

# TRANSITIONING TO MOVES4

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## Analysis of Mobile Emissions Impacts of MOVES4

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National Capital Region  
**Transportation Planning Board**

# What is MOVES and Why Transition to MOVES4 Now?

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- MOVES, or Motor Vehicle Emissions Simulator, is a tool developed by the EPA to estimate air pollution from motor vehicles. This includes criteria pollutants (e.g., VOC & NO<sub>x</sub>), greenhouse gas (GHG) emissions, and air toxic emissions
- TPB is required to use MOVES to estimate nitrogen oxide (NO<sub>x</sub>) and volatile organic compound (VOC) emissions for air quality conformity (AQC) analyses
- Regional state air agencies are required to use MOVES emissions estimates to set the motor vehicle emissions budgets (MVEBs) in state implementation plans (SIPs) for the attainment of air quality standards
- **TPB staff are moving to the latest MOVES model (MOVES4) for Visualize 2050 AQC and GHG analyses to account for the latest federal regulations and modeling capabilities embedded in the model**



# MOVES4 - Release and Deadlines

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- EPA periodically updates the MOVES model to account for changes in assumptions and methodologies:
  - Minor updates: fixing minor technical issues (“bugs”)
  - Major updates: incorporating new regulations, providing additional modeling capabilities, fixing major issues
- EPA’s latest emissions model, MOVES4, was officially released in the Federal Register<sup>1</sup> on August 30, 2023
- EPA provided a 2-year grace period, which ends on September 12, 2025, before MOVES4 must be used for conformity analyses
- EPA requires immediate use of MOVES4 for new State Implementation Plan (SIP) development

<sup>1</sup>Federal Register Vol 88, No. 175/ Tuesday September 12, 2023 “Official Release of the MOVES4 Motor Vehicle Emissions Model for SIPs and Transportation Conformity [2023-19116.pdf \(govinfo.gov\)](#)



# MOVES4 - Summary of Changes Relative to MOVES3

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- Accounts for new and changed emission rules
- Updated modeling of electric vehicles
- Updated default data and projections for vehicle populations & activity
- Updated default data and projections for fuel properties
- Improved emission rates and emission adjustments:
  - Adjusted light-duty veh.(LDV) particulate matter emission rates, updated refueling and crankcase emissions



# MOVES4 - New and Changed Rules

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## MOVES4 accounts for new and changed rulings adopted after the development of MOVES3

- **HD2027 rule (March 2023) - Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards**  
This rule sets tighter emission standards for Nitrogen Oxides (NOx), Particulate Matter (PM), Volatile Organic Compounds (VOC), and Carbon Monoxide (CO) from heavy-duty onroad vehicles and engines starting in model year 2027.
- **LDGHG 2023 rule (December 2021) - Revised 2023 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions Standards**  
These standards set tighter Greenhouse Gas (GHG) limits for light-duty passenger cars and trucks.
- **Removal of HDGHG2 trailer program (2016 rule removed in 2021)**  
An appeals court has thrown out portions of the 2016 Phase 2 greenhouse gas emissions rule that would have required heavy- and medium-duty trailers for the first time ever to adopt some combination of fuel-saving technologies.



# MOVES4 – Electric Vehicles

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## MOVES4 has improved capability of modeling electric vehicles

- Improved EV base energy rates
- Added electricity as a fuel type for heavy-duty source types
- Added temperature effects for EVs
- Added battery efficiency by age adjustments
- Added charging efficiency adjustments
- Non-zero national default EV fleet fractions



# MOVES4 – EPA Notes Possible NOx Declines

“Figure 6-7 shows national NOx emissions decline over time with the phase-in of light-duty and heavy-duty rules in MOVES3 and MOVES4. MOVES4 shows additional declines primarily due to significantly reduced heavy-duty diesel emissions with the phase-in of the Heavy-Duty NOx Rule for 2027 and Later.”

