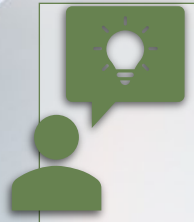
MOVES5 Review: Changes in Electric Vehicle Modeling, Emission Rates, Inputs, and Implications on Air Quality Planning

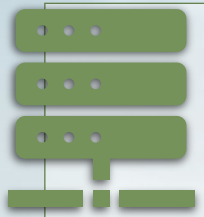
December 2024 Technical Working Group Quarterly Meeting

Texas A&M Transportation Institute

MOVES5 Release

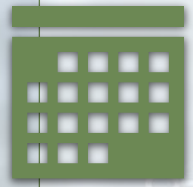


EPA released the latest version of MOVES (MOVES5) on November 21st, 2024, for use in SIPs and transportation conformity.

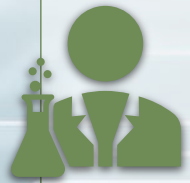


All states, other than California, should use MOVES5 for future SIPs.

- Federal Register notice will be issued shortly to establish a (two-year) grace period for transportation conformity purposes (regional and project level)



TTI was involved in MOVES5 beta testing and MOVES5 release candidate testing prior to its official release.



Structurally, MOVES5 is similar to MOVES4. However, the emission rates and activity included in MOVES5 were updated.

MOVES Version History

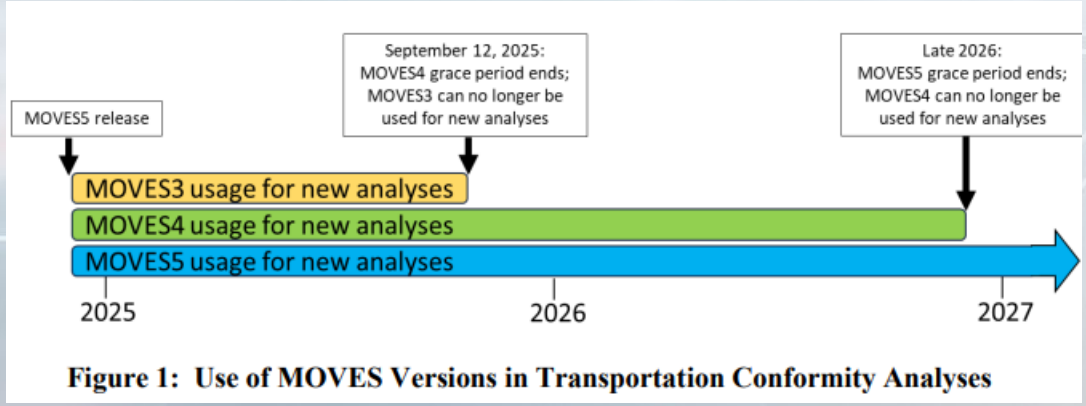


Figure 1: Use of MOVES Versions in Transportation Conformity Analyses

Source: MOVES5 Policy Guidance

MOVES5 Updates

MOVES5 Major Updates (To be Discussed in this Presentation)

New Regulations

- EPA's Light-and Medium-Duty Multi-Pollutant Rule
- EPA's Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles—Phase 3

New Features

- Vehicles up to 40 years old, instead of 30
  - 41 model years (vehicle ages 0 through 40+)

MOVES5 Major Updates (Not Discussed in this Presentation)

Updates to Emission Rates

- MOVES5 incorporates new data on brake wear from light- and heavy-duty vehicles and new data on ammonia emissions from CNG vehicles

Updates to Fuel Characteristics, Vehicle Populations and Activity

- 2020 Fuels Regulatory Streamlining rule

Updates to User Interface and User Inputs

- Age Distribution Projection Tool
- AADVMT Converter Tool
- Conversion tools

Updated MOVES5 Defaults

Regulatory Updates to MOVES5

- Higher projected electric vehicle (EV) fractions
- More stringent standards for carbon dioxide (CO_2), particulate matter (PM), non-methane organic gases (NMOG) and oxides of nitrogen (NO_X)

