Modeling with MOVES4
Comparisons to MOVES3, Guidance, Tools & Inputs

U.S. Environmental Protection Agency
Office of Transportation and Air Quality
Public Webinar, 9/13/2023

Logistics

- Appointment is 2-4pm EDT, but expect to end by 3:30 today

- We will be using Teams Webinar for today's presentation.

  – Please enter any questions in the chat

  – Everyone except the presenters will be on mute during the presentations

  – If your question refers to a particular slide, please note the slide number

- If you are not able to use the chat, you can also reach us at mobile@epa.gov

- All of the presentations will be posted online after the webinar is complete. We do not plan to post the recording.

Turning on Captions

1. Click "*. . . More*" at the top.

2. Click "**Record and Transcribe**"

3. Click "**Transcript**"

4. The transcript will appear at the far right of the screen.
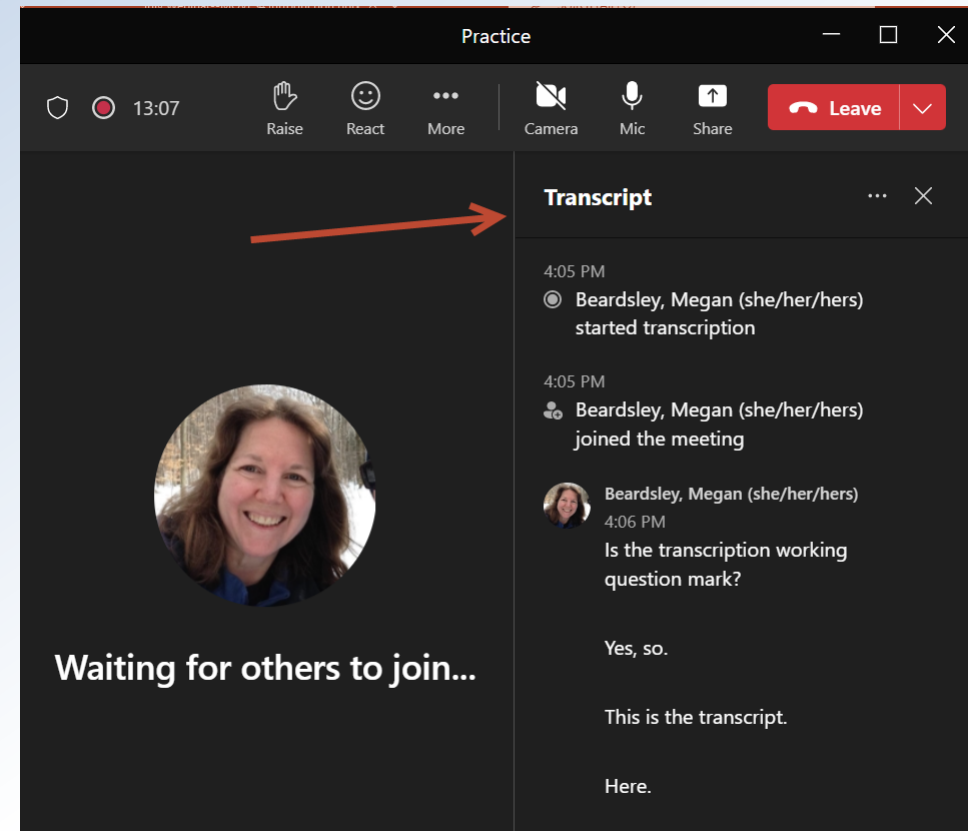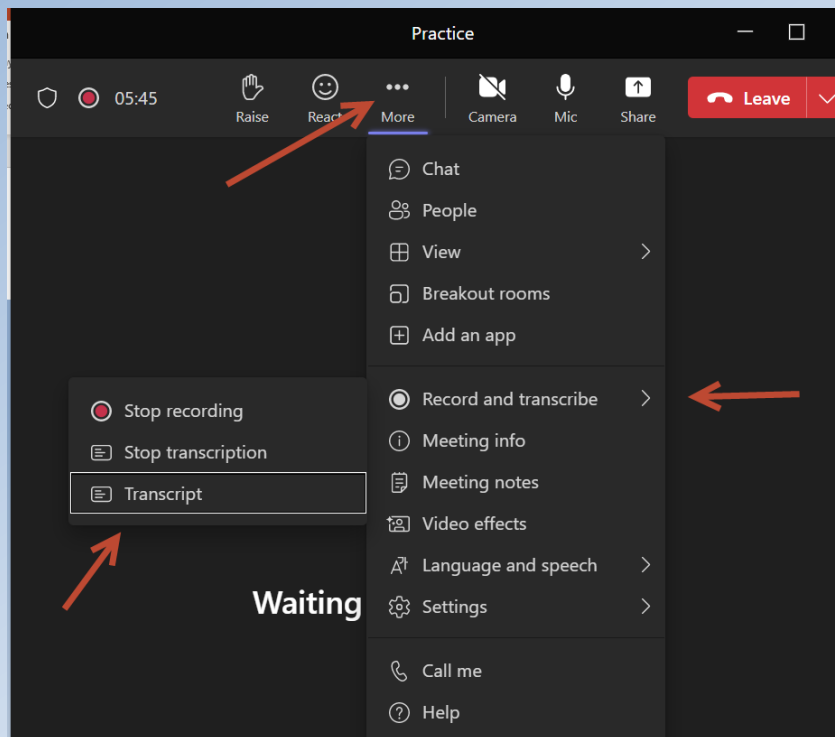
Welcome

- Welcome to EPA's webinar explaining how and when to use the EPA MOtor Vehicle Emission Simulator, MOVES4.

- MOVES4 replaces the MOVES3 series of models as EPA's latest model for estimating air pollution emissions from cars, trucks, motorcycles, and buses, as well as many categories of nonroad equipment.

- MOVES4

  – Allows users to model the benefits from new regulations promulgated since MOVES3 was released,

  – Incorporates the latest vehicle and emissions data, and

  – Expands model capabilities—especially for modeling electric vehicles

Today's Agenda

1. Overview of how MOVES4 emission results compare to MOVES3

2. Guidance on how and when to use MOVES4 for SIP development, transportation conformity, general conformity, and other purposes

3. Information on MOVES4 tools & inputs, including how to update MOVES3 inputs to work with MOVES4

4. Questions?

Resources

MOVES Website

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

- Latest model (MOVES4)

- Limited use models (MOVES3)

- Tools

- Training

- Background Information
  - Technical Reports
  - Software Information

MOVES4 Web Page

https://www.epa.gov/moves/latest-version-motor-vehicle-emission-simulator-moves has links and documents for MOVES4, including:

- EPA Releases MOVES4 Mobile Source Emissions Model: Questions and Answers

- MOVES Overview Report

- Policy and Technical Guidance

- MOVES4 Installation File
  - Instructions and trouble shooting guide are included

MOVES4 Data and Analysis Webinar

- In preparation for MOVES4 release, EPA held a July 20, 2023 public webinar describing the data and analysis planned for incorporation into MOVES4.

- The webinar included three presentations:

  - [MOVES4: Overview of Planned Updates](#)

  - [Planned Updates to Ammonia (NH3) and Nitrous Oxide (N2O) in MOVES4](#)

  - [EPA Plans for Electric Vehicles Modeling in MOVES4](#)

MOVES GitHub Site

- https://github.com/USEPA/EPA_MOVES_Model has links to the MOVES source code

- 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 MOVES4*

- *Tips for faster MOVES runs*

- *Onroad Cheat Sheet*

- *Nonroad Cheat Sheet*

Additional Resources

- MOVES4 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

- MOVES4 Federal Register Notice: https://www.govinfo.gov/content/pkg/FR-2023-09-12/pdf/2023-19116.pdf

- Coming soon: other guidance updates, updated training materials

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

MOVES4 Results

Comparisons to MOVES3

Understanding these Comparisons

National Comparisons:

- MOVES4 output is compared to MOVES3.1

- Both use MOVES default inputs

  - Averaged across entire year and entire U.S.

- Activity is different for MOVES3 and MOVES4

Your results may differ! For the most accurate results for a given time and location, you must run MOVES for the specific case using accurate local inputs.

County Comparisons

- Sample urban counties

- Inputs, including activity, are the same for MOVES3 and MOVES4

  - Exception is heavy duty (HD) electric vehicles (EVs) which do not exist in MOVES3, but do exist in MOVES4

- County A– Future year EV fractions are proportional to historic share

- County B—Future year EV fractions reflect adoption of California's Advanced Clean Car (2012) and Advanced Clean Trucks (2020) rules requiring electric vehicle sales for light- and heavy-duty vehicles.

VEHICLE MILES TRAVELLED

National VMT
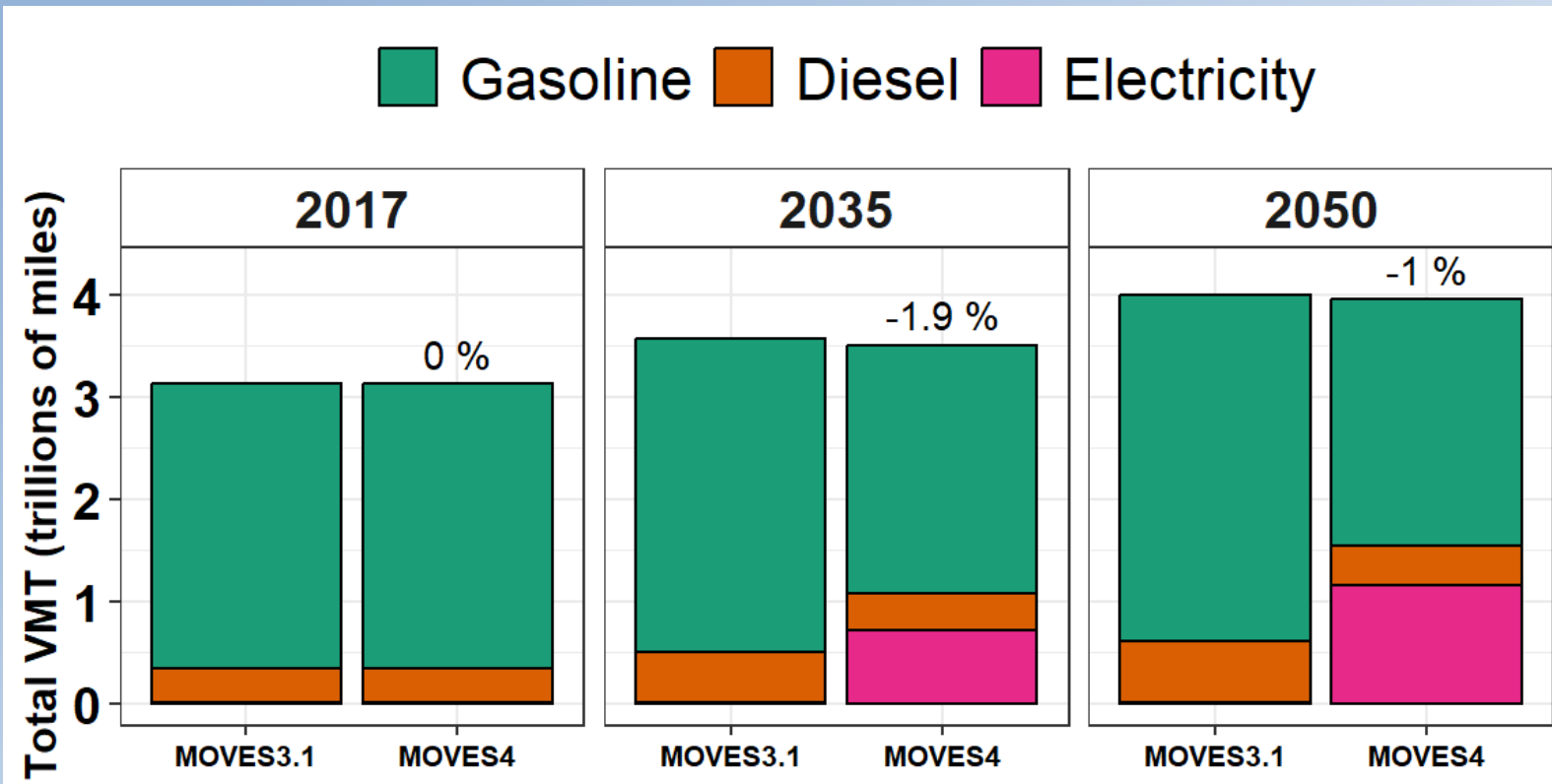
- VMT from gasoline vehicles dominates in both models in all three years

- Note shift from gasoline and diesel to electric vehicles in MOVES4
  - Reflects expected trends based on current rules & national incentives

- Also, a very slight decrease in projections of total vehicle miles travelled

National onroad vehicle miles travelled (VMT) in MOVES4 as compared to MOVES3.1. Percentage values indicate change between MOVES3.1 and MOVES4.

