Texas A&M Transportation Institute

MOVES3 Technical Review

Draft Memorandum

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Texas A&M Transportation Institute

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MOVES3 Technical Review

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HIGHLIGHTS

- On January 7th, 2021, the United States Environmental Protection Agency (EPA) issued a Federal Register (FR) notice on the availability of the new MOtor Vehicle Emission Simulator model (MOVES3) for use in State Implementation Plans and transportation conformity.
- MOVES3 replaces MOVES2014b, and all agencies outside of California have a two-year grace period for transitioning to MOVES3 for transportation conformity purposes.
- MOVES3 includes major emission rate and activity data updates over MOVES2014b based on the latest data and research findings. In addition to updated emissions rates, a key update is that MOVES now provides Compressed Natural Gas (CNG) emission rates for all heavy-duty source types.
- MOVES3 adopts MariaDB instead of MySQL as a database management system, and -0ppother minor functional changes and user interface changes are included in the MOVES3 release.
- Based on EPA's test cases (two sample counties), MOVES3 is found to generate lower emission estimates than MOVES2014, except for diesel oxides of nitrogen (NO_X) emissions (county-level total NO_X emissions also increased in MOVES3 under several test cases).
- Based on Texas-specific test cases conducted by TTI, MOVES3 is found to generate lower particulate matter ($PM_{2.5}$), volatile organic compounds (VOC), and overall NO_X emission estimates compared to MOVES2014. MOVES3 generates higher greenhouse gas (GHG) emissions and diesel NO_X emissions due to the adoption of the Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule.
- The incorporation of MOVES3 into Texas state-of-practice is ongoing with the update of the MOVES Utilities. This report intends to provide Texas practitioners with preliminary information on key changes and potential impacts, in the interim.

BACKGROUND

Transportation conformity is required by the Clean Air Act (CAA) section 176(c) to ensure that federal funding and approval are given to highway and transit projects that are consistent with ("conform to") the air quality goals established by a state air quality implementation plan (SIP) (*1*). Mobile-source emission modeling plays an important role in transportation conformity and SIP development by creating reliable air quality projections. Emissions models are also widely used to support other transportation analyses and for other local planning and decision-making purposes. The CAA requires the U.S. EPA to regularly update its mobile source emission models (*2*), with MOVES3 being the most recent update in the MOtor Vehicle Emissions Simulator (MOVES) series.

MOVES is a state-of-the-science model designed by the EPA to estimate air pollution emissions from mobile sources in the United States (*3*). The first official release of the MOVES model was in late 2009 when MOVES2010 replaced the previous MOBILE6.2 for on-road mobile source emission estimation (*2*). Since the first release, MOVES is required in ozone, carbon monoxide (CO), particulate matter (PM), and NO_2 SIP development and transportation conformity analyses in all states outside of California (*2*). It is also used for a wide range of research and analysis activities beyond mandated regulations. The model can estimate mobile source emissions at the national, county, and project level for criteria air pollutants, greenhouse gases, and air toxics. It also contains information that can be used to generate emissions rates for use in analyses outside of the MOVES environment.

MOVES3 is a major revision to the MOVES series and the latest version of the MOVES model released in late 2020 (*3*). MOVES3 is so far the EPA's best tool for estimating air pollutants and greenhouse gas emissions from on-road mobile sources for regulatory purposes (*4*). MOVES3 also follows a new naming system designated by the EPA for MOVES. Under the new naming convention, MOVES3 is the third major MOVES release, which comes after MOVES2010 and MOVES2014 (*4*). According to the EPA, the major updates in MOVES3 compared to previous versions of MOVES include the following aspects (*5*):

1. **Data updates:** Incorporating the latest data on vehicle populations, travel activity, and emission rates as well as updated fuel supply information at the county level.

2. **Methodological updates:** Adjusting the modeling approach to better account for vehicle starts, long-haul truck hoteling, and off-network idling (especially idling of light-duty vehicles).
3. **Policy context updates:** Incorporating the impacts of the heavy-duty (HD) GHG Phase 2 rule and the light-duty (LD) Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule.
4. **Software and user interface updates:** Improving the user interface and updating the platform for compatibility with newer software.

This report summarizes the major updates in MOVES3 compared to the MOVES versions that are currently used for transportation conformity analyses (MOVES 2014a and 2014b) in Texas, and the potential implications of the major updates in MOVES3 on transportation conformity analysis workflow in Texas.

The remainder of this report covers key aspects of the MOVES3 implementation, a description of key features and updates of MOVES3, and provides an assessment of differences in results between MOVES3 and MOVES2014a/b for Texas-specific input data, to provide insights into potential changes in regional emission inventory under MOVES3. Since MOVES2014a and MOVES2014b are identical in terms of on-road mobile source emissions components, they are used interchangeably or referred to as MOVES2014 within the context of this report.

IMPLEMENTATION OF MOVES3

Once the FR notice of the availability of MOVES3 was issued by the EPA, all states other than California are required to use MOVES3 for future SIPs and transportation conformity analysis to take full advantage of the improvements incorporated in this version.

The policy guidance for the implementation of MOVES3 is very similar to previous MOVES versions. There are several recommendations from the EPA for state and local practitioners on SIP and regional transportation conformity analysis *(4)*. Key highlights relevant to regional transportation conformity[1] are listed below:

[1] This report does not cover recommendations for project-level conformity included in the EPA guidance as it is beyond the scope of this task.

- Transportation conformity:
    1) EPA has issued the FR notice[2] on January 7th, 2021, kicking off a two-year grace period for using MOVES3 for regional transportation conformity purposes and a two-year grace period for project-level conformity purposes (*4*).
    2) The grace period can be less than two years if new MOVES3-based SIP budgets become applicable sooner, in which case the grace period will end for specific areas and specific pollutants once these new MOVES3-based SIP budgets are approved or adequate budgets become effective.
    3) When the grace period ends, all the new regional emissions analyses started after the end of the grace period will be based on MOVES3, even if the SIP is based on a previous EPA emissions model.
- SIP:
    1) State and local agencies that have already completed significant work on a SIP with MOVES2014 may continue to use it for that SIP (*4*).
    2) MOVES3 should be used in ozone, CO, PM, and NO_2 SIP development as expeditiously as possible, as there is no grace period for the use of MOVES3 in SIPs.
    3) The interagency consultation process must be used to develop any SIP revision based on MOVES3
- Other: EPA will use MOVES3 for the 2020 National Emissions Inventory (NEI).

