevant. We will be updating these materials to reflect MOVES4 soon.

When EPA schedules training, we update the MOVES training website with the information about how to register, and we publicize this information via the MOVES listserv. Instructions on signing up for the listserv are available at www.epa.gov/moves/forms/epa-mobilenews-listserv.

8. What other resources are available for MOVES4?

The Overview of EPA's MOtor Vehicle Emission Simulator (MOVES4) provides information about MOVES updates, model scope, appropriate use, structure, and algorithms. It also provides more information on MOVES testing and evaluation, and a comprehensive guide to MOVES documentation and guidance.

The MOVES website (https://www.epa.gov/moves) is the source for MOVES software as well as technical reports that document the data and algorithms used in MOVES, tools for use with MOVES, frequently asked questions, and information on MOVES training. EPA MOVES staff may be contacted at mobile@epa.gov.

In addition, EPA developed MOVES4 Technical Guidance: Using MOVES to Prepare Emission Inventories in State Implementation Plans and Transportation Conformity to describe how to use MOVES for SIP development and regional transportation conformity analyses. This and other guidance documents can be found at: https://www.epa.gov/state-and-local-transportation. See MOVES guidance documents for additional EPA contact information.