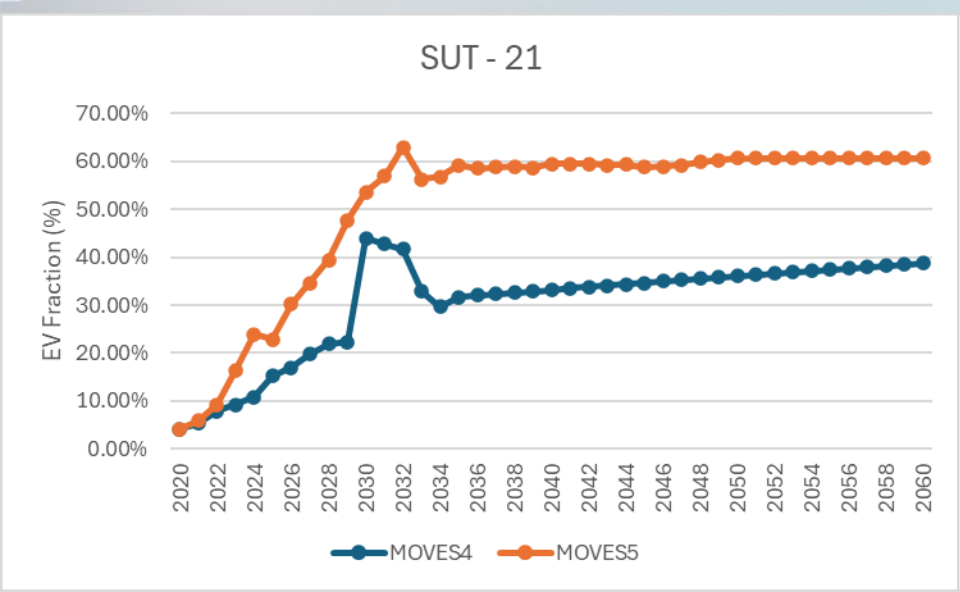
EPA's Light-and Medium-Duty Multi-Pollutant Rule

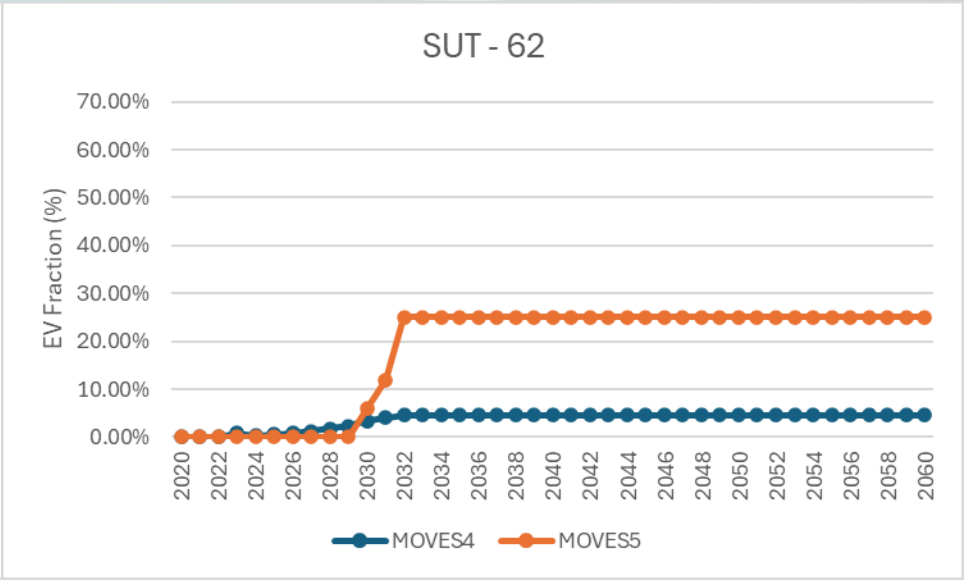
- Higher projected fractions for zero-emission vehicles
- Updated energy consumption estimates for heavy-duty vehicles