KEY FEATURES AND UPDATES OF MOVES3

MOVES3 fundamentally adopts the same modeling structure as MOVES2014, although there are minor changes in input format, and the model run time may differ from previous versions depending on application cases (*3*). In general, experienced MOVES users can have a smooth transition to MOVES3 implementation without facing significant technical challenges. However, the updated MOVES3 methodology includes

[2] EPA, FR Notice of Availability: Official Release of MOVES3 Motor Vehicle Emissions Model for Emissions Inventories in SIPs and Transportation Conformity, Accessed at: https://www.govinfo.gov/content/pkg/FR-2021-01-07/pdf/2021-00023.pdf

new county-level default data and new optional county-level inputs, which requires some modifications by the user while preparing the MOVES inputs. Users need to update their default fleet, activity, fuels, and inspection and maintenance (I/M) program data from MOVES3 for regional emission inventories instead of using default data from previous MOVES versions (*3*). Also, the local data originally derived for use with versions of MOVES2014 would likely need to be updated as well.

In this section, the technical updates contained in MOVES3 are discussed under three categories:

- Data Updates - Updates to data built into the model (emissions rates and fleet activity characteristics).
- Methodological updates – Updates in the model structure that requires users to update their implementation of the model (e.g., changing input formats, collecting new data, etc.)
- Software and user interface updates – Updates in the user interface that incorporates new functional features for users while preparing the run specification files (the RunSpec or MOVES Run Specification [MRS] files).

The "policy context updates" referenced in the introductory section, are reflected in data and methodological updates as relevant. For example, the updated emission rates reflect new fuel economy and fuel standards (i.e. policy updates), and are discussed in the data update section.

Data Updates

MOVES3 incorporates new regulations, features, and significant new data, as detailed in the MOVES3 technical reports and recent presentations (*3*, *6*). The new data sources used in developing MOVES3 emission rates are summarized in Table 1.

Table 1. Emission Rates Updates in MOVES3

Vehicle Information	Emission process	Pollutant	Data Sources	Reference
Heavy-duty (HD) gasoline trucks, model year (MY) 2010 and later	Running	All	• The latest testing data for gaseous pollutants • $PM_{2.5}$ comes from HD diesel rates	(*7*)

HD gasoline trucks, model year (MY) 2008 and later	Start	All	• Adopted recent certification data	(*7*)
HD compressed natural gas (CNG) trucks (excluding Long-haul combination trucks)	Running	All (except for ammonia, which is copied from HD gasoline trucks)	• Emissions rates for MY2010+ based on real-world CNG vehicle emissions data • For pre-2010 model years, emissions are estimated using vehicle certification data • Methane emissions are not estimated using emission rates but as a fraction of HC	(*7*)
	Start	All	• Copied from the pre-2010 model year heavy-duty diesel starts rates	(*7*)
HD diesel vehicles	Running	All	• Different pollutants are updated using various data sources from EPA, public and private sectors • Incorporates the Medium-and Heavy-Duty GHG Phase 2 rule	(*6*, *7*)
	Start	All	• Emission rates for MY2010+ based on vehicle certification data	(*7*)
HD diesel long-haul combination trucks	Extended idling	Total hydrocarbon (THC), CO, NOx, $PM_{2.5}$, and energy rates	• Different pollutants are updated using various data sources from EPA, public and private sectors	(*7*)
	Auxiliary Power Unit (APU)	All	• Emission rates have been updated to reflect new standards (HD GHG Phase 2), data, and analysis	(*7*)
Light duty (LD) gasoline vehicles for MY 1990+	Running and start	THC, CO, NOx	• Emission rates have been updated based on in-use testing data	(*8*)
LD gasoline vehicles for MY 2004+	Running and start	PM	• Use emission measurement data from various studies • Updated LD PM rates, incorporating data on gasoline direct injection (GDI) engines • Reflect the changes in emission rates under Tier 2 and Tier 3 standards	(*8*)
LD vehicles for MY 2017+	Running and start	Energy and CO_2 rate	• Emission rates were updated to incorporate the Safer Affordable Fuel Efficient (SAFE) Vehicles standards	(*9*)

MOVES3 also includes several fleet characteristics and activity updates in the default database as listed below (*4*):

- **Start and idling**: Vehicle start and idling activity patterns are based on real-world instrumented vehicle data collected by a telecommunications company for LD vehicles and the Department of Energy's (DOE) National Renewable Energy Lab (NREL) for HD vehicles;
- **Truck hoteling:** Default hoteling activity has been substantially reduced from what was included in MOVES2014 based on the NREL instrumented truck data;
- **VMT:** National vehicle miles traveled (VMT) and vehicle population inputs have been updated with newer historical data from Federal Highway Administration (FHWA) and more recent forecasts from the DOE;
- **National fleet composition:** National on-road vehicle default fuel, regulatory class, and age distributions are based on newer vehicle registration data.

Finally, besides the emission rate and activity updates, the default fuel supply and formulation data in MOVES3 have been updated for all fuel types based on recent exhaust emission testing and analysis (*10*). MOVES3 also includes new ethanol blending factors in the Fuel Wizard to help users construct alternative fuel scenarios (also discussed in the next section).

METHODOLOGICAL UPDATES

Most of the methodological updates in MOVES3 are internal in the algorithm and database and do not affect users' actions while preparing inputs and performing emission analysis. However, several methodological updates may require additional user inputs, which are summarized in

Table 2 below.

Table 2. MOVES3 Methodological Updates

Inputs	**MOVES 2014a/b** (*11*)	**MOVES3** (*4*, *12*)
Starts	Only supports 'Starts' or 'Starts per day' options to define the number of engine starts	Added 'StartsPerDayPerVehicle' input option
Hoteling	Hotelling Tab contains two input tables: • 'HotellingActivityDistribution' • 'HotellingHours'	Supports five input tables to account for time and age adjustments • HotellingHoursPerDay, • HotellingHourFraction, • HotellingAgeFraction, • HotellingMonthAdjust, • HotellingActivityDistribution.

Off-Network Idling (ONI) - not related to combination truck hotelling. ONI is defined as the time during which a vehicle engine is running idle and the vehicle is somewhere other than on the road, such as in a parking lot or driveway	Not included in the previous MOVES model	Idle Tab is used to import optional information on ONI activity that is not related to combination truck hotelling activity.
		• Input option 1:
		  ○ TotalIdleFraction
		• Input option 2:
		  ○ IdleModelYearGrouping
		  ○ IdleMonthAdjust
		  ○ IdleDayAdust

Fuel	-	Updated 'Fuel Wizard' factors under 'Fuel' input for generating alternative fuel property (*10*)

Due to the new methodology and input requirements, the EPA recommends that practitioners create new input databases using new information with MOVES3 rather than attempting to convert and update existing input databases for versions of MOVES2014 (*3*). However, for existing input databases that still contain the latest available information, MOVES3 includes version control scripts in the "Tools" menu that will convert input databases created with any version of MOVES2014 (including MOVES2014a and MOVES2014b) to the proper format for MOVES3.