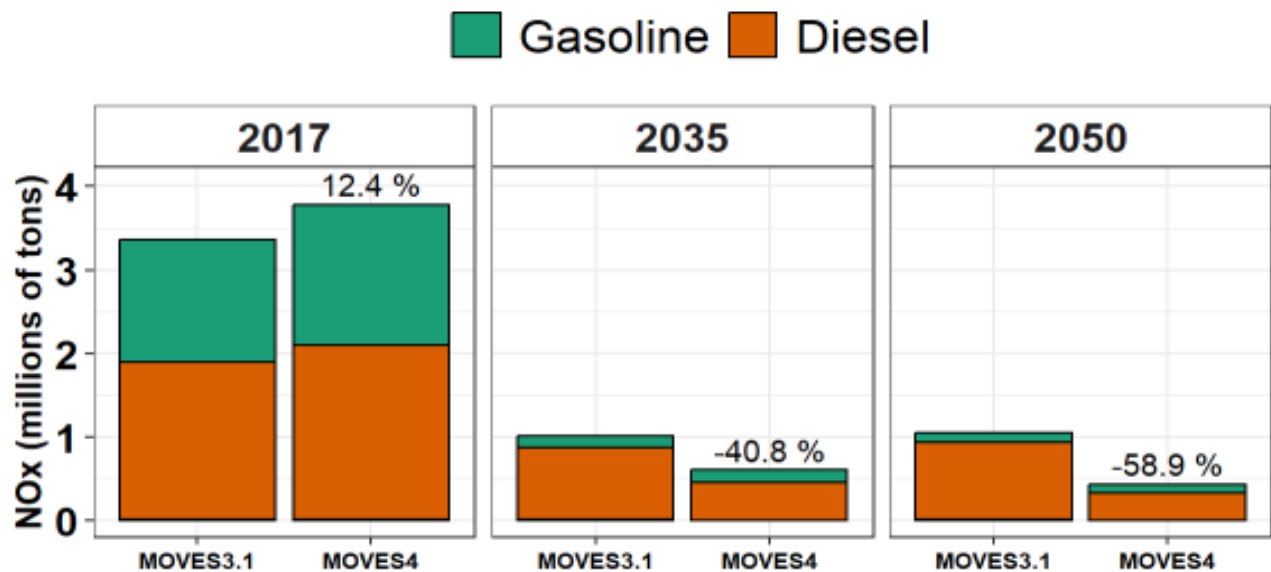


Figure 6-7—National onroad NO<sub>x</sub> in MOVES4 as compared to MOVES3. Percentage values indicate change between MOVES3.1 and MOVES4.

Source: Office of Transportation and Air Quality. “Overview of EPA’s Motor Vehicle Emission Simulator (MOVES4).” Washington, D.C.: U.S. Environmental Protection Agency, August 2023. <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockkey=P10186IV.pdf>



# MOVES4 – EPA Notes Possible VOC Declines

“Onroad VOC emissions are dominated by emissions from gasoline vehicles, which decline with the phase-in of Tier 3 standards in both MOVES3 and MOVES4, and the increased fraction of electric vehicles in the MOVES4 national results (Figure 6-11).”

