



MOVES

Motor Vehicle Emission Simulator

MOVES3 Introduction & Overview

Public Webinar
U.S. Environmental Protection Agency
Office of Transportation and Air Quality
12/8/2020



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Ask Questions
Via Q&A Chat




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

Closed Caption and Q&A






MOVES3  **MOVES**
Motor Vehicle Emission Simulator

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   LIVE 2:19 / 6:39

Q&A

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Overview

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

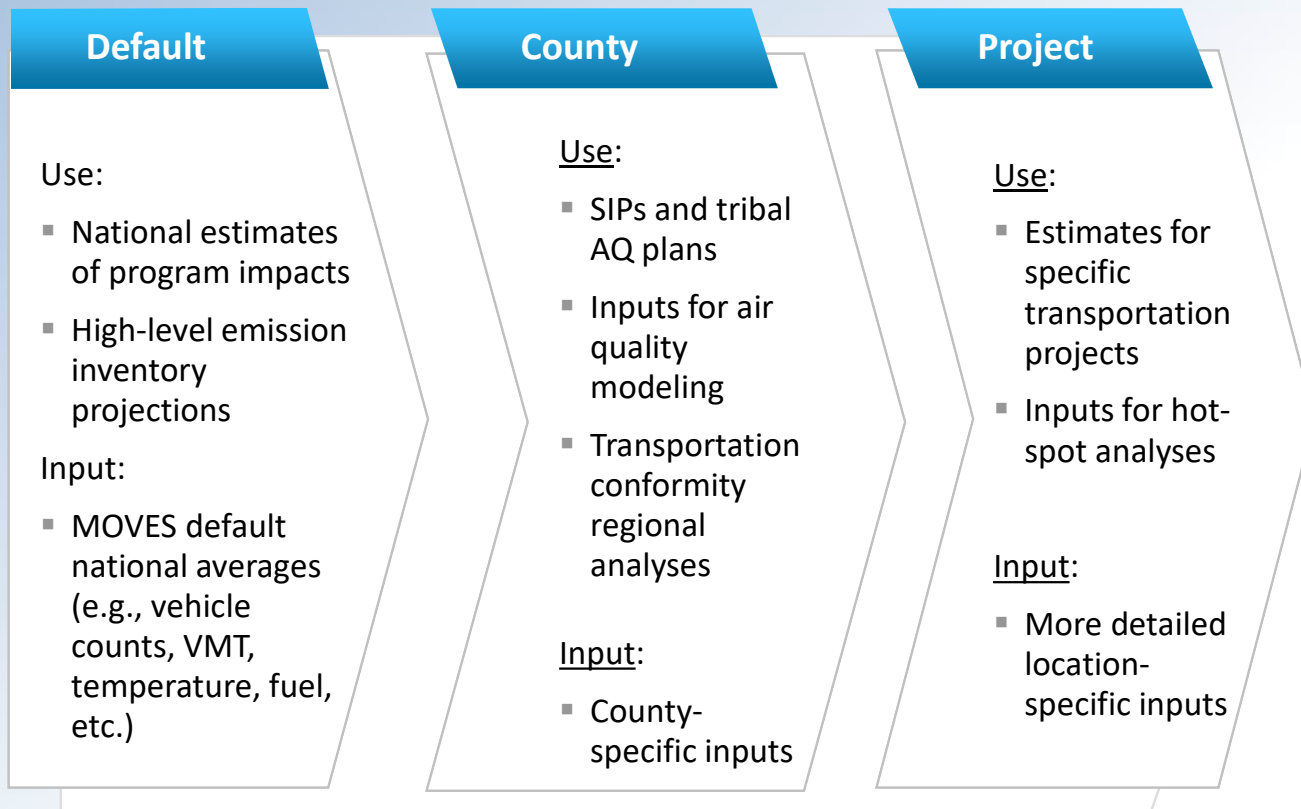


Background on MOVES

- 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





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 (NO_x) 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/>