The MOVES3 release also includes the release of an open-source repository for hosting scripts and data (https://github.com/USEPA/EPA_MOVES_Model) (*12*), which allows easy

debugging of the algorithm and encourages contributors' engagement. Furthermore, it contains comprehensive documentation on the model methodology, application, and result interpretation that are helpful for practitioners (https://github.com/USEPA/EPA_MOVES_Model/tree/master/docs).

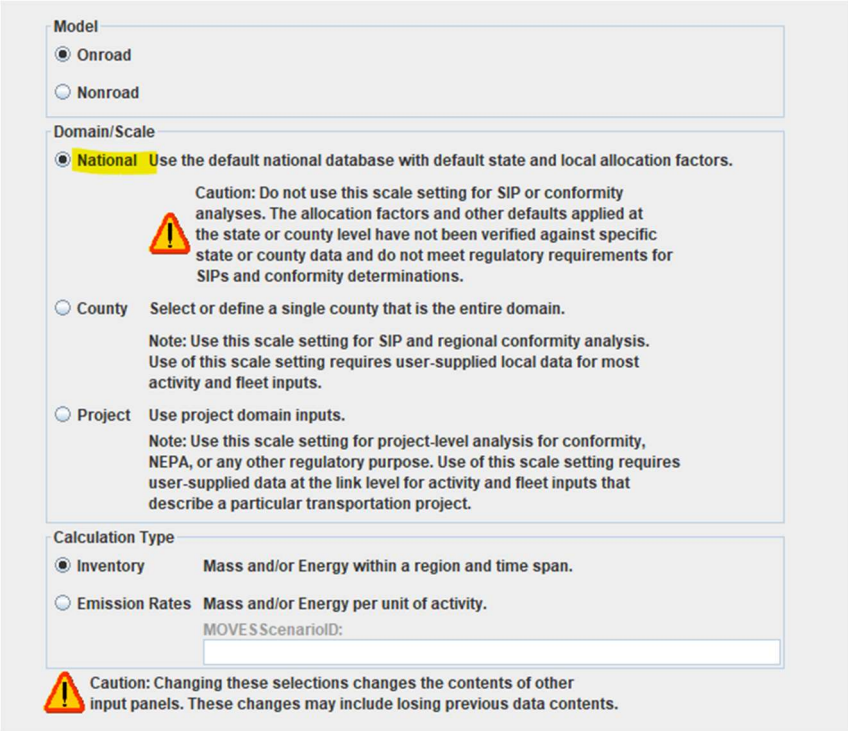
SOFTWARE AND USER INTERFACE UPDATES

The MOVES3 includes minor software and user interface (UI) updates, which are summarized in Table 3. The screenshots of UI updates are provided after the table for easy visual identification of the changes. Most of the updates are easy to adapt to, except for database updates which may change the way data is read, edited, or exported. Users can still use structured query language (SQL) as the way to process data within Maria DB, which is similar to using MySQL for the previous MOVES version. Figures 1 through 5 below are taken directly from MOVES2014a and MOVES3 interfaces and illustrate the UI changes in MOVES3, with key differences highlighted.

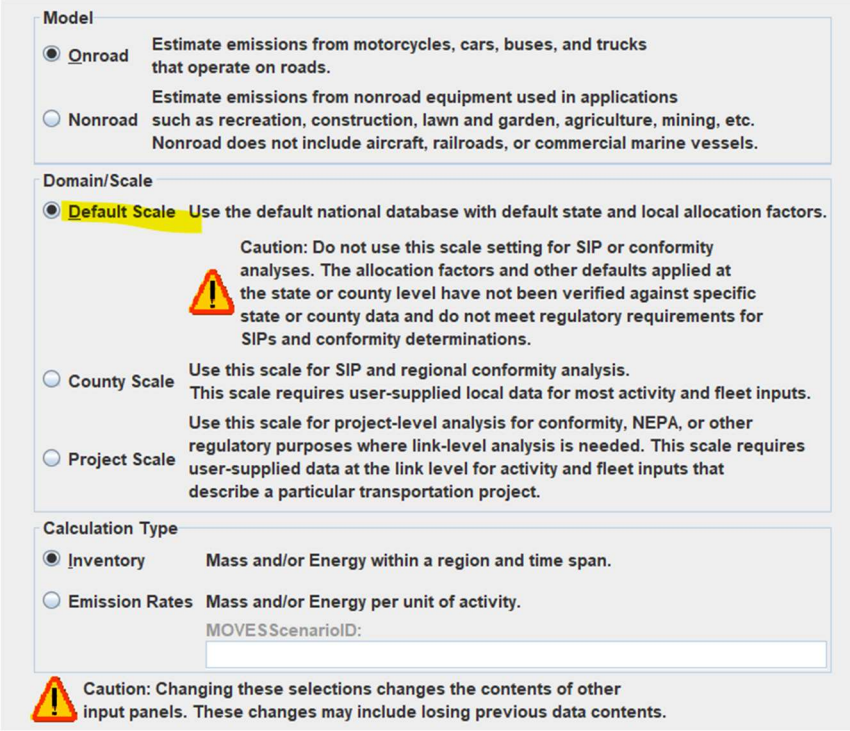
Table 3. MOVES Software Updates

Category	Elements	**MOVES 2014a/b** (*11*)	**MOVES3** (*4*, *12*)
Software environment	Database	MySQL server 5.5 or 5.6	Maria DB (version 10.4 or later)
	Java	Java Runtime Environment (JRE) version 7 or 8. Manually installed	Automatically installed (JDK version 11)
	Google Go language	Go version 1.3.3	Version 1.13 or later
Graphic User interface (GUI)	Scale (Figure 1)	National scale	Default scale
	Timespan (Figure 2)	Allows time aggregation option	Moves time aggregation option to advanced features
	Analysis year	1990-2050	1990 - 2060
	Geographic bound (Figure 3)	Allows custom domain option	Moves custom domain option to advanced features
	On-road vehicles (Figure 4)	Vehicle and fuel combinations can be manually selected and customized	Automatic selection of all fuel types Added CNG for all HDVs

		CNG for transit buses	
	Vehicle type (Figure 4)	Intercity bus	Other buses
	Ramp fraction (Figure 5)	Include ramp fraction as an input	Removes ramp fraction input