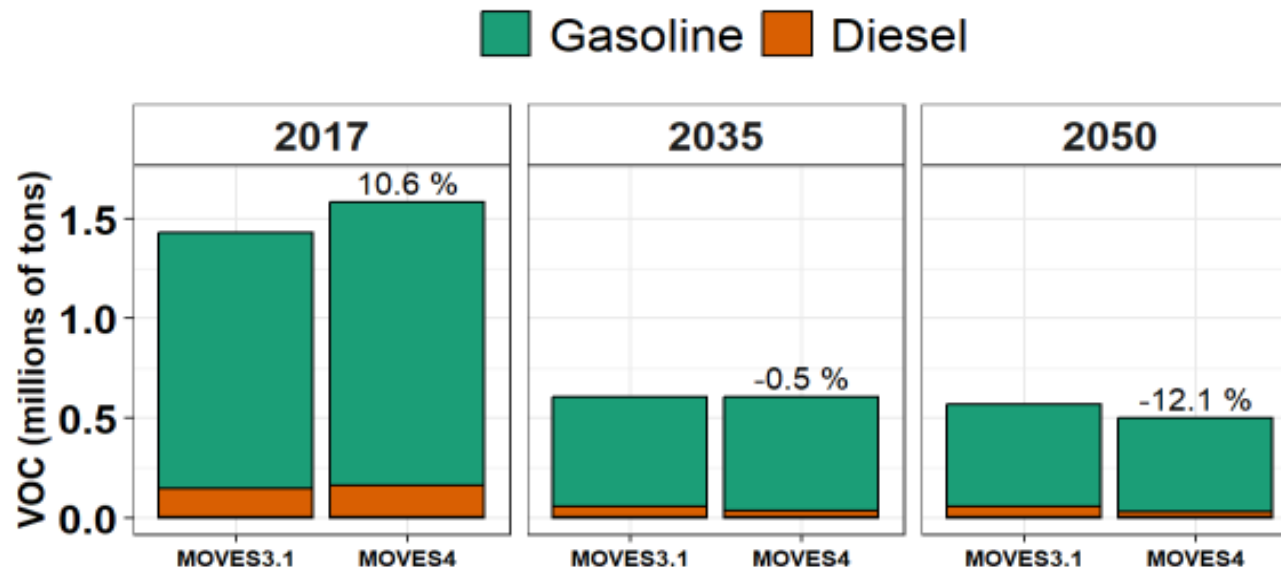


Figure 6-11—National onroad VOC in MOVES4 as compared to MOVES3.1. Percentage values indicate change between MOVES3.1 and MOVES4.

Source: Office of Transportation and Air Quality. “Overview of EPA’s Motor Vehicle Emission Simulator (MOVES4).” Washington, D.C.: U.S. Environmental Protection Agency, August 2023. <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P10186IV.pdf>





# MOVES4 – EPA Notes Possible GHG Declines

“The net CO<sub>2</sub> equivalent emissions based on the emissions of CO<sub>2</sub>, CH<sub>4</sub> and N<sub>2</sub>O as weighted by their global warming potentials are shown in Figure 6-6. The MOVES4 increase in N<sub>2</sub>O is outweighed by decreases in CO<sub>2</sub> and CH<sub>4</sub>.”