- 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 NO_x increases



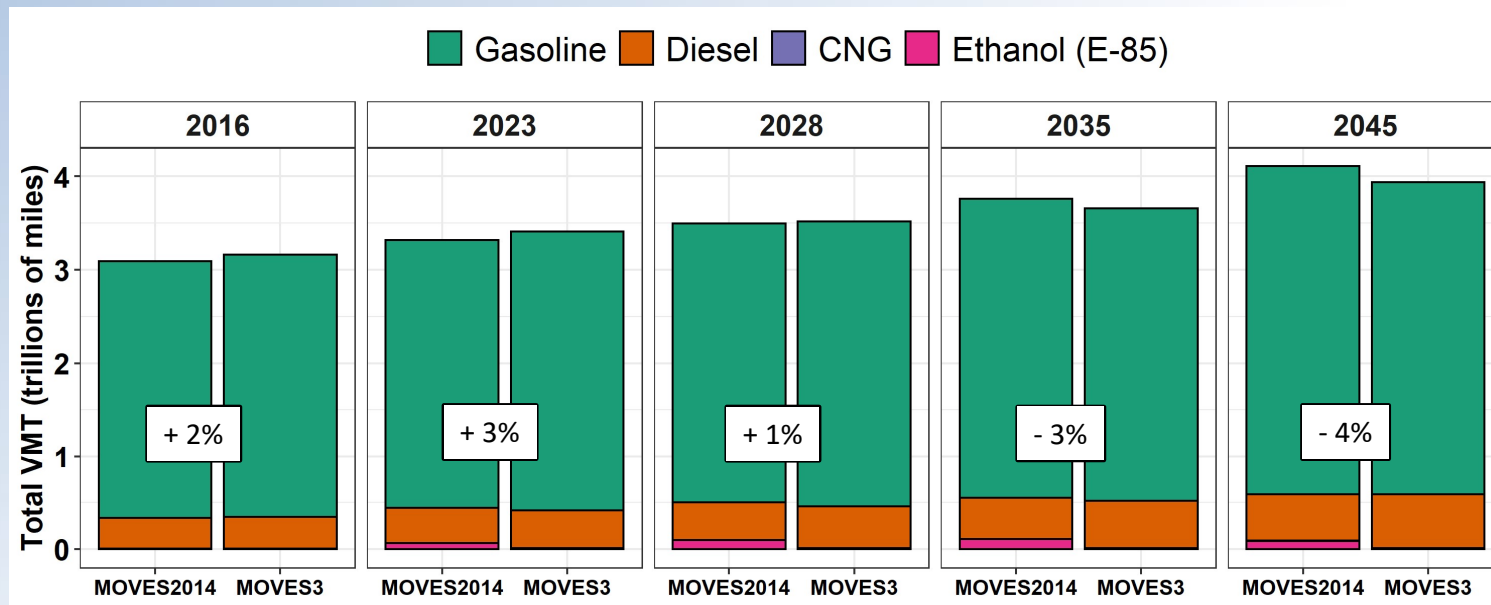
National Comparisons

- 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