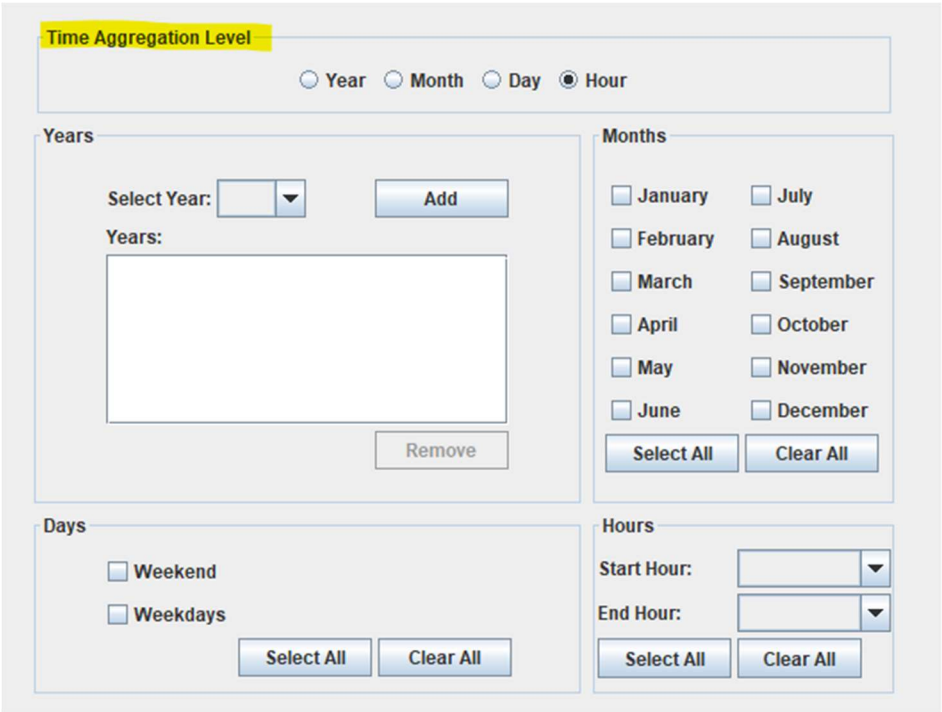


(a) MOVES 2014a

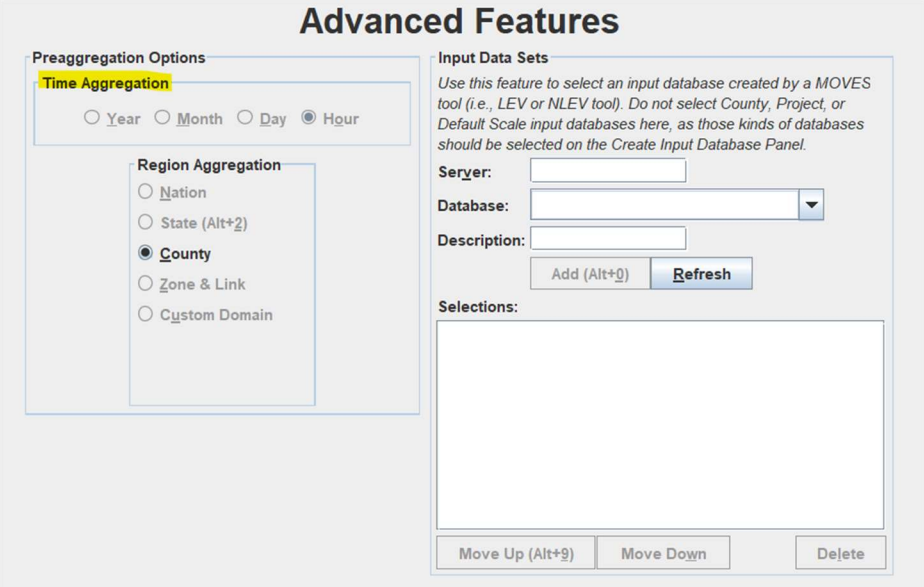


(b) MOVES3

Figure 1. MOVES2014a and MOVES3 Scale Input

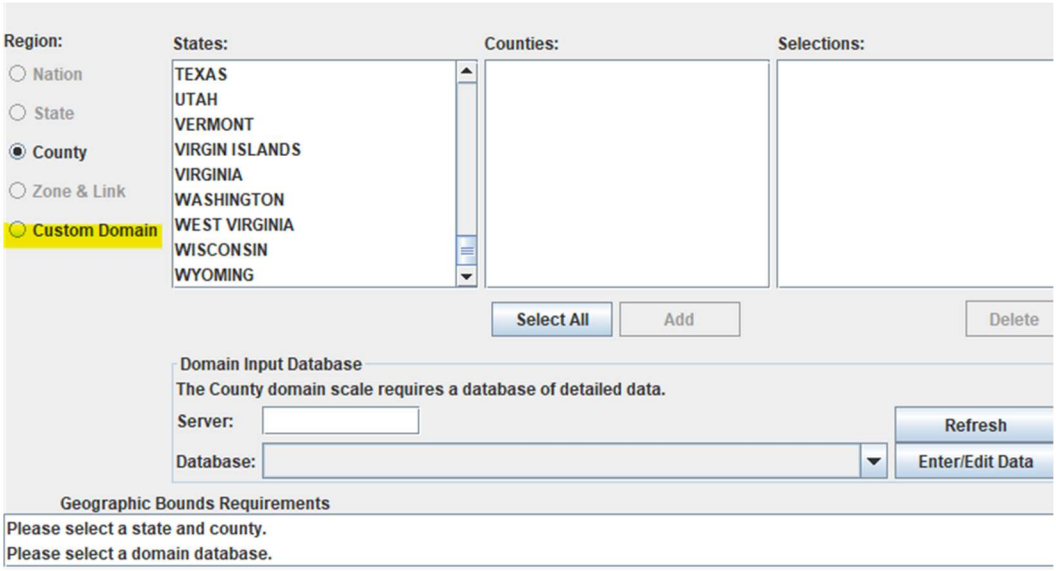


(a) MOVES 2014a

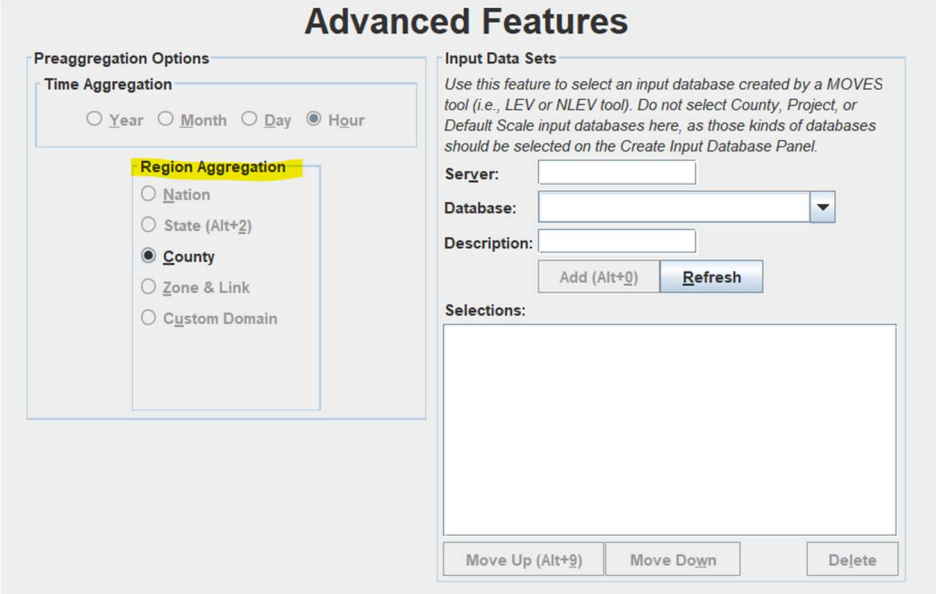


(b) MOVES3

Figure 2. MOVES2014a and MOVES3 Time Spans Input

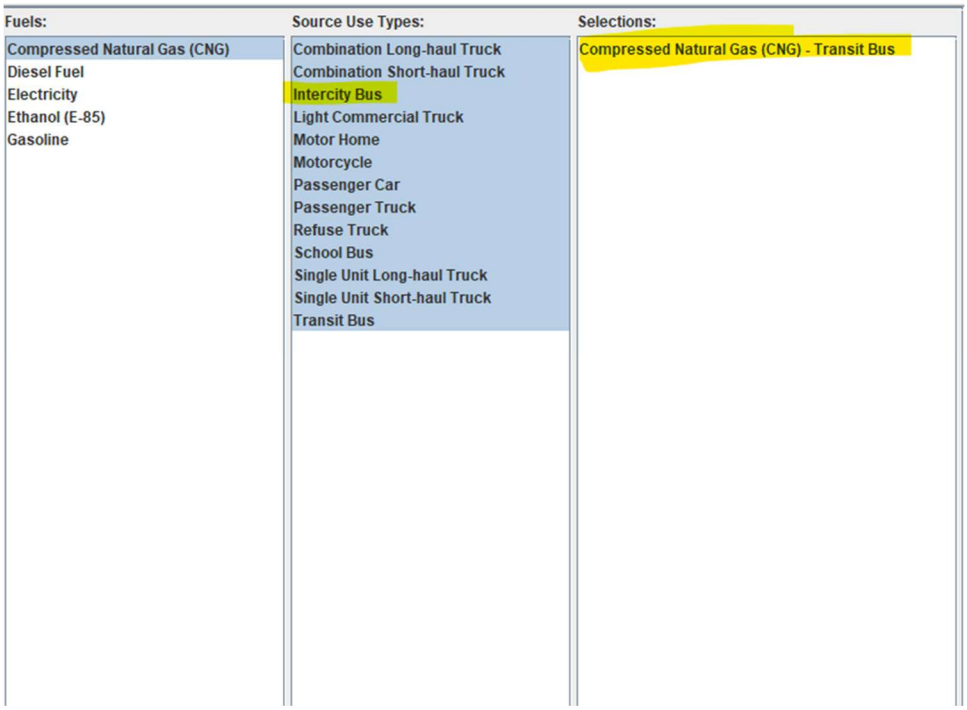


(a) MOVES2014a

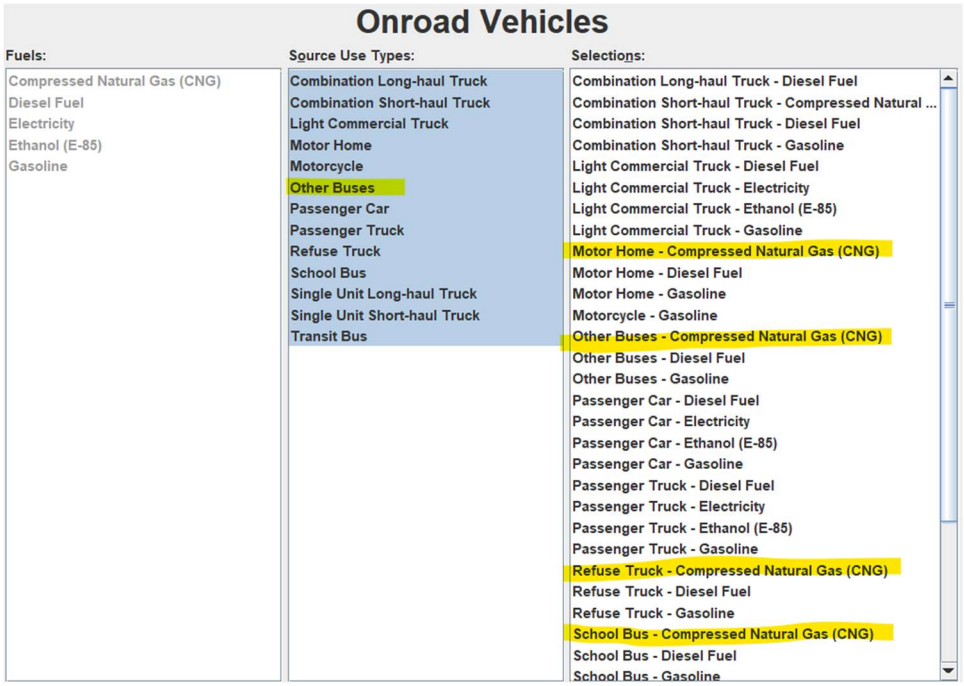


(b) MOVES3

Figure 3. MOVES2014a and MOVES3 Geographic Bounds Input

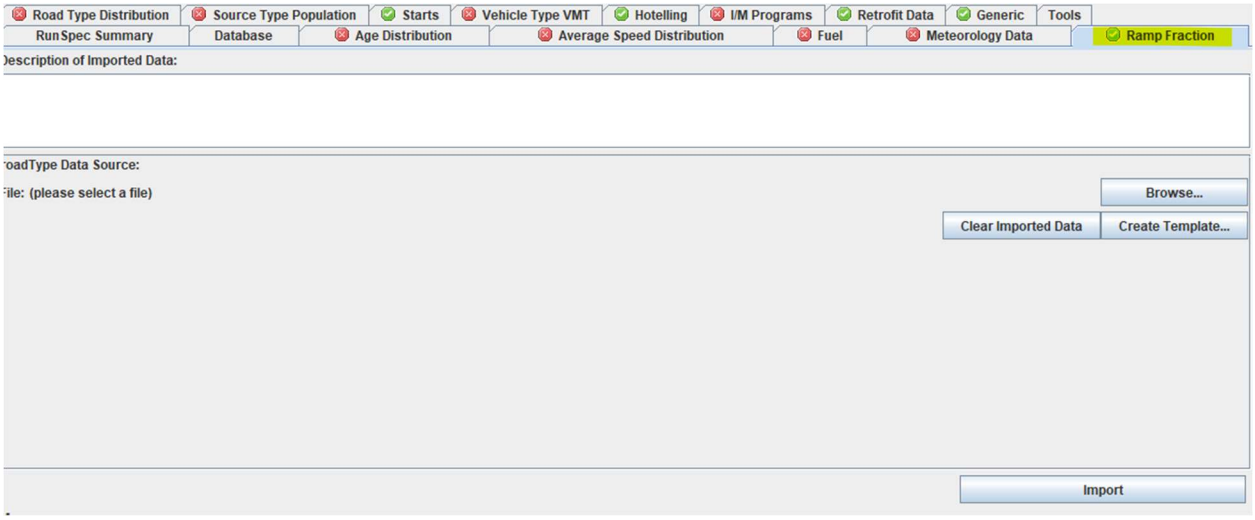


(a) MOVES2014a

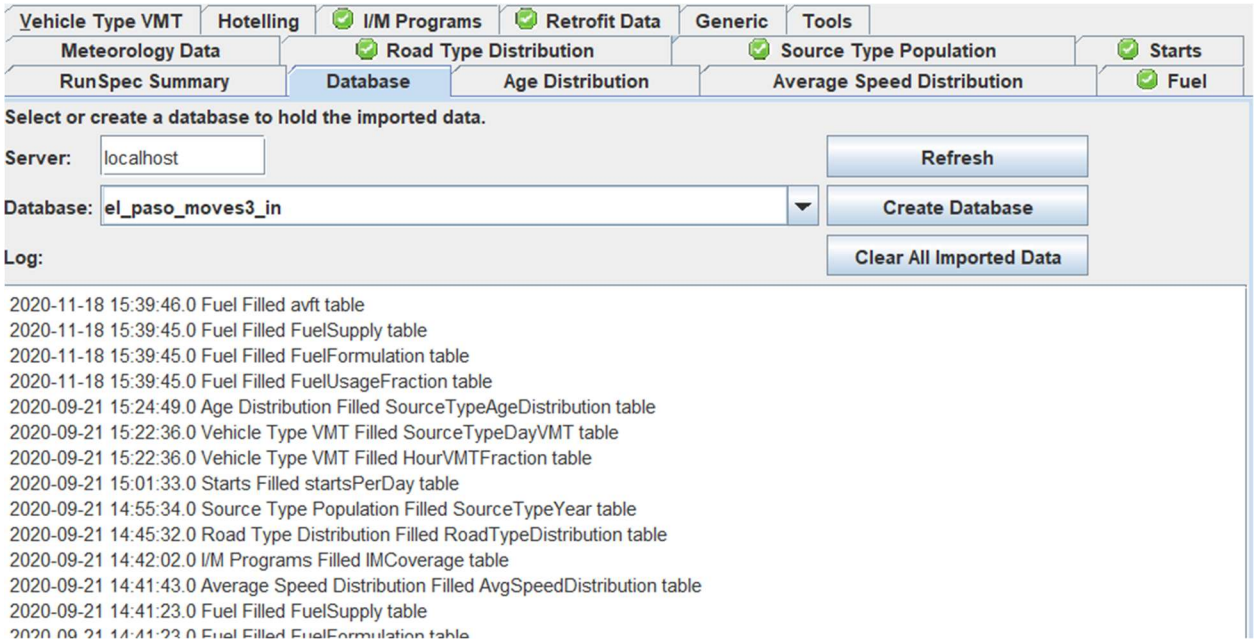


(b) MOVES3

Figure 4. MOVES2014a and MOVES3 Vehicle and Fuel Inputs



(a) MOVES2014a



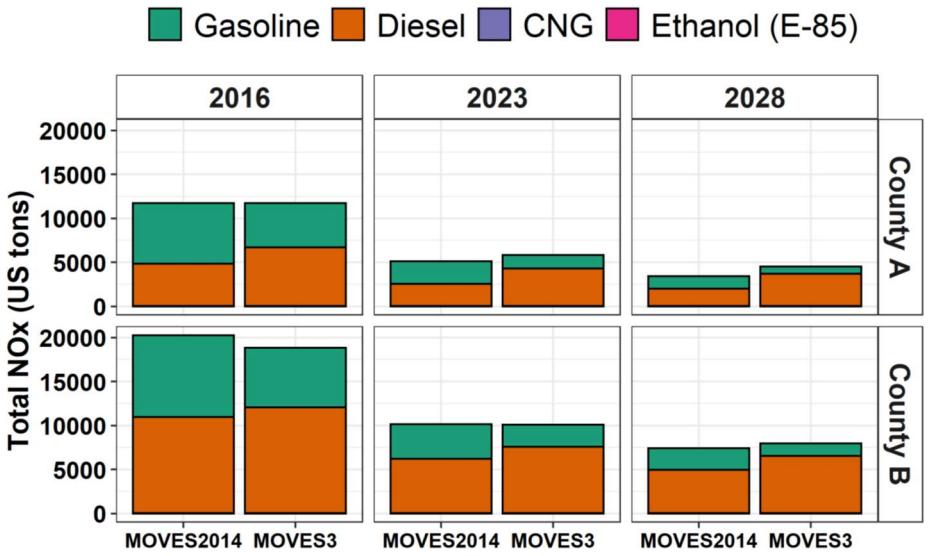
(b) MOVES3

Figure 5. MOVES2014a and MOVES3 County Database Inputs

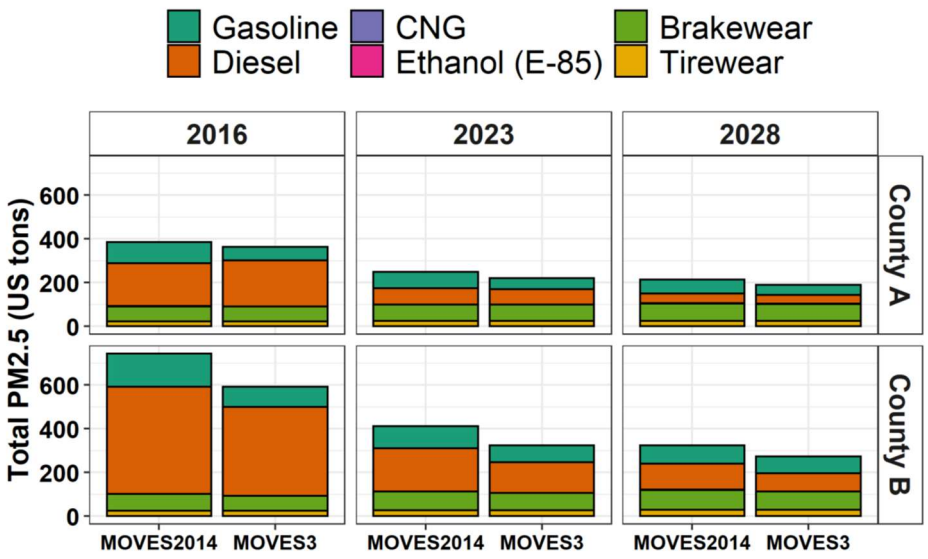
COMPARISON OF ANALYSES WITH MOVES3 AND MOVES2014

EPA'S FINDINGS

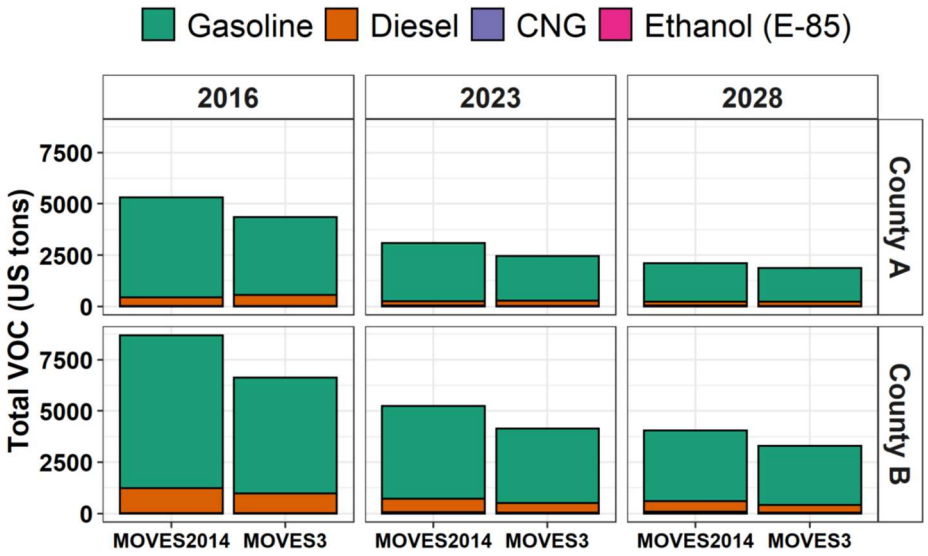
EPA has provided case studies outlining potential differences in emissions inventories when using MOVES3 compared to MOVES2014 for the same input data *(6)*. The county-level emission comparisons by pollutants from two sample counties (location unknown) between MOVES3 and MOVES2014 from EPA are in Figure 6. The county-level $PM_{2.5}$ and VOC emissions are lower than emission estimates from MOVES2014. County-level NOx emissions increased slightly in several scenarios except for 2016 County B results.