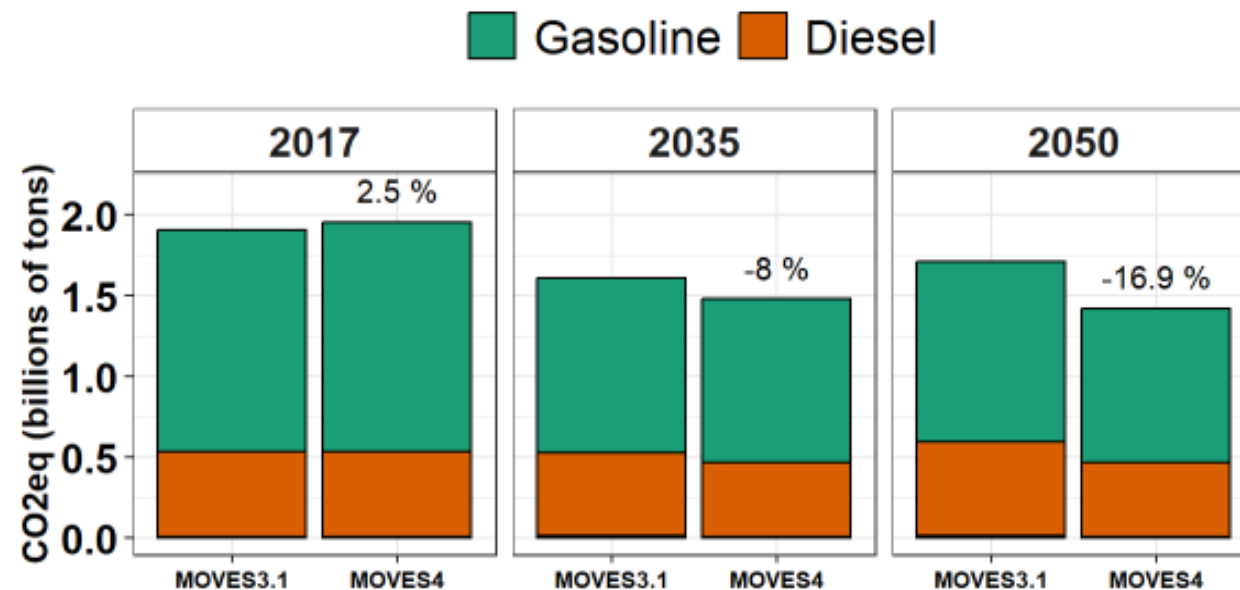


Figure 6-6—National onroad CO<sub>2</sub> equivalent in MOVES4 as compared to MOVES3. Percentage values indicate change between MOVES3.1 and MOVES4.

Source: Office of Transportation and Air Quality. “Overview of EPA’s Motor Vehicle Emission Simulator (MOVES4).” Washington, D.C.: U.S. Environmental Protection Agency, August 2023. <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockkey=P10186IV.pdf>



# MOVES4 – Preliminary Sensitivity Tests

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- TPB staff ran sensitivity tests for MOVES4 using MOVES3 inputs (converted from MOVES2014b) from the 2022 Update to Visualize 2045 air quality conformity analysis with default Alternate Vehicle and Fuel Technology (AVFT) data for each model
  - Default AVFT files are different in MOVES3 and MOVES4
- MOVES4 and MOVES3\* runs contained the same travel-related inputs and same meteorological and inspection/maintenance data
- Summaries in this presentation show differences between two different sets of estimated/modeled data

Note: \* A “sub-version” or “patch” to MOVES3, referred to as MOVES3.0.4, was used in testing.



# MOVES4 – Preliminary Sensitivity Tests

## MOVES4 vs MOVES3: NOx (tons/day)

Year	MOVES3	MOVES4	MOVES4 versus MOVES3
2021	67.442	66.014	-2.1%
2023	56.382	54.128	-4.0%
2025	46.377	43.439	-6.3%
2030	34.666	26.785	-22.7%
2040	29.183	13.889	-52.4%
2045	29.434	12.360	-58.0%



# MOVES4 – Preliminary Sensitivity Tests

## MOVES4 vs MOVES3: VOC (tons/day)

Year	MOVES3	MOVES4	MOVES4 versus MOVES3
2021	35.046	35.009	-0.1%
2023	31.402	31.375	-0.1%
2025	28.099	28.025	-0.3%
2030	22.145	21.579	-2.6%
2040	18.017	16.004	-11.2%
2045	17.774	14.797	-16.7%