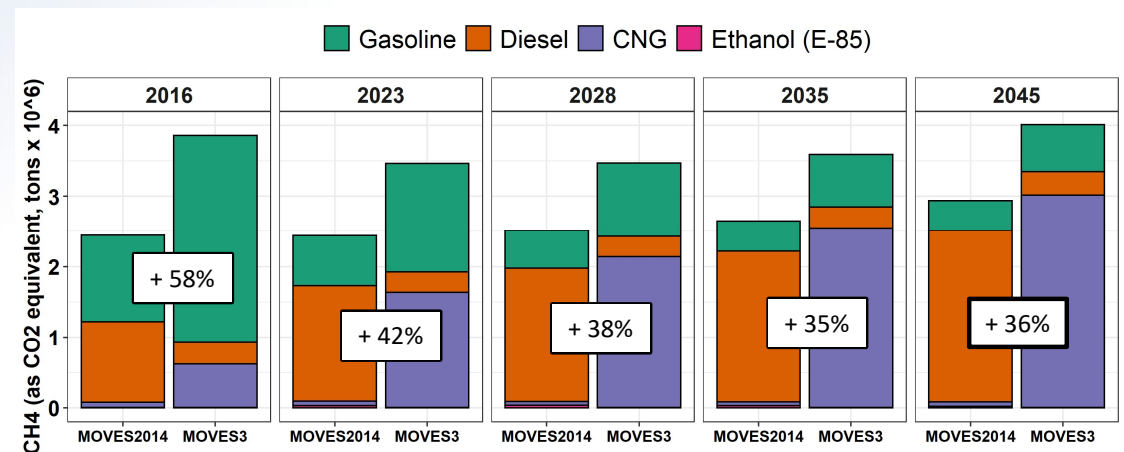
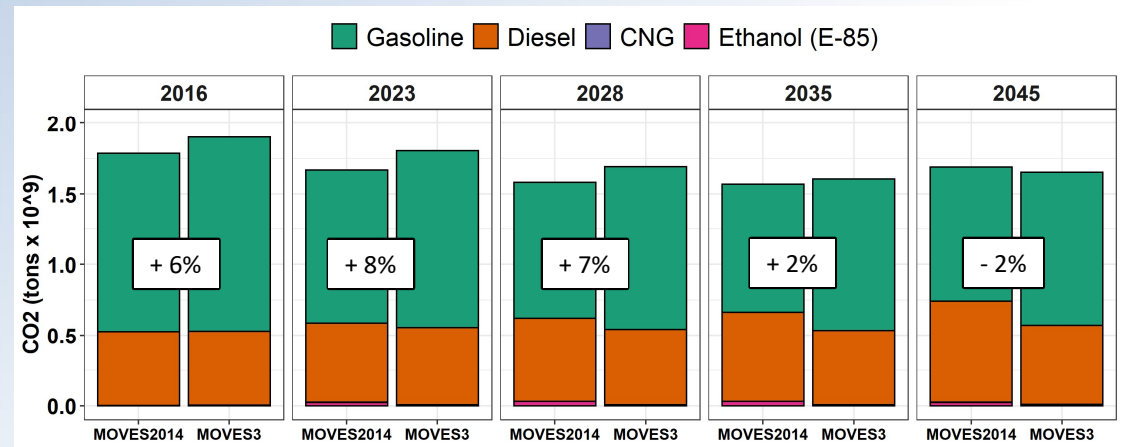


Percentage label indicates change from MOVES2014b to MOVES3.