(a) NO_X



(b) $PM_{2.5}$



(c) Volatile Organic Compound (VOC)

Figure 6. County-level Emission Inventory Comparisons between MOVES2014 and MOVES3 (*6*)

RESULTS FOR A TEXAS EMISSIONS INVENTORY

To supplement the EPA results presented in the previous section, TTI staff conducted an analysis using Texas-specific inputs from a previously conducted MOVES2014 emissions

inventory to compare results between MOVES 2014a[3] and MOVES3. The MOVES runs were prepared using recent transportation conformity inputs and outputs TTI developed for El Paso, Texas. TTI traditionally uses the TTI MOVES Utilities for emissions inventories which are currently being updated for use with MOVES3. In the absence of updated MOVES3 utilities, TTI staff used the following approach to test the difference in regional emissions predicted by MOVES3 versus Moves2014:

1. Convert MOVES Utilities input and output into MOVES format and run MOVES2014a county-level analysis.
2. Convert MOVES2014a inputs into MOVES3 inputs using MOVES3 version control tools (discussed in the previous section) and run MOVES3 county-level analysis.
3. Export emission output from SQL database and perform emission comparisons.

Under this design, most of the scenario settings and activities inputs are consistent, with a few exceptions caused by the model updates, and can provide an indication of potential differences between MOVES2014 and MOVES3 when used for emissions inventory purposes. Those exceptions include more vehicle and fuel type combinations in MOVES3, updated hoteling inputs and updated fuel inputs. The new idling inputs remain empty in MOVES3 due to a lack of input data (the idling inputs are not available in MOVES2014a). The scenario configurations are summarized in Table 4.

Table 4. MOVES2014a and MOVES3 Scenario Settings

Category	Attribute	Value
Scale	Model	On-road
	Scale	County
	Calculation Type	Inventory
Timespan	Year	2030
	Month	1
	Day	Weekday
	Hour	All hours
Geographic bound	County	El Paso County, TX

[3] As mentioned previously, MOVES2014a and 2014b are identical in the on-road emissions component,, and can be used interchangeably for estimating on-road mobile source emissions.

Vehicles/equipment	On-road vehicles	All available vehicle and fuel combinations
Road type	Road type	All available road type
Pollutant and process	Pollutant and process	Selected NOx, VOC, CO_2 equivalent and $PM_{2.5}$ as well as their pre-requisite pollutants from all processes

TTI's MOVES Utilities use an emission rate approach to estimate regional emission inventories, and the data sources used follow a different format compared to MOVES input (normally more disaggregated by roadway links, hours, vehicle types and fuel types). In this study, to prepare the MOVES county-level input database, the data inputs used to prepare conformity results in MOVES Utilities were post-processed into a standard MOVES format. Specifically, the inputs come from three major sources:

- **MOVES Utilities County-level Database for generating emission rates**: The county-level database is originally used for preparing regional-level emission rates by the process. In this study, the county-level database was used to provide inputs for vehicle age distribution, speed distribution, hoteling activity distribution, meteorology data, and the I/M program.
- **MOVES Utilities activity data**: the activity data used in MOVES Utilities, such as hourly VMT, vehicle population, starts, and hoteling data, were used to fill the activity inputs in MOVES. Those inputs include daily VMT by source type, VMT hourly fraction, number of starts, and number of hoteling hours.
- **MOVES default values**: the default hoteling and fuel inputs from MOVES2014a and MOVES3 were used due to the technical difficulty of (1) formatting Utilities data into MOVES2014a inputs and (2) converting those inputs from MOVES2014a to MOVES3. Also, it reflects the emission impact of new fuel standards and hoteling input attributes.