# MOVES4 – Preliminary Sensitivity Tests

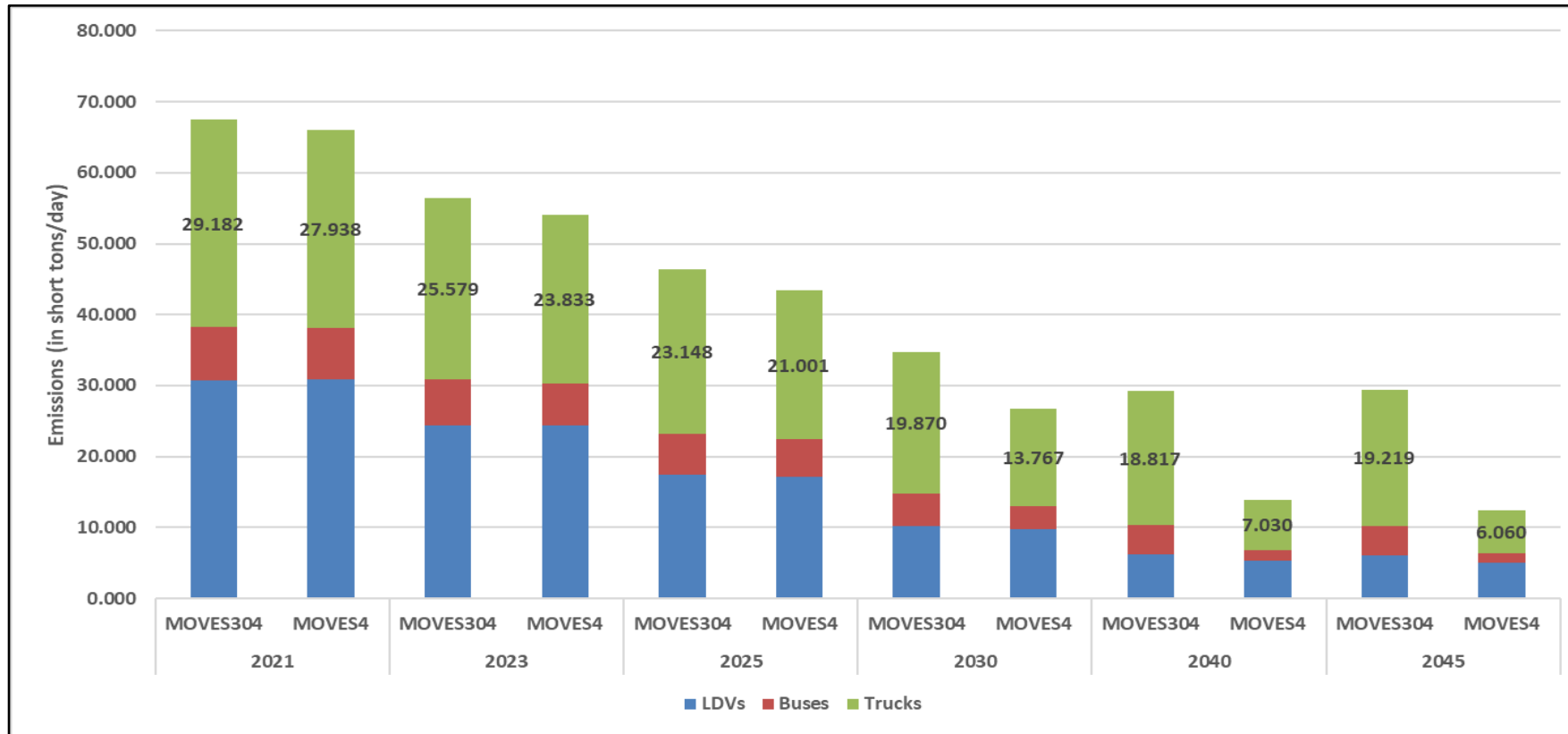
## MOVES4 vs MOVES3: GHG (tons/year)

Year	MOVES3	MOVES4	MOVES4 versus MOVES3
2021	23,121,707	23,712,599	2.6%
2023	22,555,387	23,042,297	2.2%
2025	21,975,342	22,155,650	0.8%
2030	20,830,247	19,301,552	-7.3%
2040	20,496,504	16,568,699	-19.2%
2045	20,871,539	16,318,480	-21.8%