County Scale Input VMT by Fuel Type — County A

County Scale Input VMT by Fuel Type — County B
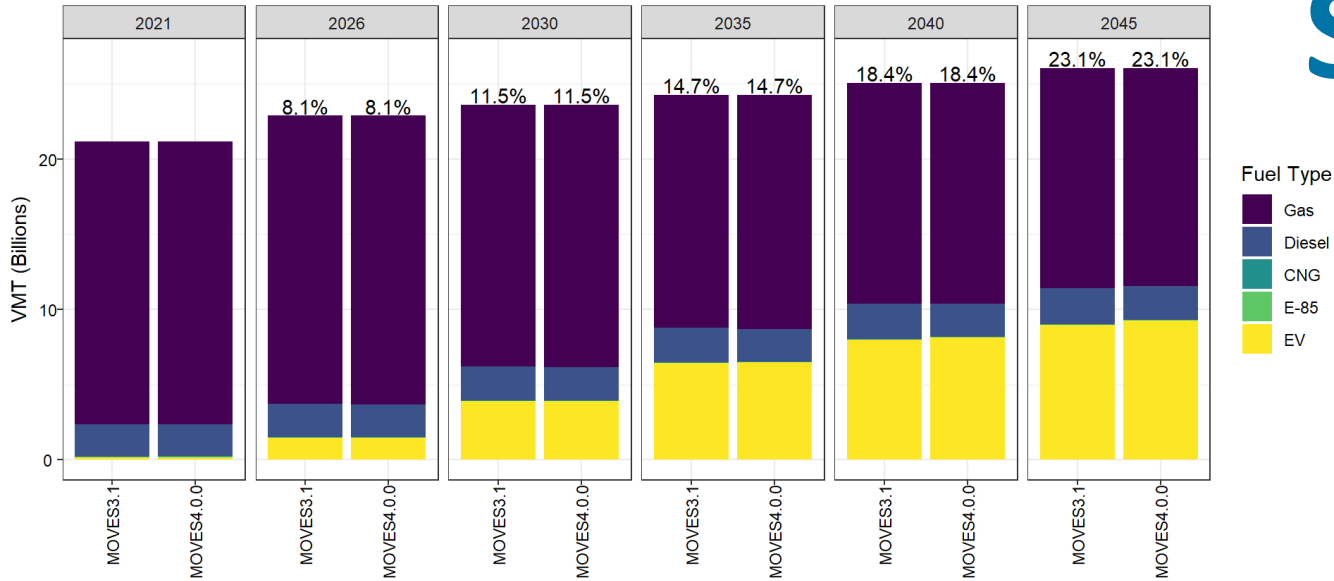
Sample County VMT

- County scale VMT is a user input, but useful for understanding later slides

- In both counties, VMT is dominated by gasoline (purple), with a growing share of electric vehicles (yellow) and relatively small share of diesel (blue)

- In both counties, slightly more EV VMT in MOVES4 because MOVES4 includes HD EVs

- In later years, EV fraction in County B exceeds County A's and displaces more diesel VMT
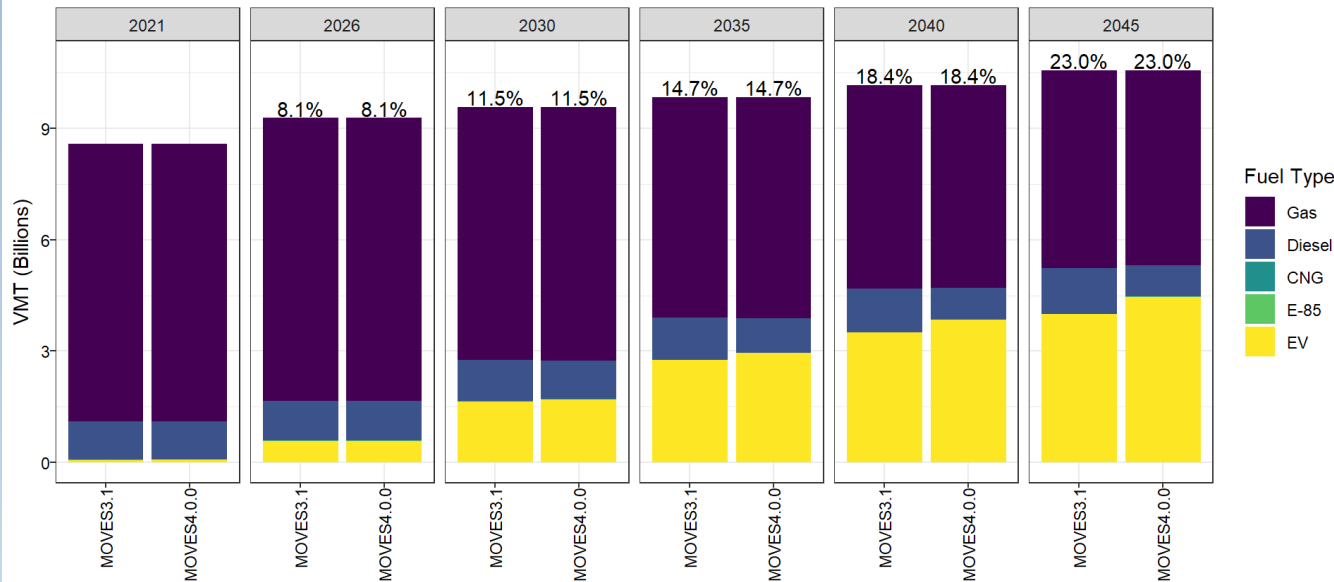
Sample county-specific onroad vehicle miles travelled (VMT) in MOVES3 and MOVES4. Percentage values indicate change compared to calendar year 2021

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ONROAD GREENHOUSE GASES (GHG)

National Carbon Dioxide

National onroad carbon dioxide (CO_2) in MOVES4 as compared to MOVES3.1.
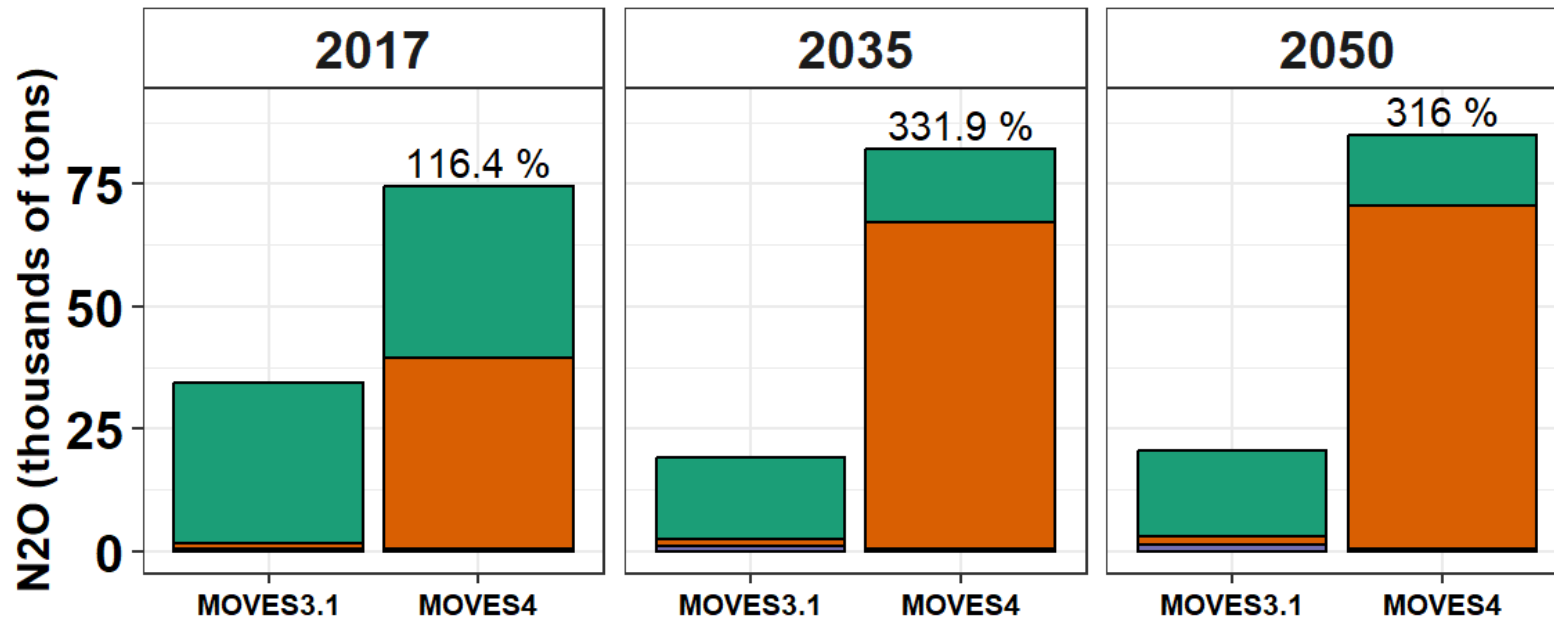Percentage values indicate change between MOVES3.1 and MOVES4.
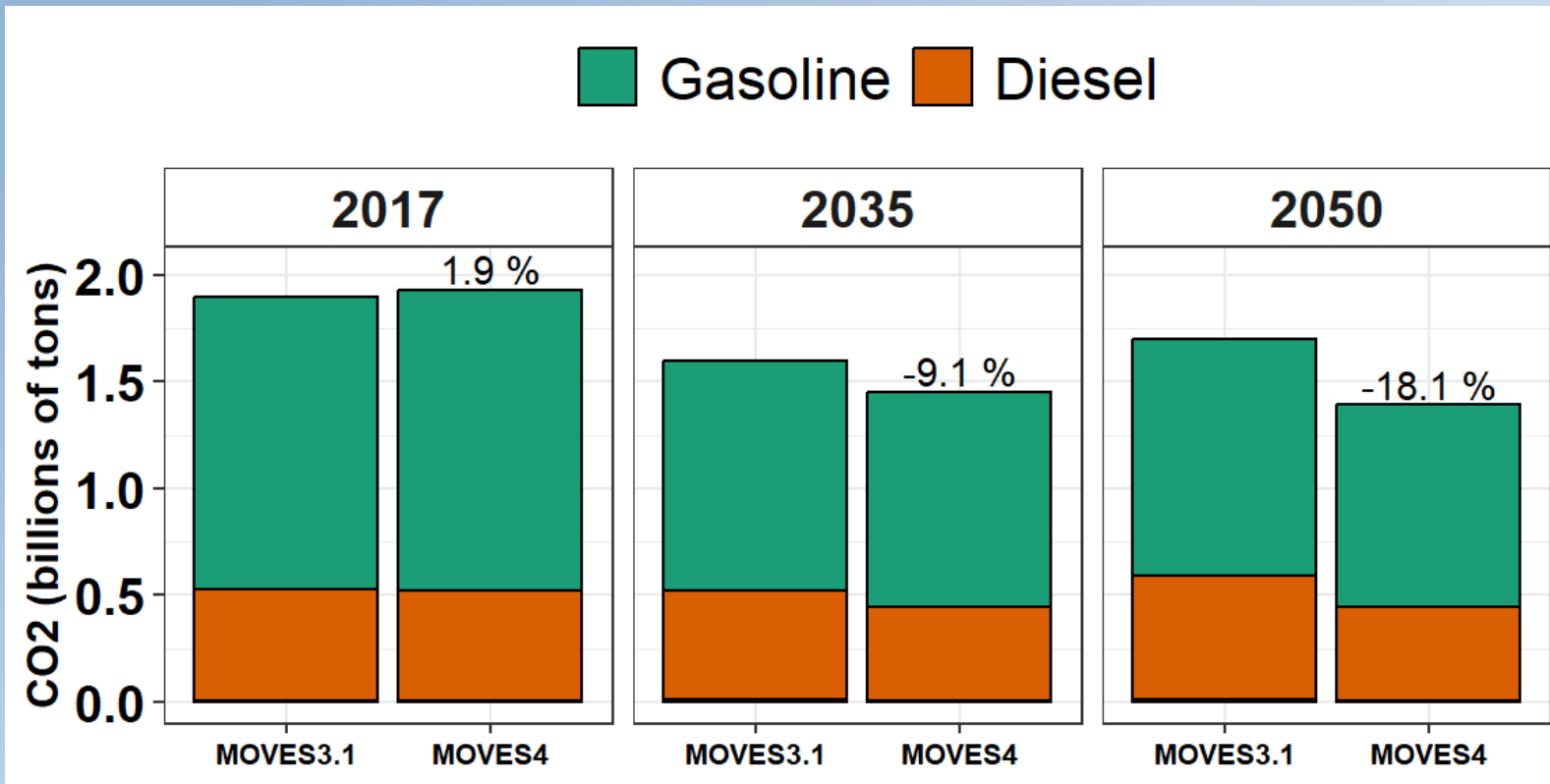
- MOVES4 projects greater CO_2 decreases over time than MOVES3.