EPA's Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles—Phase 3

Default EV Activity between MOVES5 and MOVES4

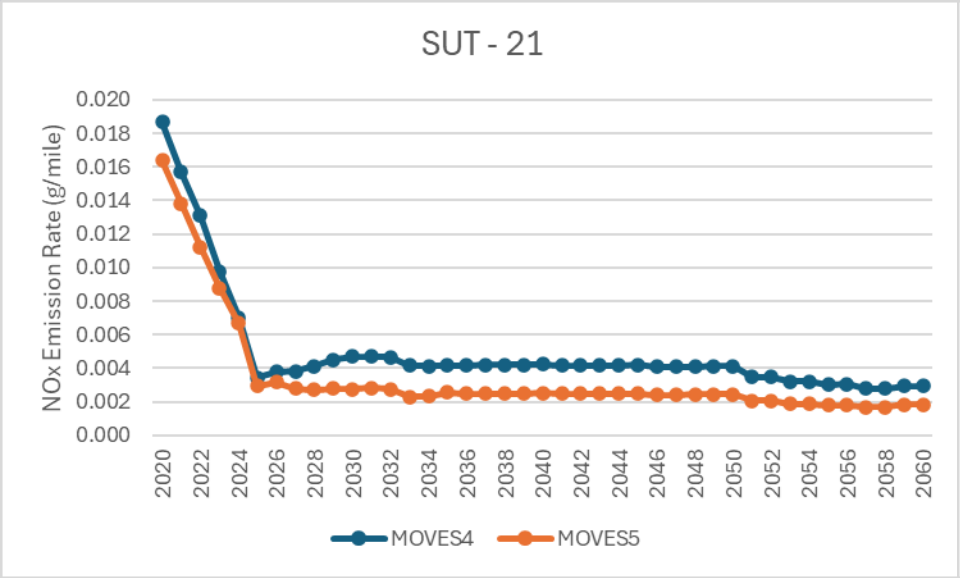
EV Population Fraction of Overall Vehicles, Passenger Car (21) and Combination Long-Haul Truck (62)