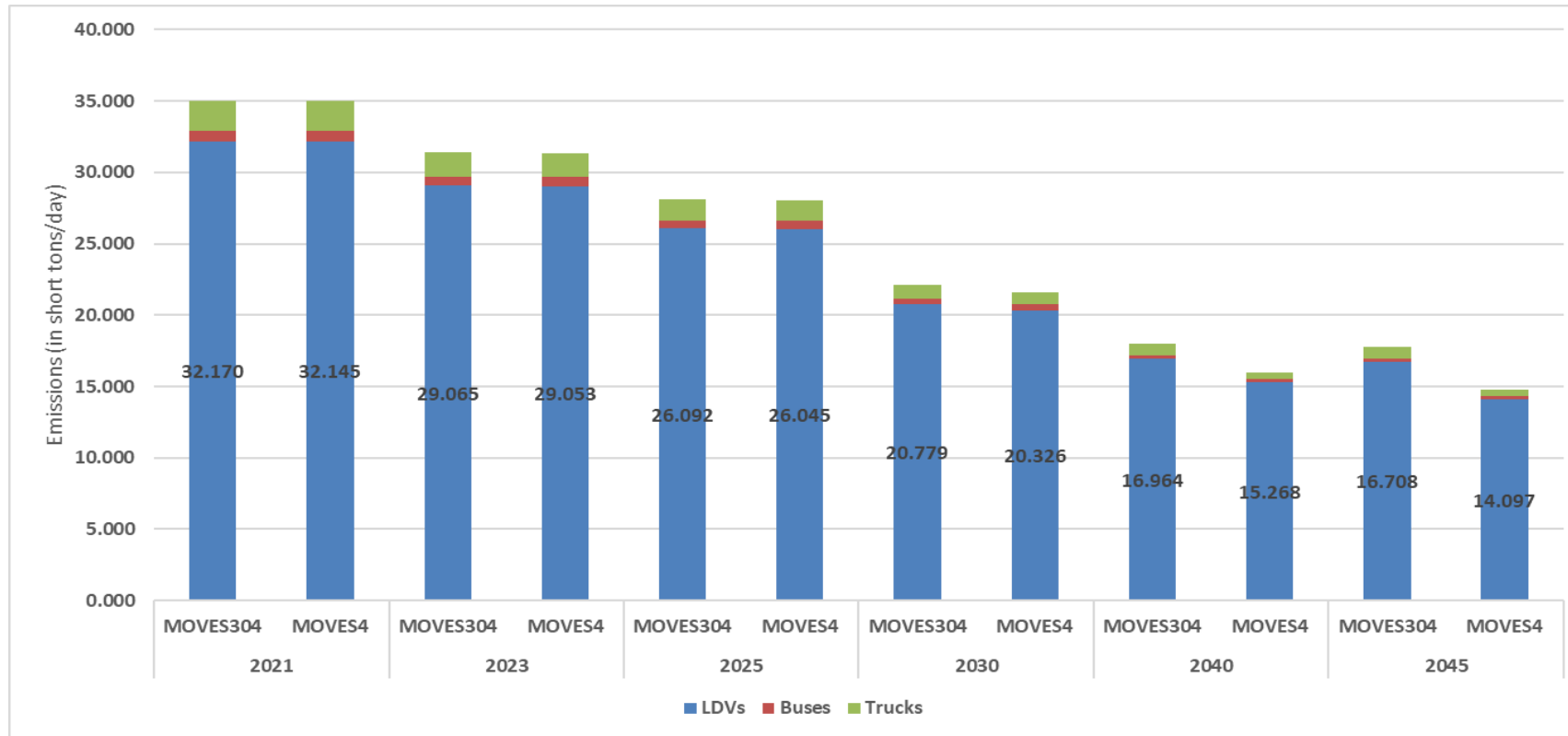
# MOVES4 – Preliminary Sensitivity Tests

Ozone NOx Emissions by Analysis Year and Vehicle Type: MOVES3 vs. MOVES4 (in short tons/day); 2022 Update to Visualize 2045