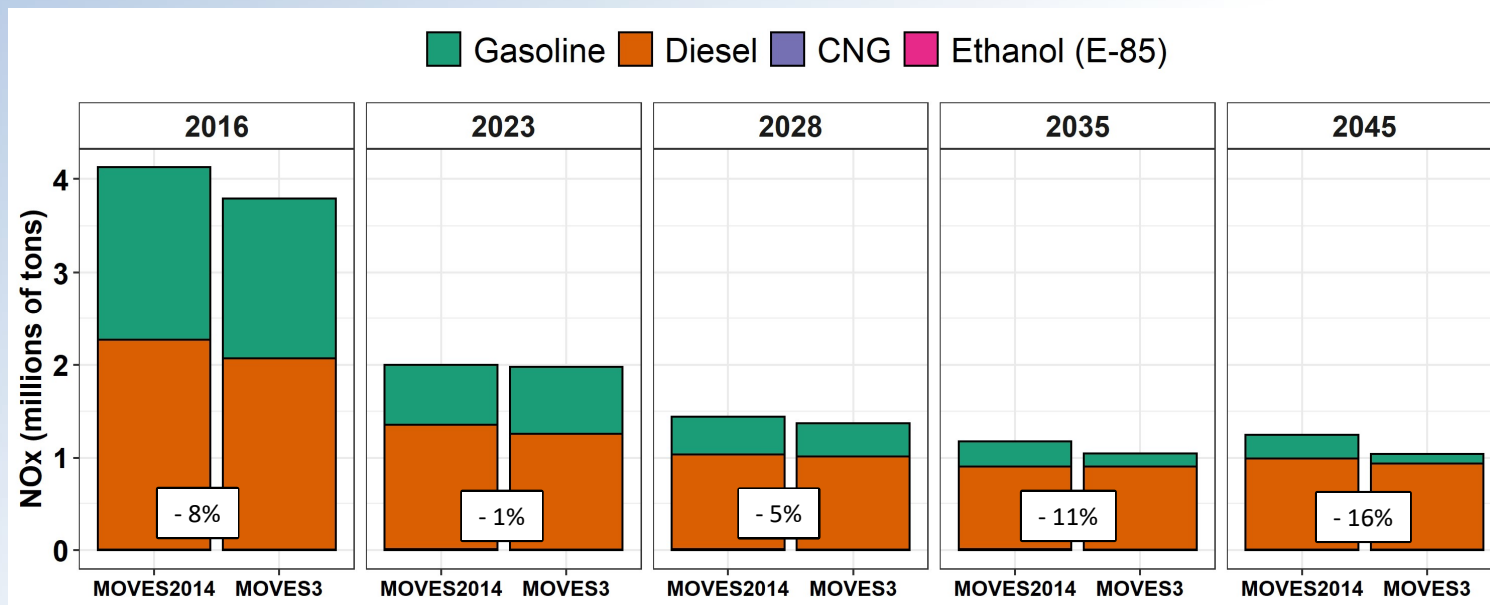
National: Onroad GHGs

- 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.