- MOVES4 captures changes in fleet mix and activity

- Also phase-in of the Revised Light Duty GHG Standards for 2023 and Later

National Methane

National onroad methane (CH_4) in MOVES4 as compared to MOVES3.1.
Percentage values indicate change between MOVES3.1 and MOVES4.
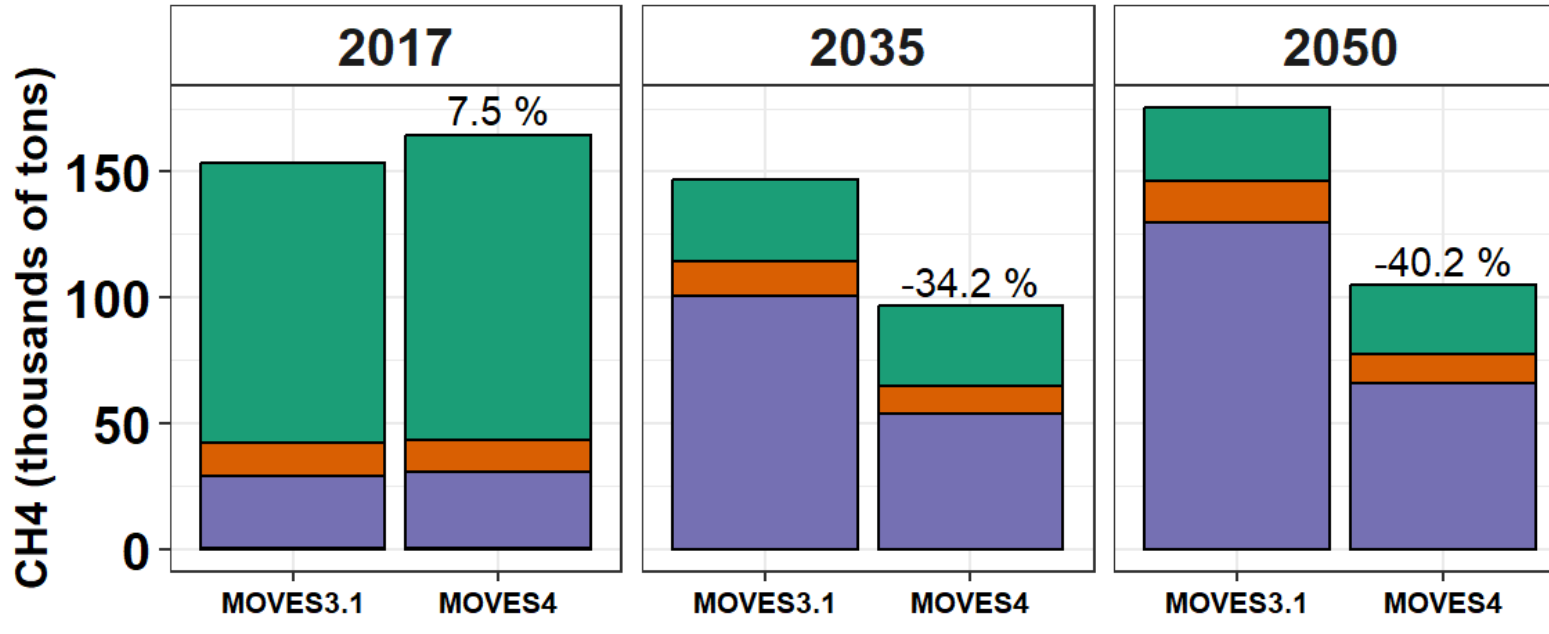
- MOVES4 projects declining CH_4

- Reflects shift from compressed natural gas (CNG) vehicles, which have high methane emissions, to electric vehicles, which have none

National Nitrous Oxide

National onroad nitrous oxide (N$_2$O) in MOVES4 as compared to MOVES3.1.
Percentage values indicate change between MOVES3.1 and MOVES4.

- MOVES4 projects higher N$_2$O

- Reflects incorporation of new real-world data for diesel vehicles

National GHG Totals

National onroad CO_2 equivalent in MOVES4 as compared to MOVES3.1.
Percentage values indicate change between MOVES3.1 and MOVES4.
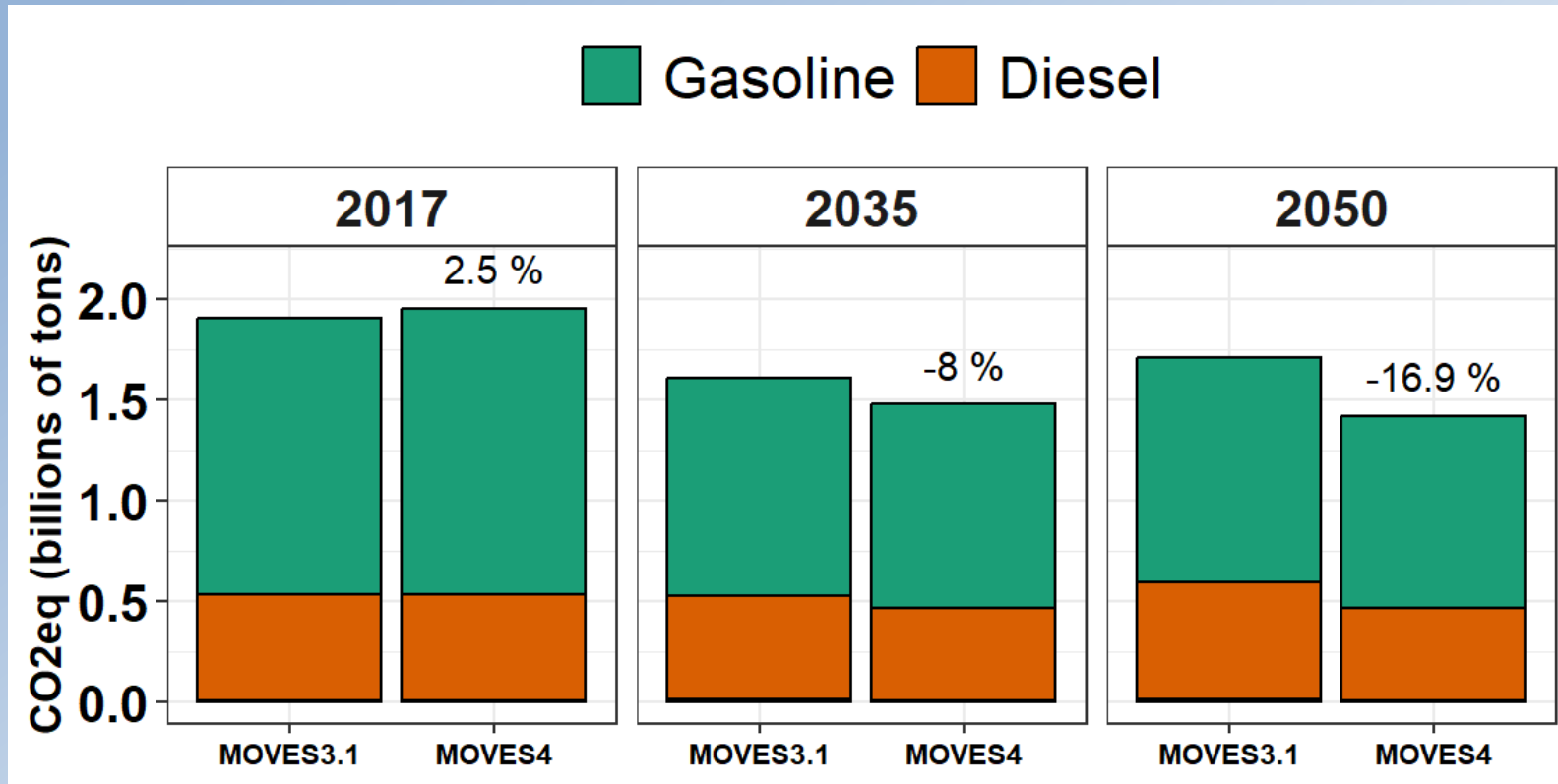
- Graph shows net CO_2 equivalent emissions based on the emissions of CO_2, CH_4 and N_2O weighted by their global warming potentials

- Overall, MOVES4 projects greater GHG decreases over time than MOVES3

- MOVES4 increase in N_2O is outweighed by decreases in CO_2 and CH_4

ONROAD CRITERIA POLLUTANTS & PRECURSORS

National Oxides of Nitrogen
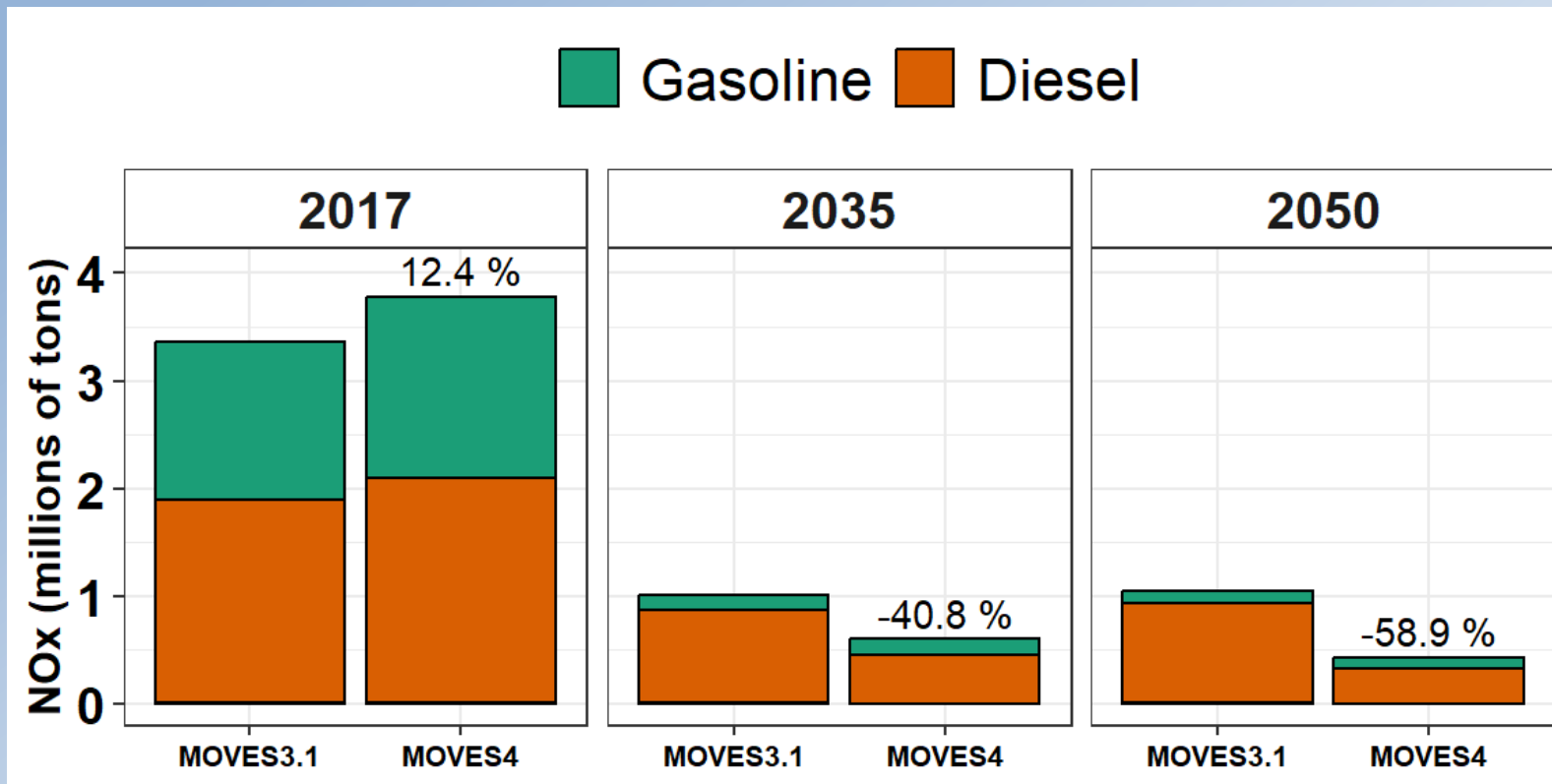
- In both versions, national NO_X emissions decline over time with the phase-in of light-duty and heavy-duty rules.