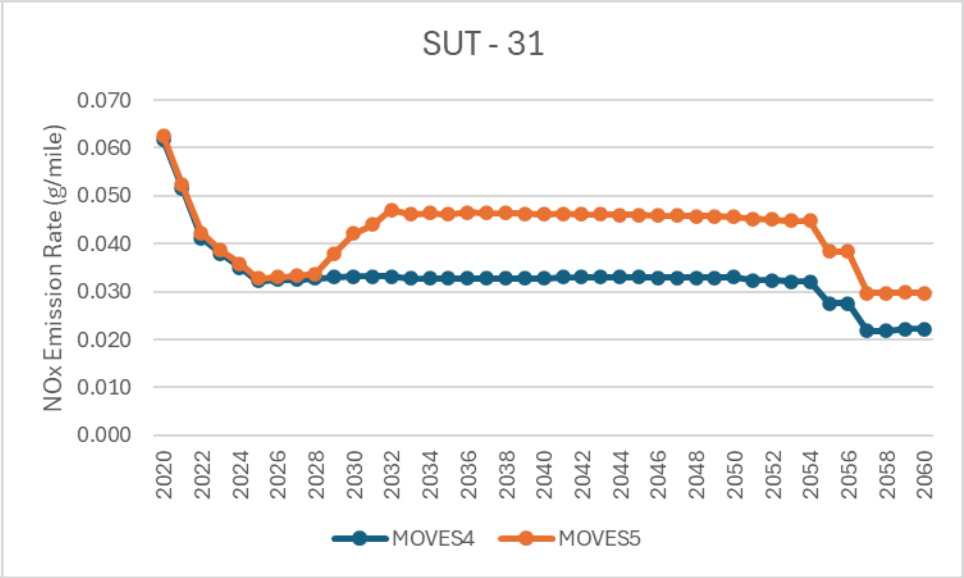




Light/Medium-Duty NOx Rate Comparison between MOVES4 and MOVES5

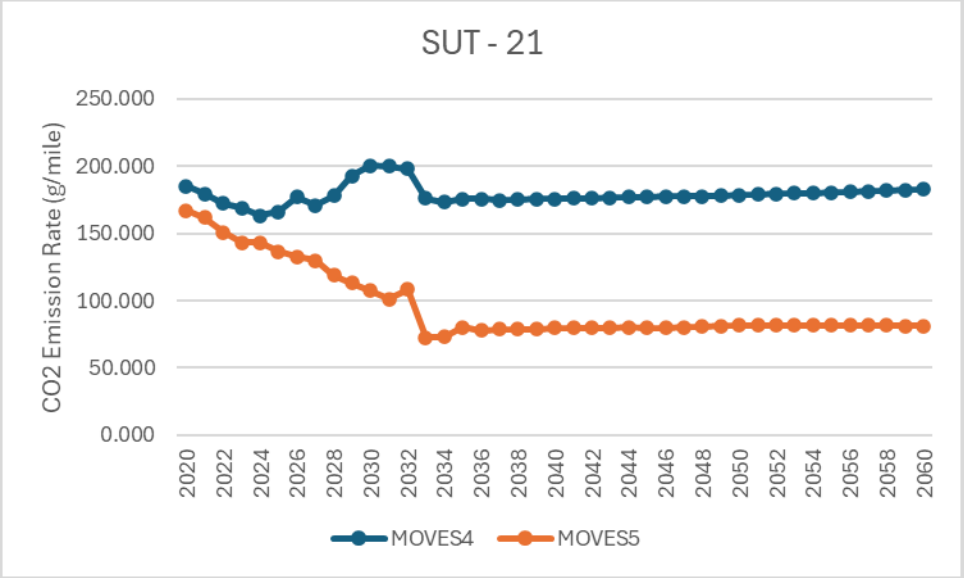
Light/Medium-duty Vehicle NOx Rate for Passenger Car (21) and Passenger Truck (31)

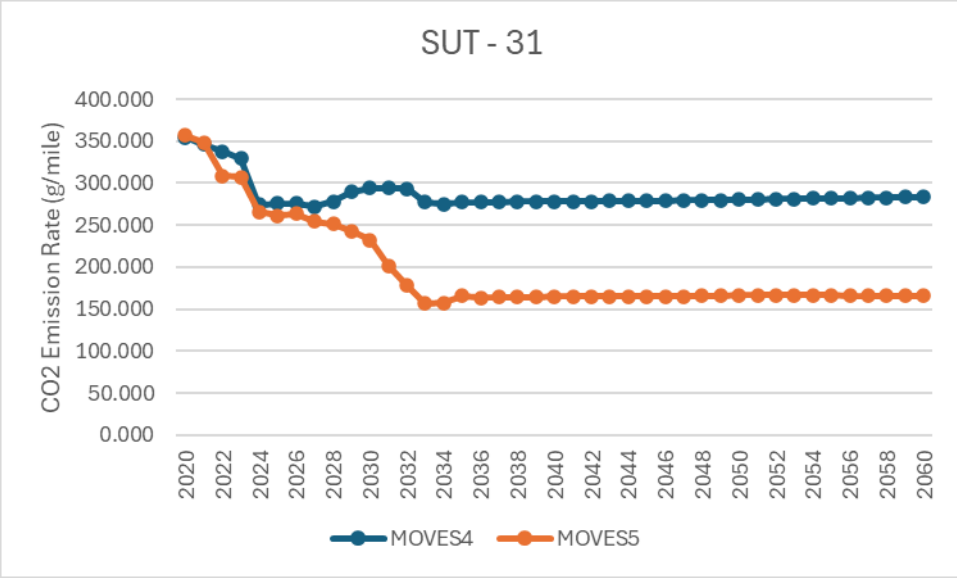




Light/Medium-Duty CO2 Rate Comparison between MOVES4 and MOVES5

Light/Medium-duty Vehicle CO_2 Rate for Passenger Car (21) and Passenger Truck (31)