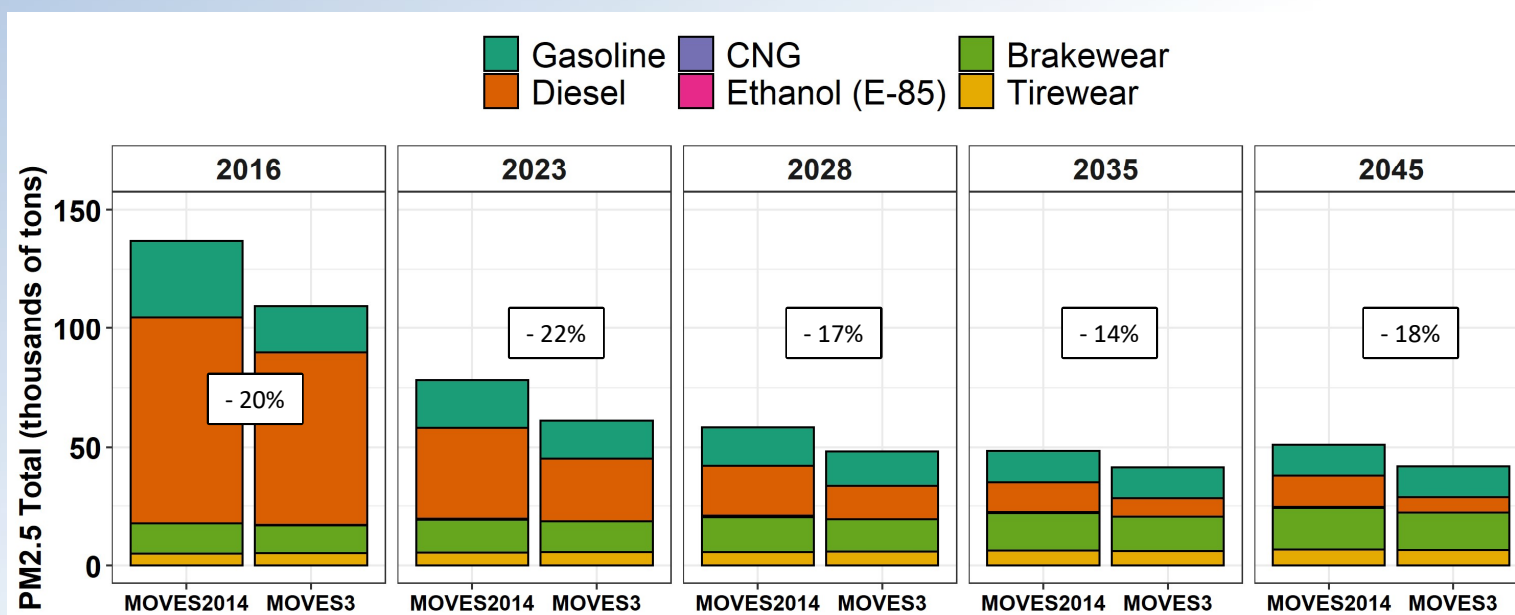
National: Onroad NOx

- 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



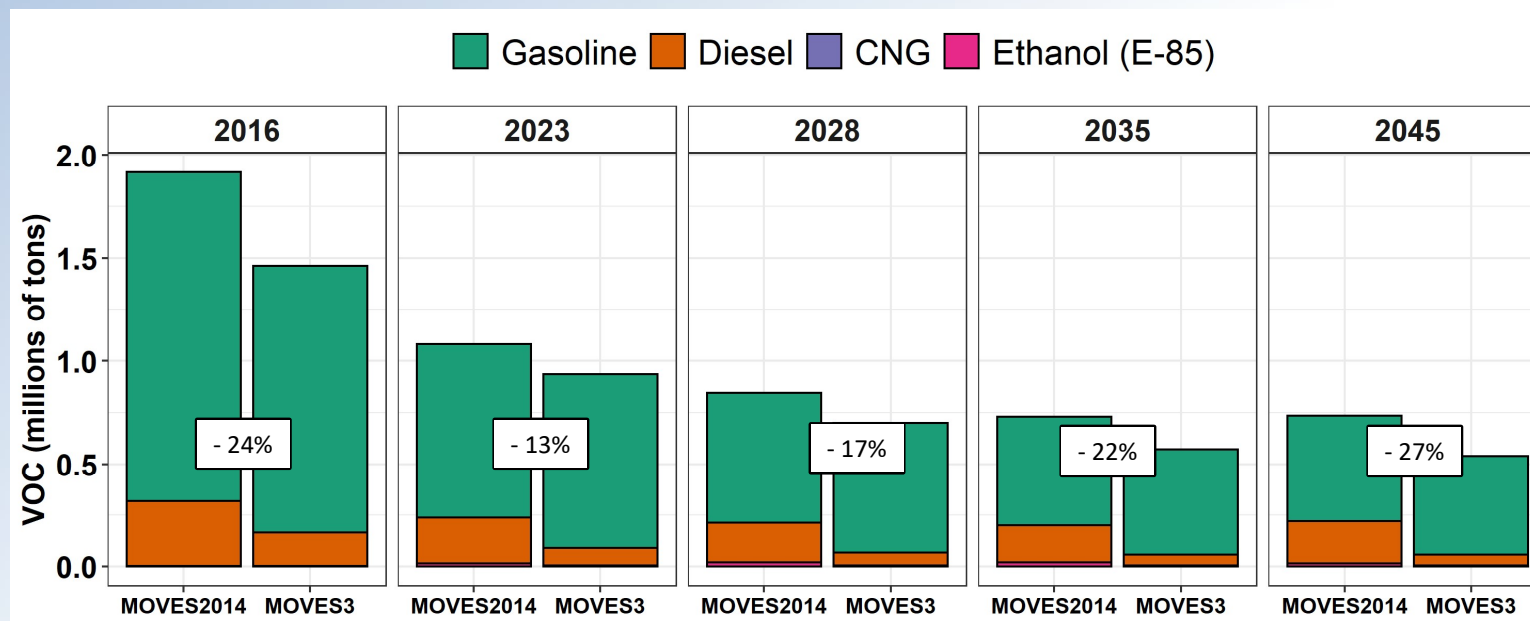
National: Onroad PM_{2.5}

- 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