- MOVES4 shows additional declines due to phase-in of the Heavy-Duty NOx Rule for 2027 and Later (HD2027)

- Also, MOVES4 has growing share of electric vehicles

National onroad NO_X emissions in MOVES4 as compared to MOVES3.1.
Percentage values indicate change between MOVES3.1 and MOVES4.
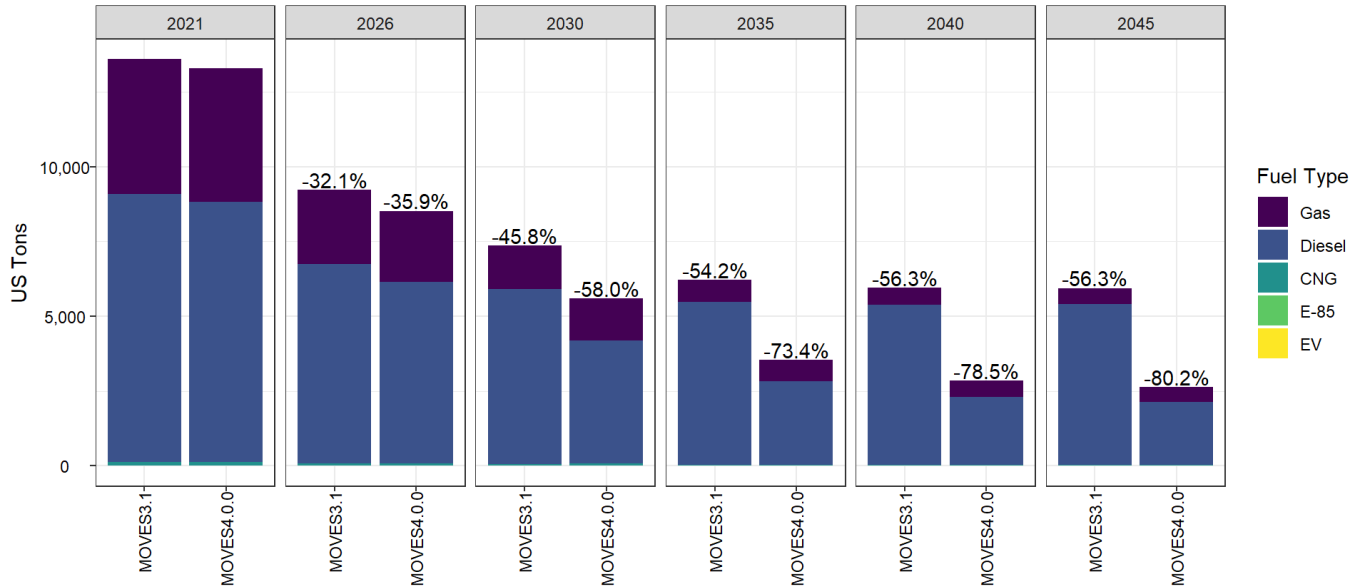
Sample County NO$_x$

- Sample counties use the VMT inputs shown in earlier slide

- Declining gasoline vehicle emissions in both versions reflect the Tier 3 standards for gasoline vehicles and a shift from gasoline to electric vehicles

- Additional diesel reductions in MOVES4 show effect of HD2027 rule, reduced number of gliders, and HD shift from diesel to battery and fuel cell electric vehicles
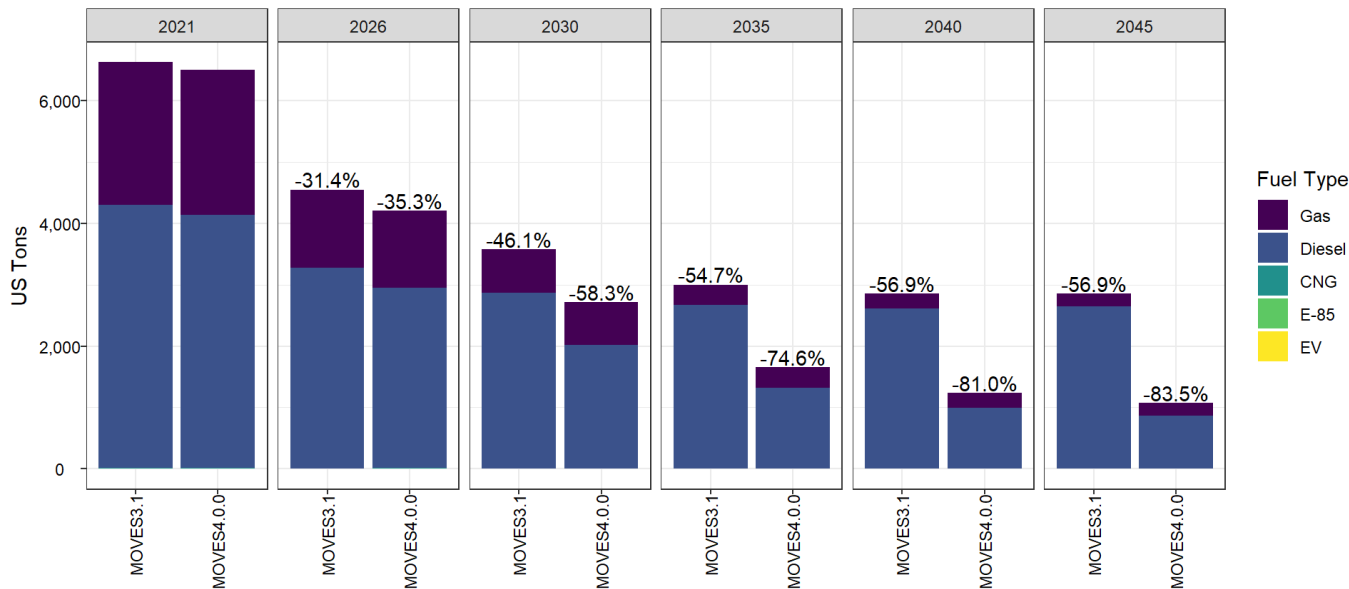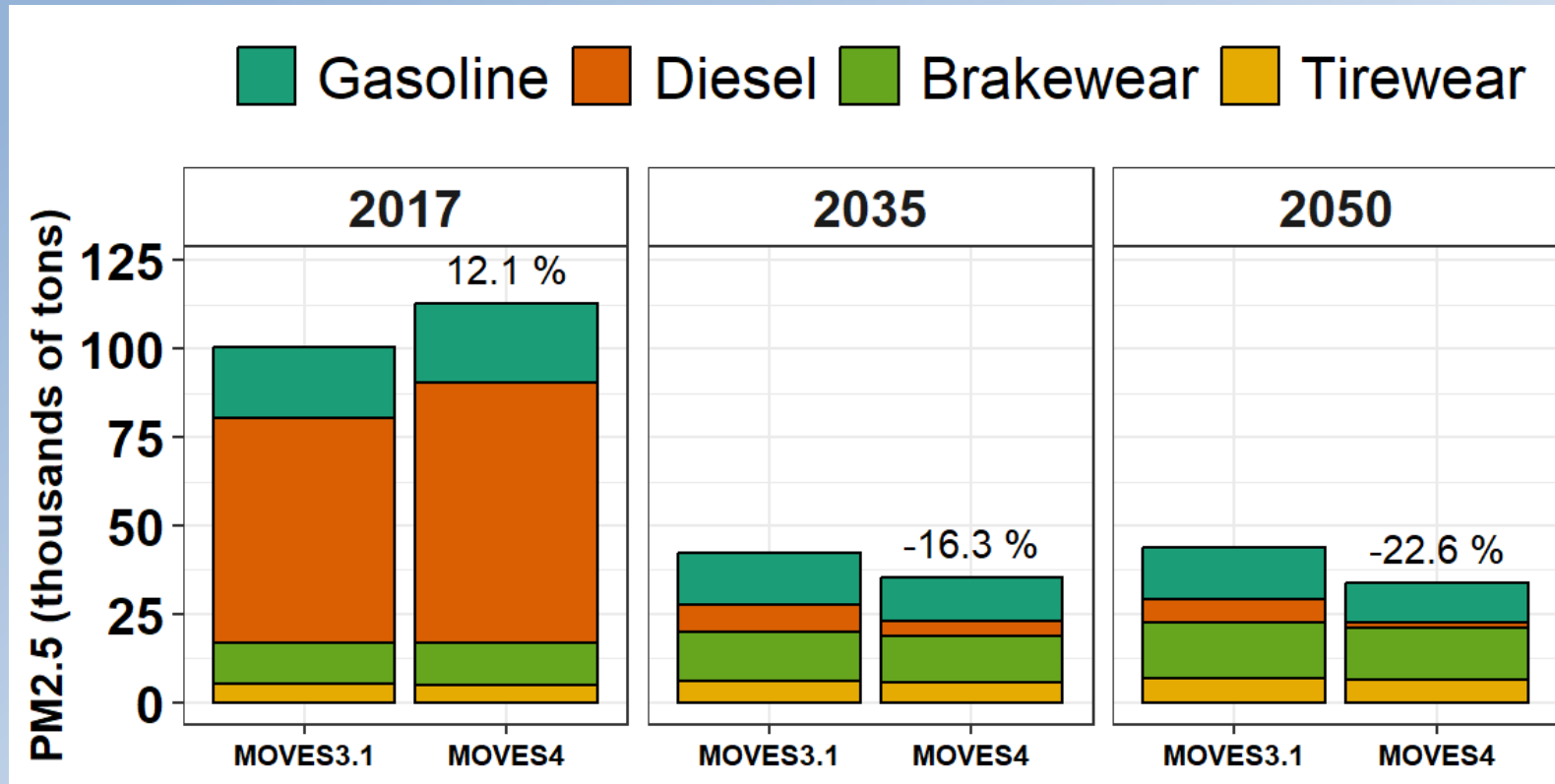
Sample county-specific onroad NOx emissions in MOVES3 and MOVES4. Percentage values indicate change compared to calendar year 2021
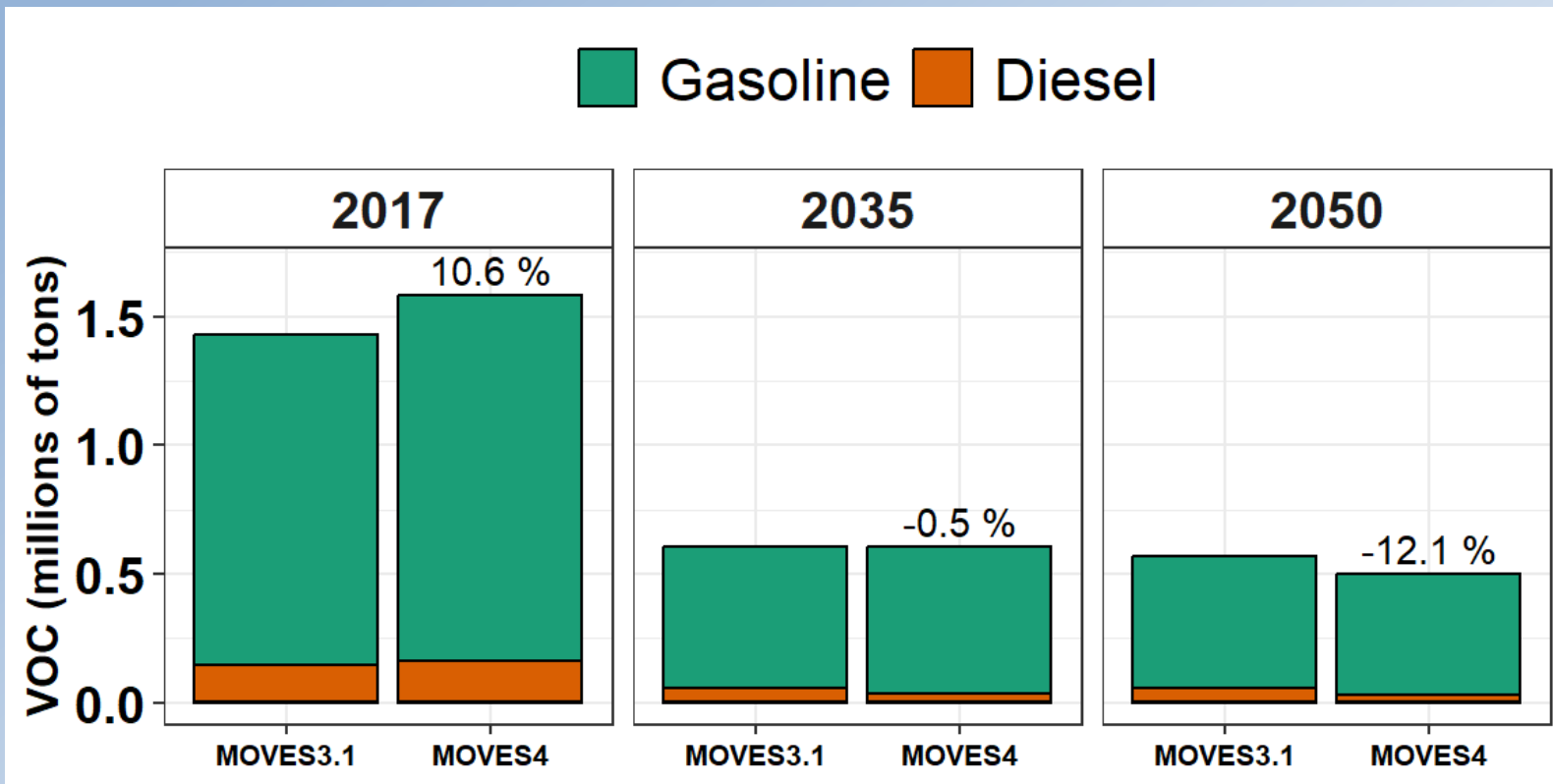
National Particulate Matter

National onroad PM$_{2.5}$ emissions in MOVES4 as compared to MOVES3.1. Percentage values indicate change between MOVES3.1 and MOVES4.