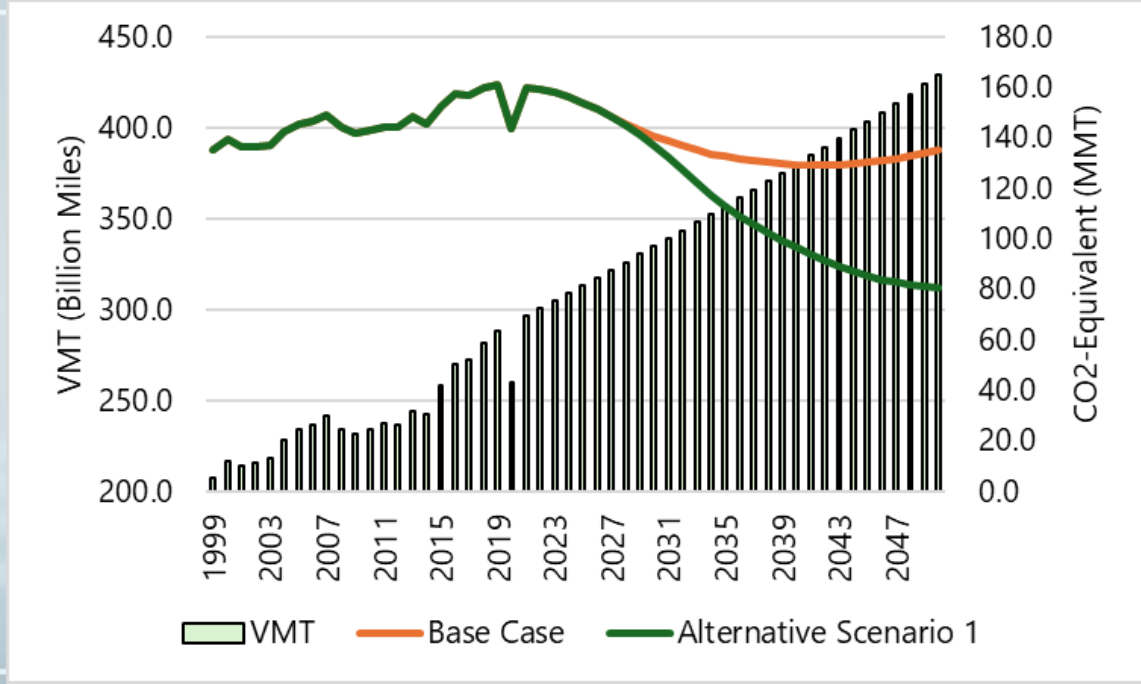




Impacts of Regulatory Updates to CO_2 Emissions

- Base Case – MOVES4 defaults
- Alternative Scenario 1 – MOVES4 defaults with adjusted emission rates for:
  - Light-and Medium-Duty Multi-Pollutant Rule,
  - Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles—Phase 3

*Results were developed on MOVES4 in September 2024.



Discussion - Update on Vehicle Age Distribution

Local Input Changes in MOVES5- Age Distribution

MOVES CDB Input: *sourcetypeagedistribution* table:

MOVES4

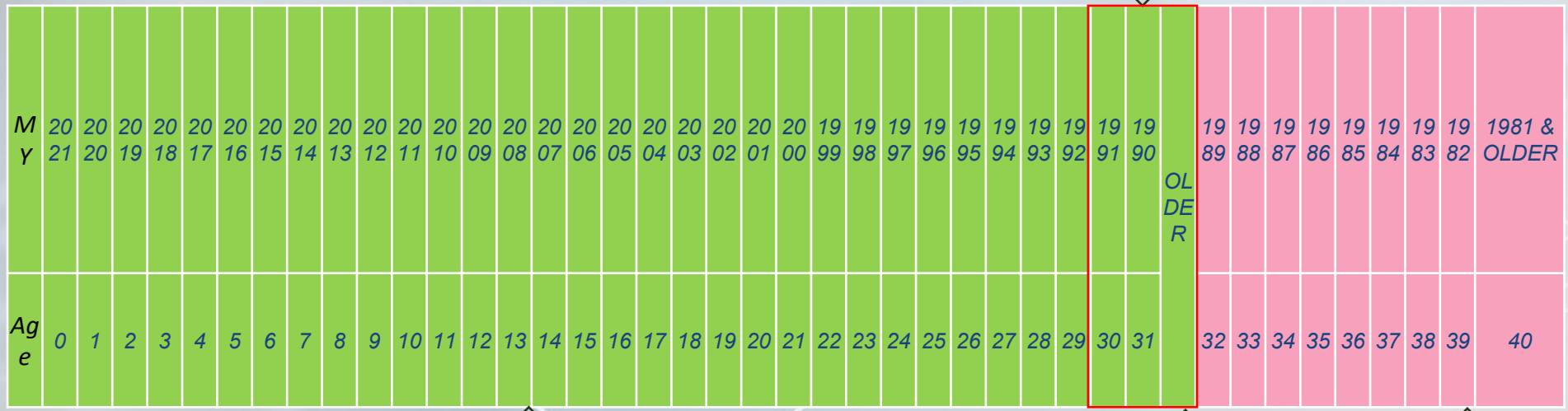
- ages 0- 30, years 1990, 1999- 2060
- MOVES4 and earlier versions of the model calculate emissions for 31 model years in any individual calendar year analysis (vehicle ages 0 through 30+).
- Vehicles older than 30 years are assigned characteristics of age 30 vehicles.

MOVES5

- ages 0- 40, years 1990, 1999- 2060
- MOVES5 calculates emissions for 41 model years (vehicle ages 0 through 40+).
- This better quantifies emissions from vehicles in the 31-40 age range and allows pre-OBD vehicles and pre-OBD I/M tests to be modeled.
- Vehicles older than 40 years are assigned characteristics of age 40 vehicles. (This is a much smaller number of vehicles and VMT.)

Next Step- Local Age Distribution

Model years not distinguished in MVS4, will be used in MVS5
Vehicle counts added to 1991 previously



2021 Registration Data
Unchanged ageFraction mvs4/mvs5

To be applied to the trends of the new data source

New data source

Age Distribution Build Scenarios

Scenario 1: Use 2011 registration age fraction trends from 1981 - 1989

- Procedure:

Preprocess the 2011 registration data and filter for model years 1981 to 1989.

- Normalize the vehicle counts over the years for each SUT and county.

Multiply the normalized 1981 to 1989 fraction to the "OLDER" model year category in the 2021 registration data by their SUT and county.

- This creates a "***pseudo***" vehicle count for model years 1981 to 1989.
- The "***pseudo***" vehicle counts adds up to the original "OLDER" value.

The ageDistribution table was developed using the "***pseudo***" vehicle counts for model years 1981 through 1989 and the original vehicle counts for model years 1990 through 2021.

- MOVES5 default values are used for SUTs 41 (OBus), 42 (TBus), 43 (SBus), 51 (RT), and 54 (MH).

Age Distribution Build Scenarios

Scenario 2: Use MOVES5 default age fraction trends from 1981 - 1989

- Procedure:

To match the 2021 registration data, the MOVES5 default "sourcetypeagedistribution" table was filtered for:

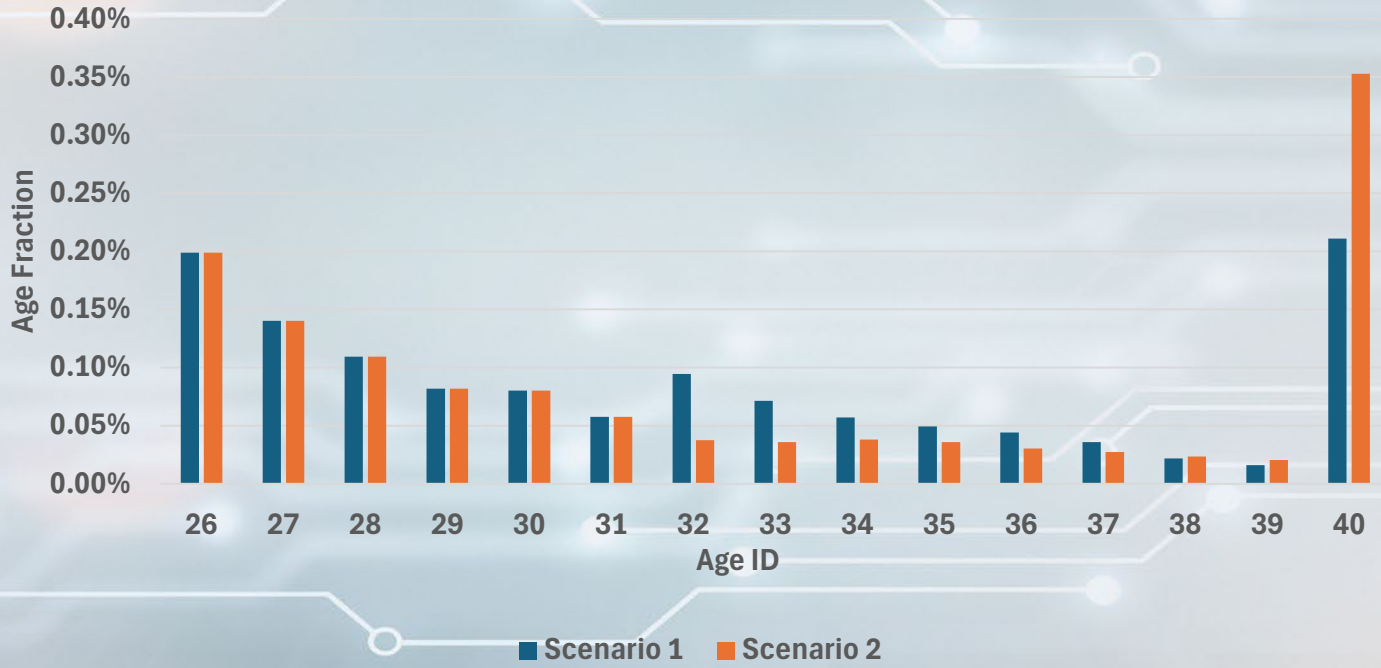
- yearID = 2021;
- ageID = 32- 40;
- SUTs = 11, 21, 31, 32, 52, 53, 61, 62 (SUTs that are using local data).

- ageFraction for ageIDs 32 through 40 were normalized.

Create the 2021 registration age distribution with model year "OLDER" fractions.

- Multiple the "OLDER" fractions with the normalized MOVES5 ageFraction for ageID 32- 40 for each region and SUT.
- Remove the calculated "OLDER" fractions

Age Distribution (San Antonio Area)



Age Distribution Comparison (after age 25)

Age Distribution Impact on Emissions (San Antonio Area)