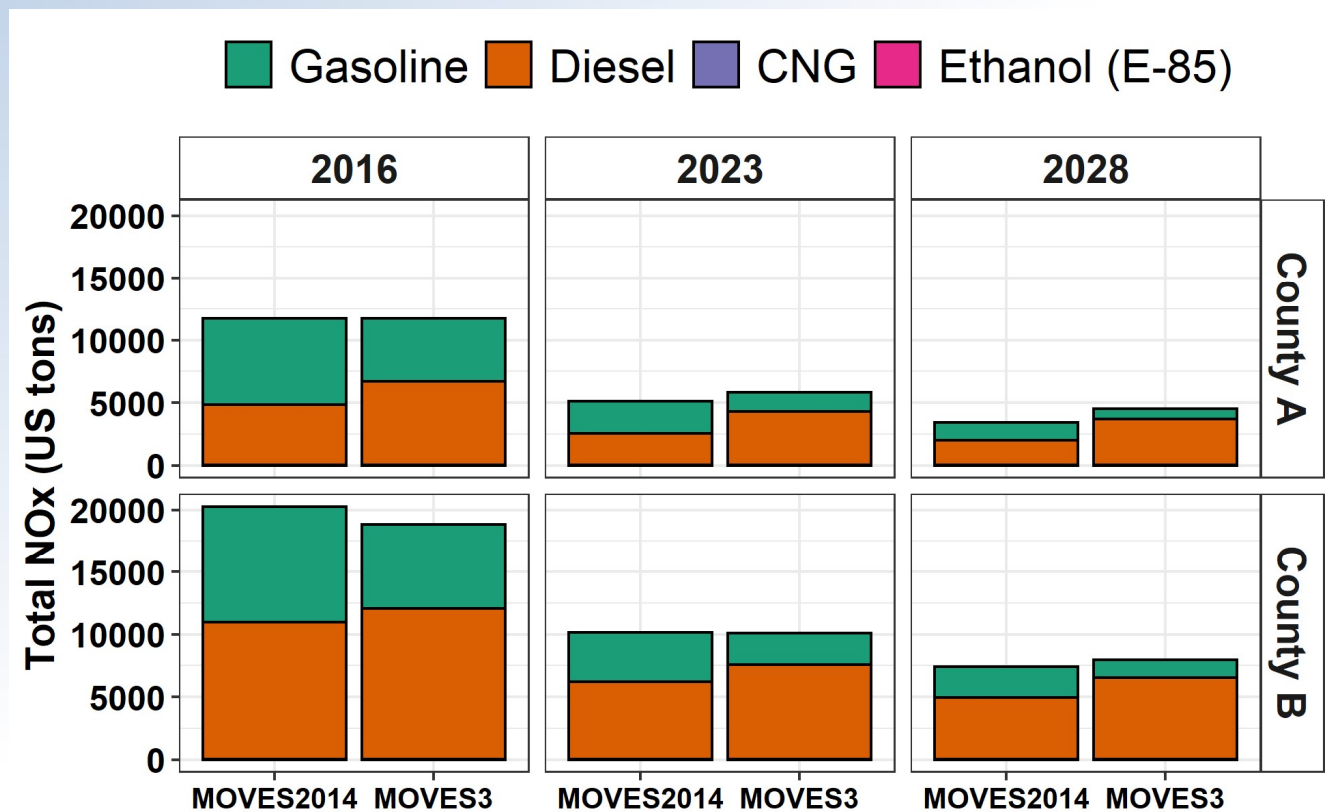
- Next slides show results for two sample counties for selected years
 - Two core urban counties with different local travel patterns and ambient conditions



Sample Counties: Onroad NOx

In these counties, compared to MOVES2014b:

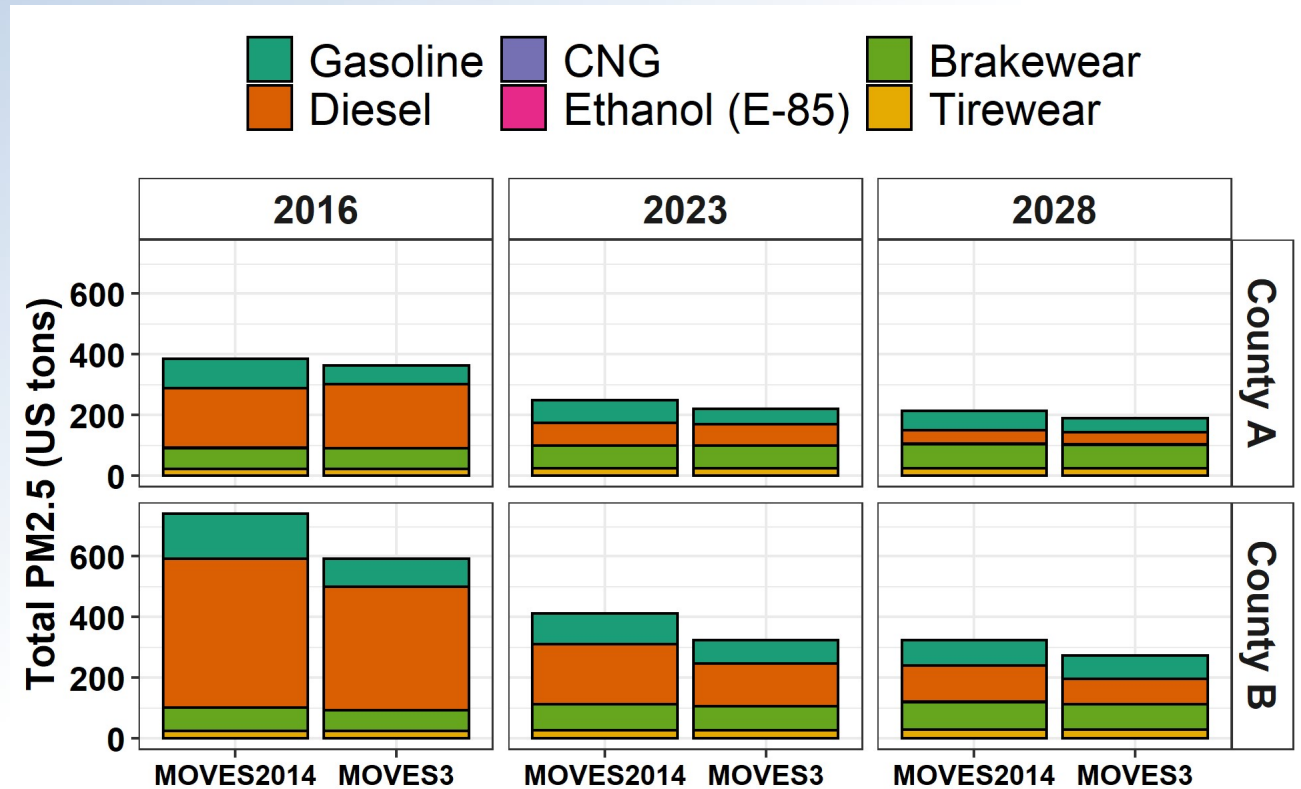
1. Lower gasoline NOx
2. Higher diesel NOx
 - Urban diesel is dominated by running NOx (which increased) rather than extended idle (which decreased)



Sample Counties: Onroad PM_{2.5}

In these counties, compared to MOVES2014b:

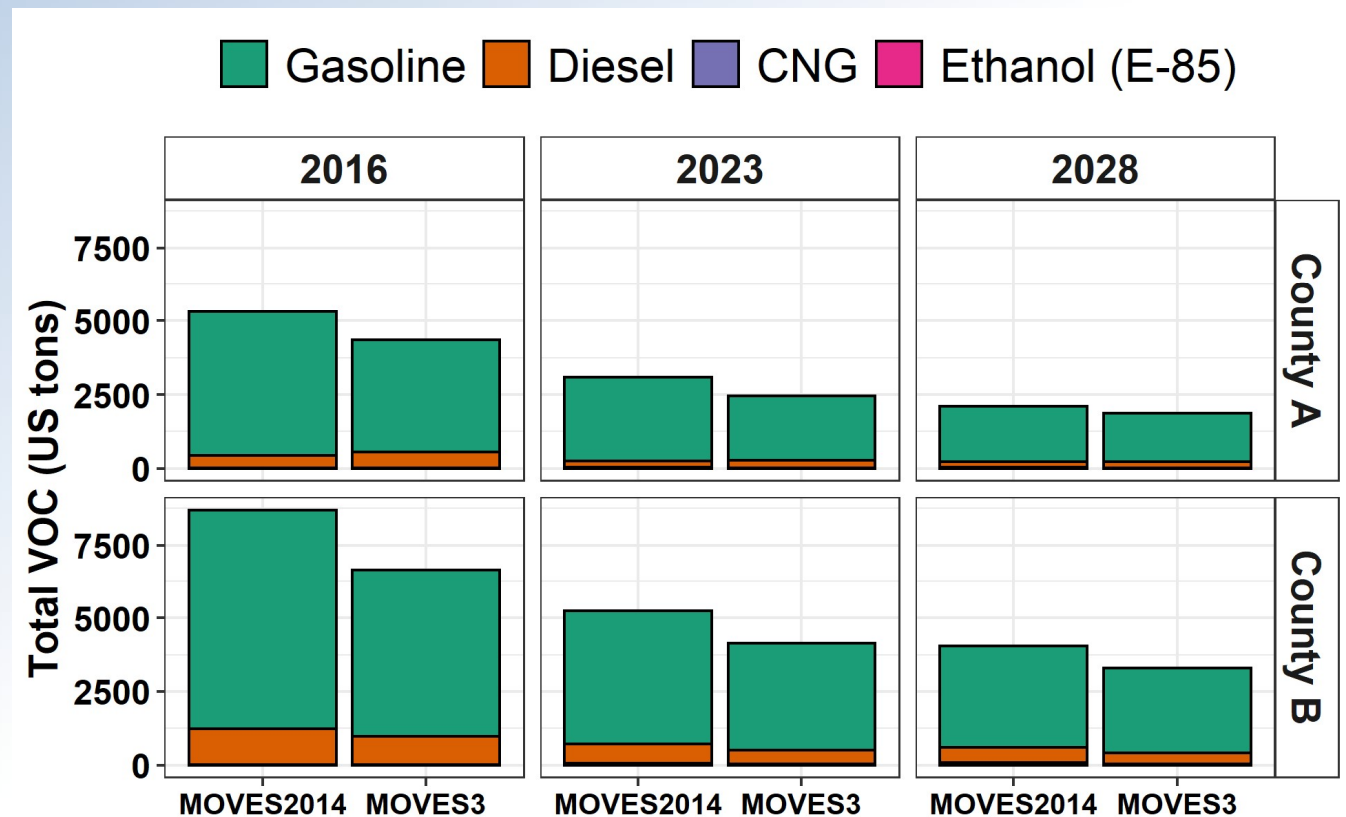
1. Lower PM from gasoline
2. Lower PM from diesel
 - Dominated by running emissions & sensitive to local fleet mix
3. Brake and tire wear emissions are unchanged, but contribute a significant fraction of future year PM



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





MOVES3 Technical Guidance



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





Resources



MOVES Webpage

<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

The screenshot shows the EPA website's homepage for MOVES. At the top, the EPA logo and navigation menu are visible. The main heading is "MOVES and Other Mobile Source Emissions Models". Below this, there is a section for the "MOTOR Vehicle Emission Simulator (MOVES)" with a list of pollutants and a photo of a person working at a computer. To the right, a text box describes MOVES as a state-of-the-science emission modeling system. Below the main heading, there are three columns of links: "MOVES and Other Mobile Source Emissions Models Using MOVES", "Understanding Algorithms & Default Data", and "Older Models". A search bar is located at the bottom right of the page.

MOVES and Other Mobile Source Emissions Models

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MOTOR Vehicle Emission Simulator (MOVES)

Latest version of MOVES

- Primary PM2.5 - Brakewear Particulate
- Primary PM2.5 - Tirewear Particulate
- Primary Exhaust PM10 - Total
- Primary PM10 - Brakewear Particulate
- Primary PM10 - Tirewear Particulate
- Sulfur Oxide (SO2)
- Total Energy Consumption
- Petroleum Energy Consumption
- Fossil Fuel Energy Consumption
- Atmospheric CO2
- CO2 Equivalent
- Benzene
- Ethanol
- MTBE
- 1,3-Butadiene
- Formaldehyde

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.

MOVES and Other Mobile Source Emissions Models Using MOVES

- [Latest MOVES Model](#)
- [MOVES Limited Use Models](#)
- [Tools to Develop or Convert MOVES Inputs](#)
- [MOVES Training Sessions](#)
- [Methods to Produce Emission](#)

Understanding Algorithms & Default Data

- [MOVES Software Information on GitHub](#)
- [MOVES Onroad Technical Reports](#)
- [Nonroad Technical Reports](#)
- [MOVES Model Review Work Group](#)
- [Mobile Source Emission Factors Research](#)
- [Fuel Analysis Programs](#)

Older Models

- [Previous MOVES Versions](#)
- [MOBILE Model](#)

Search MOVES and Other Models

[Search this Site](#)

Can't find what you are looking for, search the archive at archive.epa.gov



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>