- PM$_{2.5}$ inventory declines with the phase-in of light-duty and heavy-duty PM regulations

- Compared to MOVES3, MOVES4 results in less PM exhaust primarily due to a reduction in the number of glider vehicles and shifts to electric vehicles

- Brake and tire wear emissions are similar in MOVES3 and MOVES4

  - MOVES uses the same brake and tire wear rates for all fuel types

- Sample county trends are similar

National Volatile Organic Compounds

National onroad VOC emissions in MOVES4 as compared to MOVES3.1.
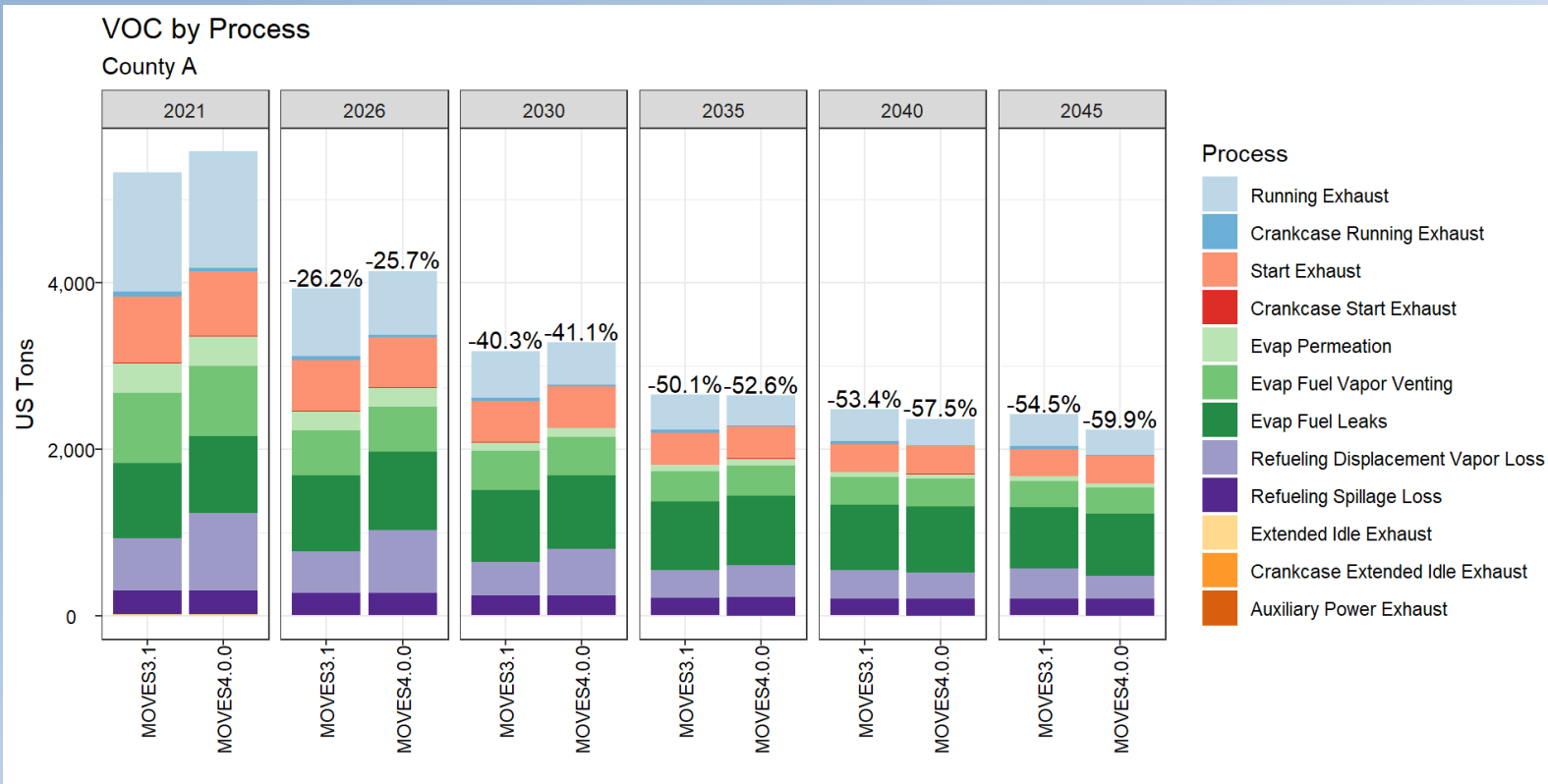Percentage values indicate change between MOVES3.1 and MOVES4.

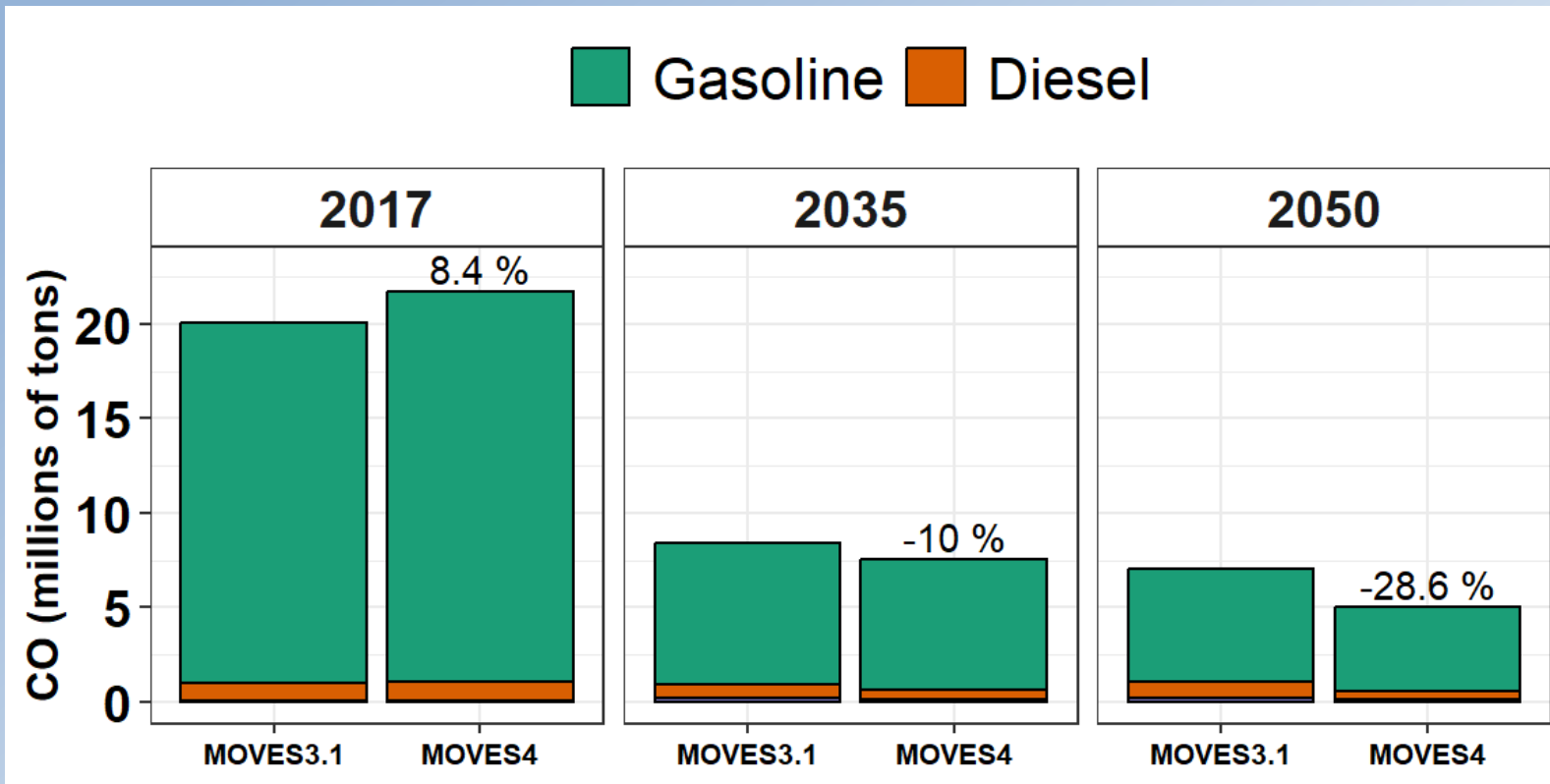- VOC emissions are dominated by gasoline vehicles

- Both models show reductions due to Tier 3 standards

- MOVES4 shows additional reductions from increased fractions of EVs

Sample County VOC

Sample county-specific onroad VOC emissions in MOVES3 and MOVES4, by emission process. Percentage values indicate change compared to calendar year 2021

- This graph shows County A VOC by emission process; County B is similar

- Trends in total VOCs echo the national case

- Detail by process highlights the importance of evaporative emissions (greens and purples)

- Note that MOVES4 initially has higher refueling vapor emissions (lavender)

  – For more information see the July 20 webinar and the MOVES4 Evaporative Emissions technical report

National Carbon Monoxide

National onroad CO emissions in MOVES4 as compared to MOVES3.1. Percentage values indicate change between MOVES3.1 and MOVES4.

- CO emissions are dominated by gasoline vehicles

- Both models show reductions due to Tier 3 standards

- MOVES4 shows additional reductions from
  - Increased fractions of EVs and other fleet mix changes
  - Declines in diesel CO with HD2027 regulations
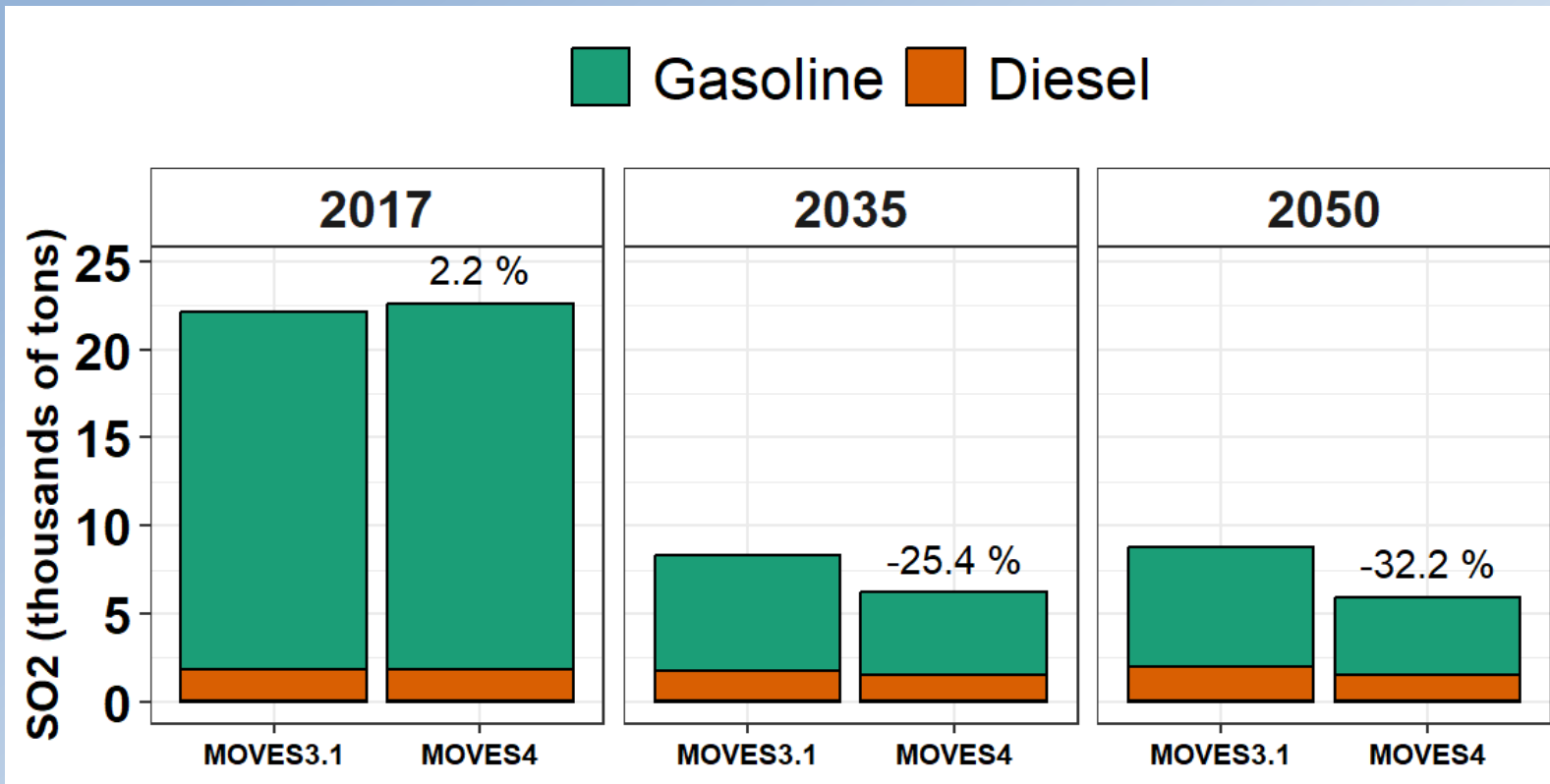
- Sample county trends are similar