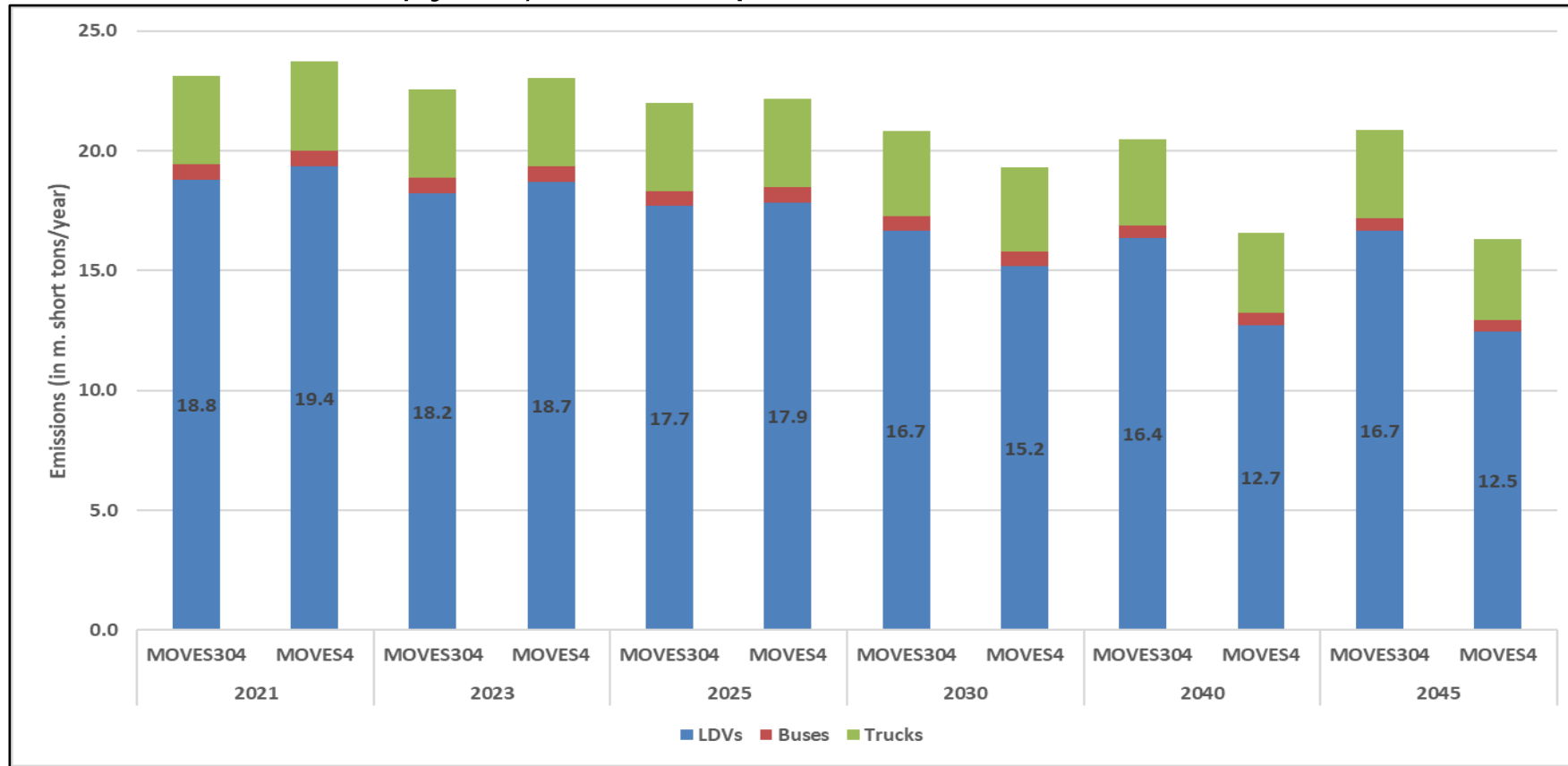
# MOVES4 – Preliminary Sensitivity Tests

Ozone VOC Emissions by Analysis Year and Vehicle Type: MOVES3 vs. MOVES4 (in short tons/day); 2022 Update to Visualize 2045



# MOVES4 – Preliminary Sensitivity Tests

GHG Emissions by Analysis Year and Vehicle Type: MOVES3 vs. MOVES4 (in millions short tons/year); 2022 Update to Visualize 2045





# MOVES4 – COG’s Sensitivity Tests Findings

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- At the regional level, COG’s MOVES4 sensitivity results are in line with those conducted by the EPA at the national level
- MOVES4 estimates greater NOx reductions over time compared to MOVES3 due to the phase-in of the heavy-duty vehicle NOx rule
- Light-duty vehicles are the highest contributors to VOC emissions in both models
- Light-duty vehicles account for the majority of GHG decreases in MOVES4, especially in later years



# MOVES Resources

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- Want to learn more about MOVES?

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



# Next Steps:

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- MOVES4 will be used in the upcoming air quality conformity and greenhouse gas emissions analyses of the region's Long-Range Transportation Plan, Visualize 2050, and the FY2026-2029 Transportation Improvement Program
  - MOVES4 “non-travel-related” inputs for the analyses will be requested from state air agencies in the near future
- Further down the line, MOVES4 will also be used in emissions modeling associated with the 2015 Ozone National Ambient Air Quality Standards (NAAQS) SIP development



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