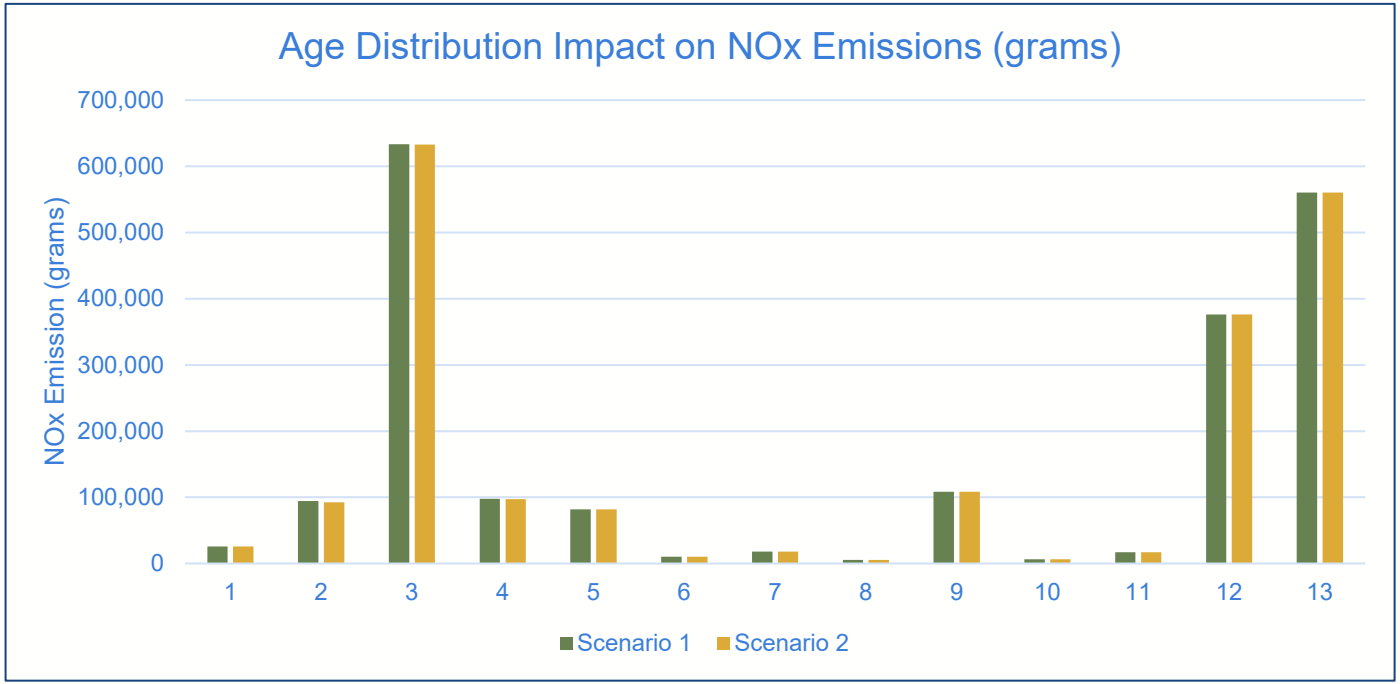
2023 Analysis Year

Pollutant	Difference (%)
CO	0.070%
NOx	-0.123%
VOC	0.137%
CO2	0.015%
PM10	-0.025%
PM2.5	-0.025%

2027 Analysis Year

Pollutant	Difference(%)
CO	0.021%
NOx	-0.240%
VOC	-0.083%
CO2	0.000%
PM10	-0.084%
PM2.5	-0.087%

Age Distribution Impact on Emissions (San Antonio Area)



SUT	Difference (Scenario 2 -1) (%)
11	-0.0017%
21	-1.9770%
31	-0.0772%
32	-0.1223%
41	0.0000%
42	0.0000%
43	0.0000%
51	0.0000%
52	-0.0002%
53	-0.0089%
54	0.0000%
61	-0.0052%
62	-0.0023%
Total	**-0.1234%**

Age Distribution Impact

The Inventory differences between 2 scenarios were minor

TTI will use MOVES default trends to map the last ten years with the current age distribution.

TTI will continue to request new registration data to fit into this 40-year input requirement in the future.

Next Steps

Next Steps

- The MOVES5 Overview listed the following updates:
  - Brake wear from light-and heavy-duty vehicles,
  - Ammonia emissions from CNG vehicles,
  - Future-year base emission rates, and
  - Fleet-averaging adjustments for light-and medium-duty internal combustion engine CO_2, PM, hydrocarbons, and NO_x.

- TTI has not currently performed any analysis to identify the impacts of these updates between MOVES4 and MOVES5.
  - TTI will perform these analyses and report the outcome in an upcoming TWG quarterly meeting.

Next Steps - Continue

- 2020 Fuels Regulatory Streamlining rule Impacts
  - The MOVES5 Overview describes that:
    - Sulfur levels are generally higher than in MOVES4,
    - Summer RVP values are generally lower than in MOVES4,
    - Winter RVP values are generally higher than in MOVES4,
    - Increased default E85 usage, and
    - Updated default biodiesel blend level.

  - These MOVES default values are generally used in the fuel formulation for MOVES runs; TTI will compare the difference of these fuel formulation on emission.

Questions?

Texas A&M Transportation Institute