National Ammonia
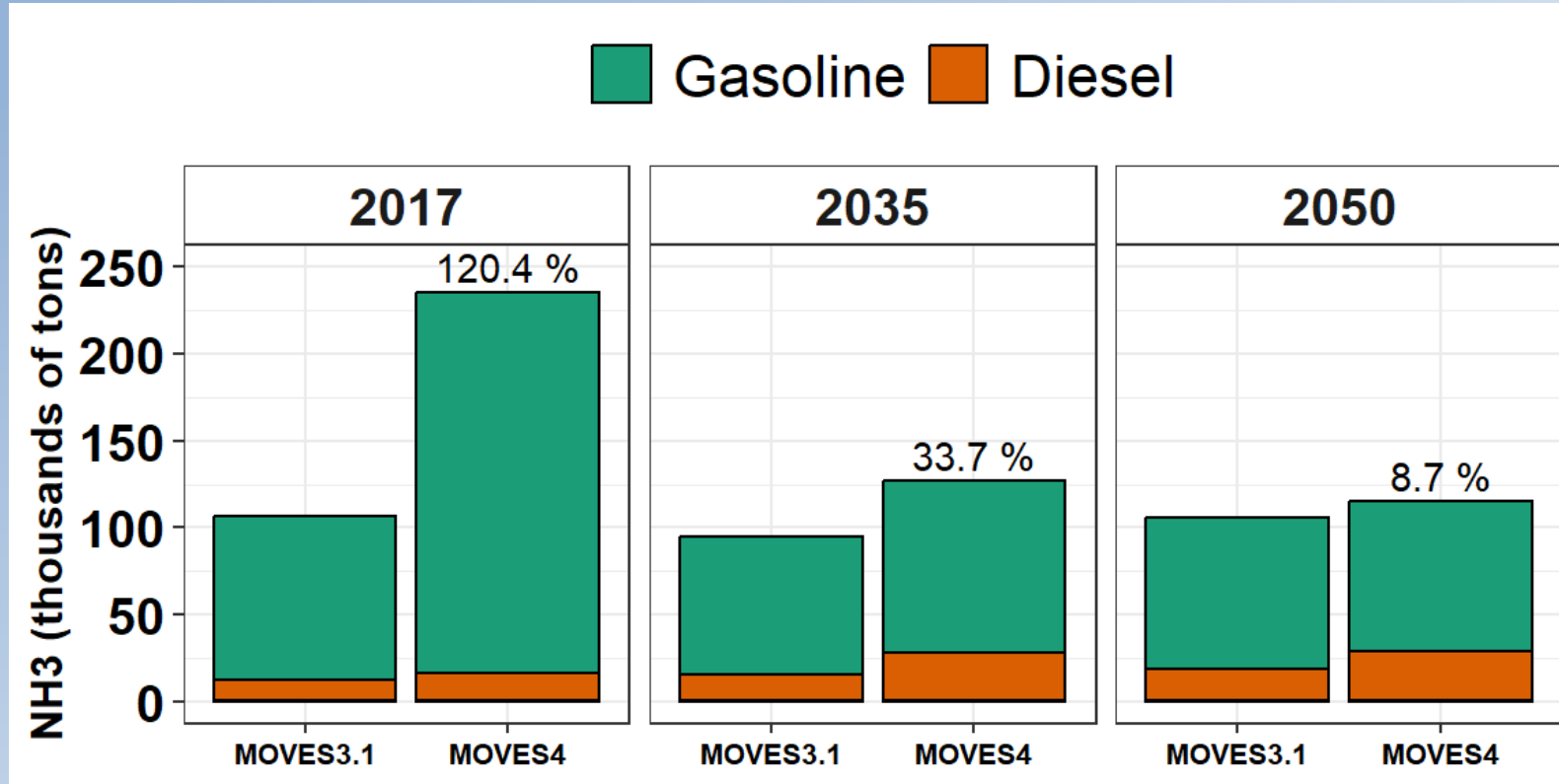
National onroad NH$_3$ emissions in MOVES4 as compared to MOVES3.1.
Percentage values indicate change between MOVES3.1 and MOVES4.

- NH$_3$ emissions are higher in MOVES4

- This change reflects the updated emission rates for gasoline and diesel vehicles in MOVES4 that incorporate new data

- Sample county results show similar increases

- For more information, see the ammonia presentation from the July 20 webinar and the MOVES4 LD and HD technical reports

National Sulfur Dioxide

National onroad SO_2 emissions in MOVES4 as compared to MOVES3.1.
Percentage values indicate change between MOVES3.1 and MOVES4.

- SO_2 emissions are lower in MOVES4

- This reflects MOVES4 updates to gasoline sulfur content as well as lower estimated gasoline consumption

- Sample county trends are similar
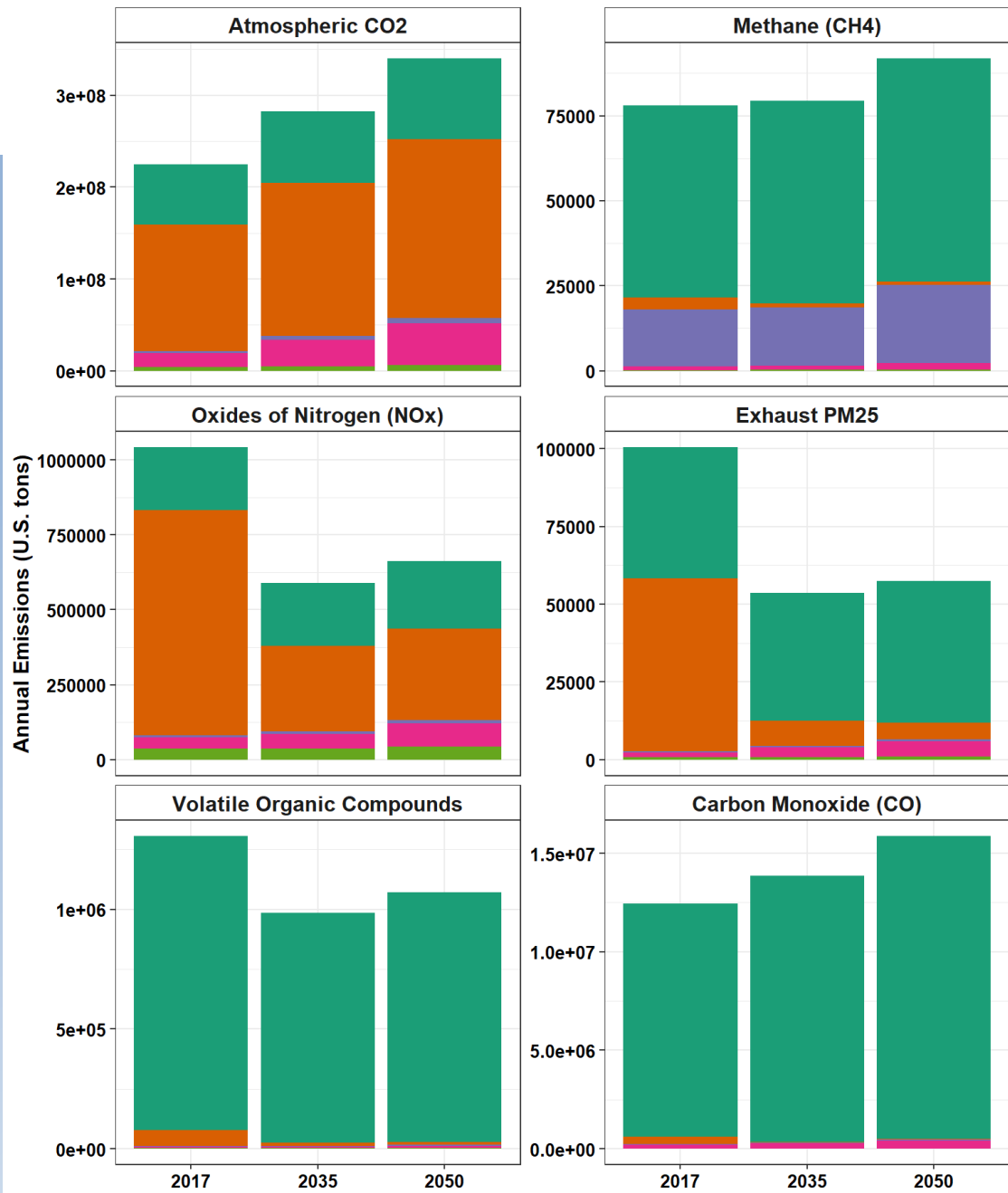
NONROAD EMISSIONS

Nonroad Emissions

- Nonroad-specific inputs have not changed in MOVES4 so most emission results are identical in MOVES3 and MOVES4

- Because nonroad activity varies substantially with season and geography, results for specific times and locations will differ from these national results

Nonroad Sulfur Dioxide
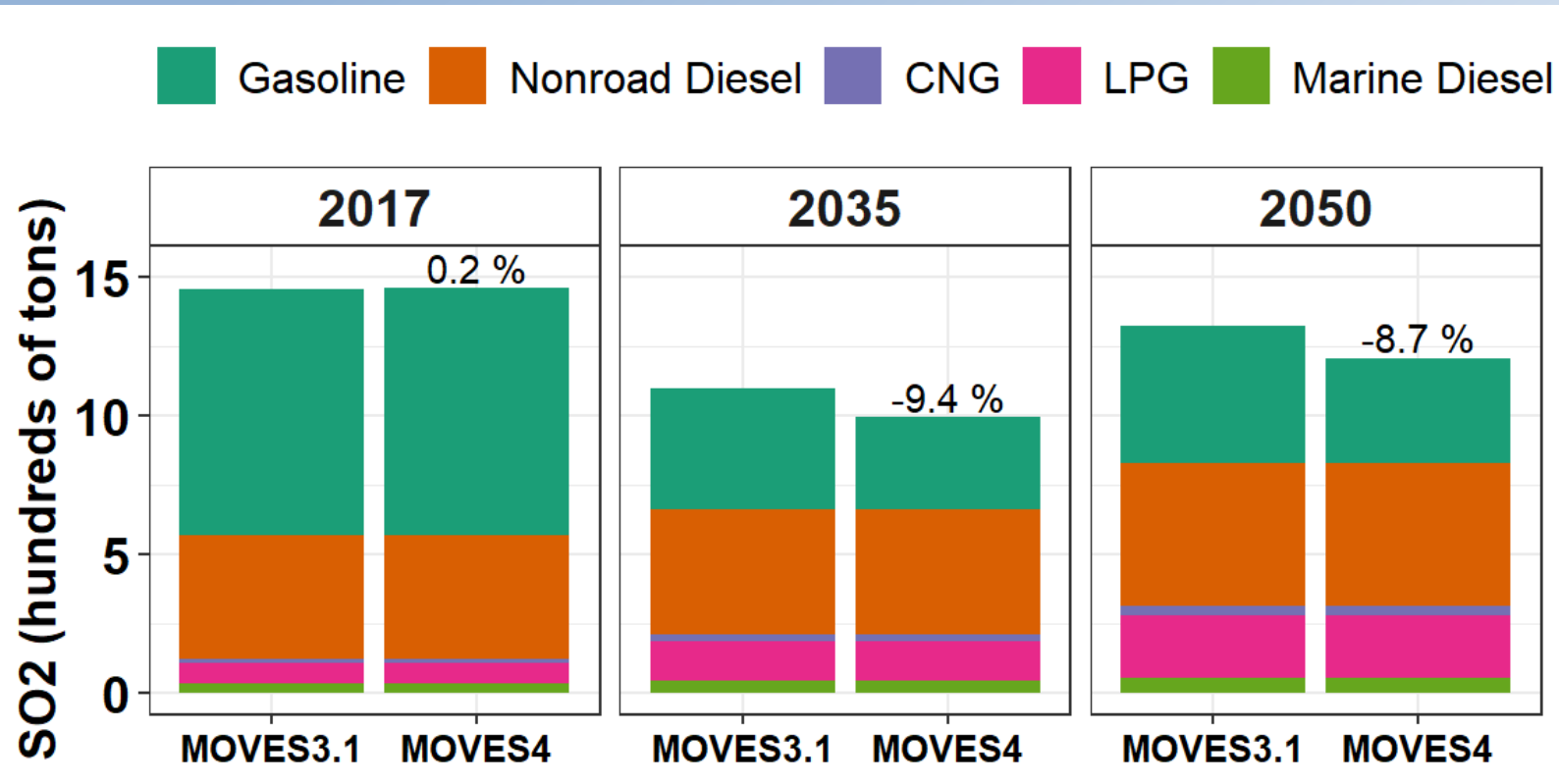
- The one notable nonroad difference for MOVES4 is lower SO_2 emissions

- This is due to MOVES4 updates to gasoline sulfur content

For more comparisons

[Overview of EPA's MOtor Vehicle Emission Simulator (MOVES4)](#)

August 2023

EPA-420-R-23-019

MOVES4 Guidance

MOVES4 Policy Guidance

When to use MOVES4

MOVES4 Policy Guidance: Use of MOVES for State Implementation Plan Development, Transportation Conformity, General Conformity, and Other Purposes (EPA-420-B-23-009)

State Implementation Plans

- MOVES4 must be used to develop new SIPs after its release – there is no grace period

- However, if a state has done significant work on a SIP using MOVES3, it may continue with that model

- In general, incorporating MOVES4 into the SIP now could be useful in some areas; MOVES4 will have to be used for transportation conformity at the end of the grace period

Transportation Conformity

- EPA's September 12, 2023 *Federal Register* notice announces the availability of MOVES4 and establishes a two-year grace period for using MOVES4 for both:

    – regional emissions analyses (unless MOVES4-based SIP budgets become applicable sooner) and

    – project-level conformity $PM_{2.5}$, PM_{10}, and CO hot-spot analyses

- Grace period will end September 12, 2025

- Analyses that are started during the grace period may use either MOVES4 or MOVES3

- Analyses started after the grace period must use MOVES4

Using MOVES4 for Other Purposes

- I/M performance standard modeling
- General conformity
- Greenhouse gas analyses
- Mobile source air toxics analyses
- EPA's National Emissions Inventory (NEI)

- See the MOVES4 Policy Guidance for more information

MOVES4 Technical Guidance

How to use MOVES4 for SIP and transportation conformity analyses

MOVES4 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity (EPA-420-B-23-011)

MOVES4 Technical Guidance

Just like the MOVES3 version, the MOVES4 Technical Guidance provides guidance on

- Developing onroad emission inventories for SIPs and conformity (in states other than California) using the County Scale
  - Section 2, planning an onroad emissions analysis
  - Section 3, creating a Run Specification
  - Section 4, entering local data using the County Data Manager
- Developing nonroad inventories – Section 5
- Includes information on available tools
- Other EPA guidance covers MOVES at the Project Scale (used for hot-spot analyses), using MOVES to model specific control programs (e.g., vehicle and equipment replacements), and using MOVES to estimate GHGs
  - Until updated, existing guidance generally applies to MOVES4

MOVES4 Technical Guidance (cont'd)

- Main changes in MOVES4 guidance compared to previous version:
  - How to document a MOVES run (new section 2.6)
    - Good documentation is necessary to meet requirements for interagency consultation and public review, and serves as a reference for future MOVES runs
  - New guidance for the fuels Alternate Vehicle Fuel and Technology (AVFT) input
    - more next slide
  - How states that have adopted California emission standards, consistent with CAA section 177, can use MOVES to model them (new section 2.5)
    - Using either one of the available MOVES tools, or via updating information in an input database table

MOVES4 Technical Guidance (cont'd)

- AVFT is the input where modelers provide the fraction of vehicles capable of using different fuels/technologies:

  - gasoline, diesel, E-85, compressed natural gas (CNG), battery electric, and fuel cell electric

  - For each source type, these fractions sum to one

- Default information represents the nation as a whole, but these fractions are highly variable by county, e.g., EVs are more prevalent in some areas than others

MOVES4 Technical Guidance (cont'd)

- Guidance:
  - Where available, use local data for this input
  - If not, use EPA's National Emissions Inventory data – see guidance for how to obtain this information
  - When modeling a future year, information from these sources needs to be adapted for that future year, and we have a new tool:

- The AVFT Tool can help modelers create a complete AVFT table based on data available
  - Technical Guidance includes information about what the tool does and how it works
  - AVFT Tool, available within the model, also includes instructions
  - More information in later in this webinar

MOVES4 Tools & Inputs

MOVES4 User Input and Post-Processing Changes

- Overview:
  - Error checking improvements
  - Changes affecting RunSpecs
  - Changes affecting output databases
  - Changes affecting input databases

Error Checking Improvements

- MOVES3 included improved error checking that prevented the model from running if the user input database did not get all green checks

- MOVES4 extends this error checking to runs performed on the command line
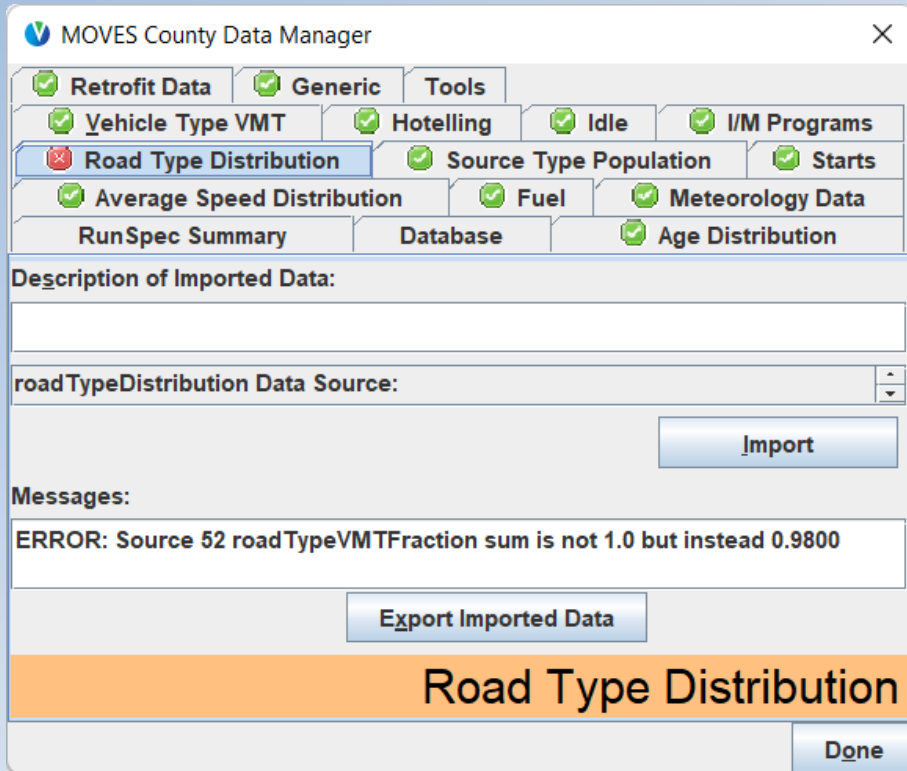

```
ant run -Drunspec=test.mrs
INFO: Done loading system configuration.
INFO: Initializing default database connections...
INFO: Reading default database table definitions...
INFO: Done initializing database connections.
INFO: Performing compatibility checks between RunSpec and domain database...
INFO: Done performing compatibility checks between RunSpec and domain database.
INFO: Performing domain database validation...
ERROR: ERROR: Source 52 roadTypeVMTFraction sum is not 1.0 but instead 0.9800
```

Changes Affecting RunSpecs: Fuel Types

- MOVES4 adds Electricity as a fuel type for all heavy-duty vehicles, as well as CNG long-haul combination trucks

- MOVES requires all relevant fuel types to be selected in the RunSpec

- For your convenience, MOVES4 will add any missing fuel types when loading a MOVES3 RunSpec

MOVES3

Source Use Types:

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

Selections:

- Combination Long-haul Truck - Diesel Fuel
- Combination Short-haul Truck - Compresse...
- Combination Short-haul Truck - Diesel Fuel
- Combination Short-haul Truck - Gasoline
- Motor Home - Compressed Natural Gas (C...
- Motor Home - Diesel Fuel
- Motor Home - Gasoline
- Other Buses - Compressed Natural Gas (C...
- Other Buses - Diesel Fuel
- Other Buses - Gasoline
- Refuse Truck - Compressed Natural Gas (C...
- Refuse Truck - Diesel Fuel
- Refuse Truck - Gasoline
- School Bus - Compressed Natural Gas (CN...
- School Bus - Diesel Fuel
- School Bus - Gasoline
- Single Unit Long-haul Truck - Compressed ..
- Single Unit Long-haul Truck - Diesel Fuel
- Single Unit Long-haul Truck - Gasoline
- Single Unit Short-haul Truck - Compressed ..
- Single Unit Short-haul Truck - Diesel Fuel
- Single Unit Short-haul Truck - Gasoline
- Transit Bus - Compressed Natural Gas (CN...
- Transit Bus - Diesel Fuel
- Transit Bus - Gasoline

Opening a M3 RunSpec in M4

```
WARNING: Added missing vehicle selection: Other Buses - Electricity
WARNING: Added missing vehicle selection: Transit Bus - Electricity
WARNING: Added missing vehicle selection: School Bus - Electricity
WARNING: Added missing vehicle selection: Refuse Truck - Electricity
WARNING: Added missing vehicle selection: Single Unit Short-haul Truck - Electricity
WARNING: Added missing vehicle selection: Single Unit Long-haul Truck - Electricity
WARNING: Added missing vehicle selection: Motor Home - Electricity
WARNING: Added missing vehicle selection: Combination Short-haul Truck - Electricity
WARNING: Added missing vehicle selection: Combination Long-haul Truck - Compressed Natural Gas (CNG)
WARNING: Added missing vehicle selection: Combination Long-haul Truck - Electricity
```

MOVES4

Source Use Types:

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

Selections:

- Combination Long-haul Truck - Compresse...
- Combination Long-haul Truck - Diesel Fuel
- Combination Long-haul Truck - Electricity
- Combination Short-haul Truck - Compresse...
- Combination Short-haul Truck - Diesel Fuel
- Combination Short-haul Truck - Electricity
- Combination Short-haul Truck - Gasoline
- Motor Home - Compressed Natural Gas (C...
- Motor Home - Diesel Fuel
- Motor Home - Electricity
- Motor Home - Gasoline
- Other Buses - Compressed Natural Gas (C...
- Other Buses - Diesel Fuel
- Other Buses - Electricity
- Other Buses - Gasoline
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- Single Unit Long-haul Truck - Electricity
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- Single Unit Short-haul Truck - Diesel Fuel
- Single Unit Short-haul Truck - Electricity
- Single Unit Short-haul Truck - Gasoline
- Transit Bus - Compressed Natural Gas (CN...
- Transit Bus - Diesel Fuel
- Transit Bus - Electricity
- Transit Bus - Gasoline

Changes Affecting RunSpecs: Pollutants

- MOVES4 does not model chemical mechanism species, but adds NonHAPTOGMechanism as a selectable pollutant, intended to be used with the Speciation Profile Scripts tool

- RunSpecs created with older versions of MOVES3 that include chemical mechanisms will not work with MOVES4. For this reason, MOVES4 will provide a warning message if you load a MOVES3 RunSpec

RunSpec Version Message ✕

⚠ Warning: The loaded RunSpec was created with MOVES3, which may not be compatible with this version of MOVES. To avoid compatibility issues, you may need to recreate this RunSpec using this version of MOVES. If you need a reference for the selections made in this RunSpec, you can use the File > Print... feature.

OK

- If you are not using the chemical mechanisms feature, you may safely re-save your MOVES3 RunSpec with MOVES4 to include any missing fuel types and prevent this warning message in the future
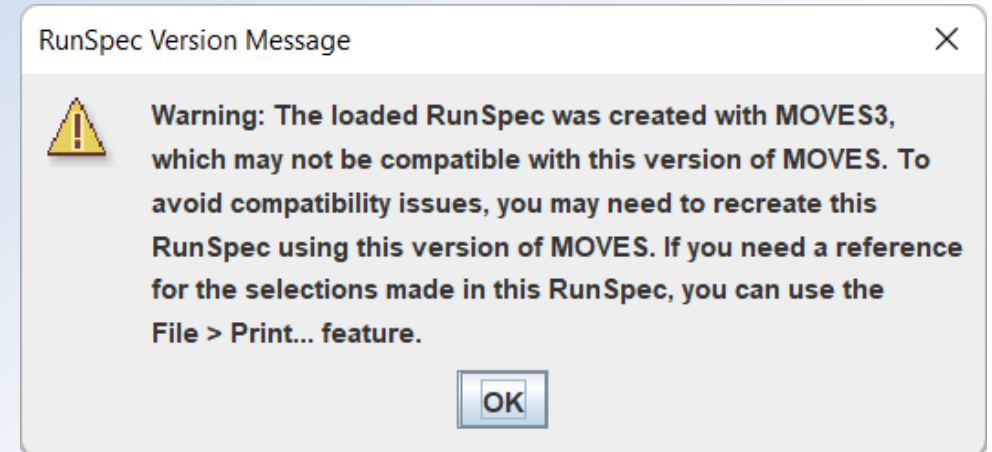
Changes Affecting Output Databases: Process Selection

- With the addition of shore power (plug in) as a hotelling operating mode, the "Auxiliary Power Exhaust" column has been renamed "Other Hotelling Exhaust"

- MOVES will calculate results for both APU and shore power with this option selected

Pollutants and Processes

Pollutant	Running Exhaust	Crankcase Running Exhaust	Brakewear	Tirewear	Start Exhaust	Crankcase Start Exhaust	Extended Idle Exhaust	Crankcase Extended Idle Exhaust	Other Hotelling Exhaust	Evap Permeation	Evap Fuel Vapor Venting	Evap Fuel Leaks	Refueling Displacement Vapor Loss	Refueling Spillage Loss
Total Gaseous Hydrocarbons	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Non-Methane Hydrocarbons	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Non-Methane Organic Gases	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Total Organic Gases	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
Volatile Organic Compounds	☐	☐			☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

- Note that this change does not have a corresponding change in the RunSpec

- MOVES will automatically calculate shore power energy demand if Auxiliary Power Exhaust is selected in the RunSpec

Changes Affecting Output Databases: Definition Tables

- MOVES4 output databases now include definition tables for all numeric "ID" fields for post-processing convenience

- All definition tables are named with "translate_" as a prefix
  - The *activitytype* table in MOVES3 output databases is now named *translate_activitytype* in MOVES4 output databases
  - Any custom post-processing scripts that refer to the old table name will need to be updated

Changes Affecting Input Databases
AVFT

- AVFT (Alternate Vehicle Fuel and Technology) is a required table at County Scale and Project Scale, and is used to specify fuel type distributions by source type and model year

  - For HD EVs, this includes the split between battery electric (BEV) and fuel cell electric (FCEV)

- All supported source type / fuel type combinations must be present in this table

- Therefore, MOVES4 requires rows for HD BEV and FCEV, and CNG long-haul combination trucks (62s)

- The AVFT Tool can help prepare this input

Changes Affecting Input Databases
HotellingActivityDistribution

- This is an optional table at all scales and allows users to specify long-haul combination truck hotelling operating modes by model year

- MOVES4 adds *fuelTypeID* so that CNG and EV trucks can be modeled with different operating modes

- Operating mode definitions have changed slightly:
  - 203 = Shore power (plug in)
  - 204 = Battery or Off

Changes Affecting Input Databases
ZoneMonthHour

- This is a required table at County Scale and Project Scale, and is used to specify meteorological conditions

- The user input columns are *temperature* and *relHumidity*

- No changes to user input columns, but MOVES4 changes the schema to remove unused columns and adds a computed column

    - The computed columns in this table are *heatIndex, specificHumidity,* and *molWaterFraction*

MOVES4 Tools

- Overview:
  - Database Converter
  - AVFT Tool
  - Speciation Profile Scripts

- No changes to other tools

Tools	Settings	Help
Multiple RunSpec Creator		
Process DONE Files		
Convert MOVES3 Input Database to MOVES4		
AVFT Tool		
Build NLEV Input Database		
Build LEV Input Database		
ONI Tool		
Speciation Profile Scripts		

Database Converter Overview

- This tool is used to convert MOVES3 input databases to be compatible with MOVES4

- When running MOVES for regulatory purposes, the latest local information should be used wherever possible. This tool should only be used when the input databases developed for MOVES3 still contain the latest local information

  - If you have newer data, create a new input database using MOVES4

- To access the tool, select "Convert MOVES3 Input Database to MOVES4" from the Tools menu

  - Alternatively, a command line version of this tool is also available

- See the Technical Guidance (§1.5) and the built-in help document for more information

- Note that if you open a RunSpec that points to a MOVES3 input database, you will receive error message popups. This tool can help resolve those error messages

Database Converter Use

- To use:
  - Specify the database to be converted as the "Input Database"
  - Specify the new database name
  - Click "Convert Database"

- The tool will fix the schema changes for *HotellingActivityDistribution* and *ZoneMonthHour* in the new database
  - If hotelling data is provided, the tool will assign the diesel fuel type to all transferred data and add default values for CNG and EV

Database Converter Additional Steps

- Additional steps are necessary after running the tool:
  - Fuels data are not converted by the tool
    - Export the defaults, review them, and make any changes as necessary to the *AVFT*, *FuelSupply*, and *FuelUsageFraction* tables before reimporting them
    - Use the Fuels Wizard to make any changes to fuel formulation parameters
    - The AVFT Tool can help with developing inputs for the AVFT table
  - Age Distributions
    - The tool carries over all age distribution data
    - However, if the inputs in your table were based on previous model defaults for some source types, those data should be discarded and the updated MOVES4 defaults (for those source types only) should be used instead

Database Converter Additional Steps

- I/M Programs

  - The tool carries over all *IMCoverage* data

  - However, if the inputs in your table were based on previous model defaults, those data should be discarded and the MOVES4 defaults should be used instead. Remember to review and make any necessary changes to the default data before reimporting

- Hotelling

  - If local hotelling activity distribution data are available for CNG and EV, export the imported data for this table, review and make any necessary changes, and then reimport this table

AVFT Tool

- The AVFT table is used to specify fuel type distributions:

  - For each source type, the fraction of vehicles designed to run on gasoline, diesel, E-85, CNG, battery electric, fuel cell electric; sums to 1

- These distributions are needed for the analysis year chosen in the RunSpec, which could be a future year

- These distributions are also needed for the 30 years preceding the analysis year, because MOVES considers vehicle ages

  - MOVES uses a 30-year age distribution

- However, information available for this input:

  - Will be historical (even if "current") and will need to be projected into the future

  - May also not be complete – it may have gaps

AVFT Tool

- This tool is useful for:
  - Projecting future fuel type distributions from local historic data (typically vehicle registration data) and projected national trends
  - Gap-filling local historic fuel type distribution data
  - Combining local data for some source types with default data for other source types
- Local historic data should be formatted like the AVFT table to use as input for the AVFT Tool

AVFT Tool

- The last complete model year forms the baseline for future projections
  - Partial model years are common in vehicle registration data
  - E.g., data pulled on July 1, 2023 would have a partial view of the MY2023 and MY2024 cohorts; MY2022 would be the last complete model year

AVFT Tool

- The analysis year is the calendar year to be modeled, i.e., the year chosen in the RunSpec
  - The tool will project fuel type distributions for all model years between the baseline and the analysis year

AVFT Tool

- Gap-filling method:
  - If there are gaps in the input data, the tool will fill them to avoid getting errors when using the results of the tool
  - <u>Fill with 0s</u>: Provides all missing key combinations with a value of 0

  E.g., if no rows for CNG because they don't exist locally

  - <u>Use defaults and renormalize</u>: Fills any missing key combinations with national default values and proportionally reduces user-provided values so that the distributions sum to 1 for each model year

  E.g., if missing model years or no rows for HD EV because the data were collected for MOVES3, which couldn't model them

AVFT Tool

- Projection method:
  - <u>Proportional</u>: Projects distributions based on proportional differences between the local and the national distributions
  - <u>National Average</u>: Applies the national default fuel type distributions
  - <u>Known Fractions</u>: Allows you to provide known fractions for specific fuel types, and use the proportional method for other fuel types
  - <u>Constant</u>: Applies the distributions for the last complete model year as-is for all projected model years

  See the <u>Technical Guidance</u> and <u>Population & Activity technical report</u> for more details

AVFT Tool

- The output of the AVFT Tool is an Excel file, containing the resulting AVFT table and plots of each source type's fuel type distributions

- The plots are not needed by MOVES, but can be useful to ensure the results of the tool appear reasonable

- Example tool output:
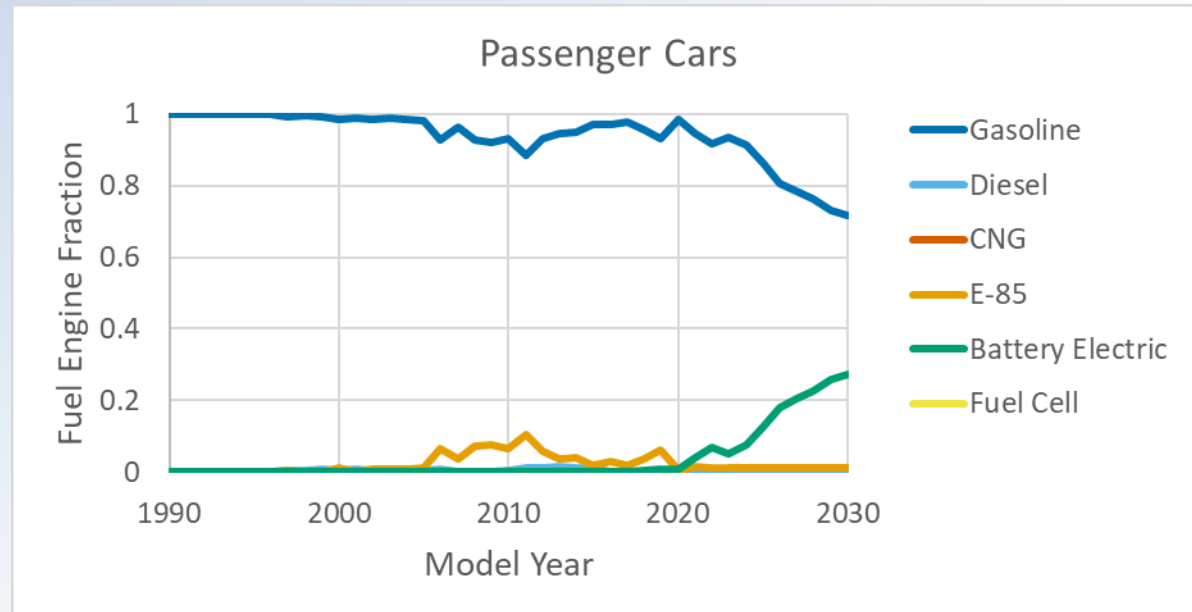
Speciation Profile Scripts

- This tool is used to calculate profile weights used to speciate residual total organic gases, particulate matter, total organic matter, and residual particulate matter

- This is useful if you need to convert these emissions into chemical mechanism species for use in air quality models

Speciation Profile Scripts

- This tool supports two sets of speciation profiles:
  - "Non-volatility resolved" is consistent with chemical mechanisms supported in previous versions of MOVES, such as CB5 and CB6.
  - "Reactive Organic Carbon" provides updated speciation profiles and a ratio that can be used to calculate Condensable and Gaseous Reactive Organic Carbon (CROC and GROC, respectively)

Speciation Profile Scripts

- To use this tool, MOVES must be run with the following selections:
  - Pollutants: NONHAPTOG, nonSO4nonECnonOM, and TOM
  - Output detail: SCC, model year, and regulatory class
  - Multiple runs may be used, but only a single calendar year may be present in the output database

- The output of the tool includes tables of residual TOG, residual PM, and TOM emissions (as well as CROC/GROC ratios if applicable) to be speciated with the given profile

Wrap Up

- MOVES instructions are embedded in the model
- Slides from this webinar will be posted on the MOVES website, https://www.epa.gov/moves

  - Also see the website for detailed guidance, documentation, and training information

  - Additional documentation is available at https://github.com/USEPA/EPA_MOVES_Model/tree/master/docs

- Subscribe to our listserv for MOVES updates
- Thank you for attending this webinar!

QUESTIONS?