The total emissions by pollutant from all processes are summarized in Figure 7. The emission inventories of all the measured pollutants decreased in MOVES3, except for the GHG, represented by Carbon Dioxide equivalent (CO_2e). The total emissions of VOC, NO_X, and $PM_{2.5}$ reduced by 23.5%, 1.1%, and 1.9% respectively, while CO_2 equivalent increased by 3.6%. The GHG emissions in MOVES3 are larger due to the implementation of the new SAFE standard (*6*, *9*). Besides, the diesel NO_X emissions are higher in MOVES3, which is consistent with findings from EPA's test runs. Finally, under

the test run, MOVES3 was found to run faster than MOVES2014a with results generated in approximately 15 minutes, while MOVES2014a took nearly double the time.

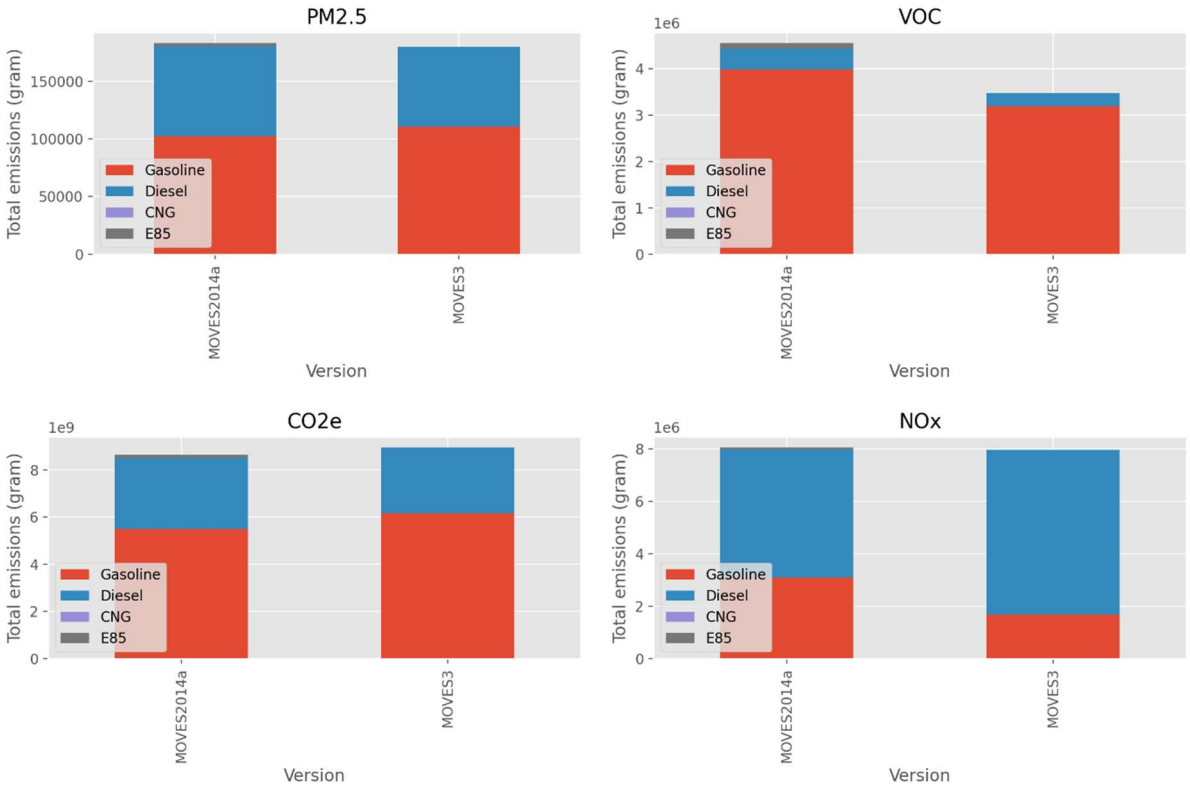


Figure 7. Emission Comparison between MOVES2014a and MOVES3

RESULTS FOR TEXAS-SPECIFIC EMISSIONS RATE GENERATION

In addition to an emission inventory comparison, TTI also compared the emission rates from MOVES2014a and MOVES3 using the emission rate mode in MOVES. Local inputs for El Paso county were used to develop the MOVES input database, under the same scenario settings listed in Table 4. The MOVES county database used for this comparison is from an ongoing study by TTI to develop statewide emission rate lookup tables, and is based on the following data sources[4]:

- 2018 vehicle registration data: provide source type year and age distributions.
- Texas Commission on Environmental Quality (TCEQ) data: I/M program, fuel, meteorology, hoteling activity distribution.

[4] The VMT, number of starts and hoteling hours have no impact on emission rate output, so they are filled with hypothetical numbers in county database.

- MOVES default: speed distribution, road type distributions.

The emission rate outputs from various emission processes were generated from two versions of MOVES. The following sections provide a comparison of the emission rates per distance, per hour, per start, and per profile from the MOVES output databases. According to EPA's guidelines, emissions per unit of distance can be used for running emissions, emissions per profile can be adopted for evaporative processes, rate per start can be used for start emissions and rate per hour can be used for hoteling emissions (*13*). Only selected comparisons of emissions rates are included in this report, for ease of presentation. The emission rates from hour 7 are selected and aggregated to reflect the composite emission rates under pre-specified vehicle type, age, and fuel types. For the emission rate per distance comparisons, results are shown for urban restricted and urban unrestricted roadway types.

The light-duty vehicle off-network idling (ONI) was not considered as it is a new feature in MOVES3 and the data inputs were not yet available. The emission rates of ONI are only reported in MOVES3 in rate per hour for off-network road type (Road Type ID = 1) under the rate per distance table. As the ONI emission rates are not available in previous versions of MOVES, the comparison of ONI emission rates is not applicable in this study.

a. Emission Rate per Distance

The emission rate per distance output combines emission rates from running exhaust, crankcase running exhaust, evaporative emissions during operating, PM brake wear, and tire wear. The comparison of emission rates per mile of travel by average speed bins for two urban road types are provided in Figure 8 and Figure 9 respectively. Under most speed conditions, the CO_2e and NO_X emission rates from running exhaust are higher in MOVES3. The NO_X emission rates under low speeds in MOVES3 are several times higher than MOVES2014a, and could potentially impact emission inventory results under the low-speed range. The VOC rates from MOVES3 are very close to MOVES2014a rates, and the $PM_{2.5}$ emission rates are generally lower in MOVES3.

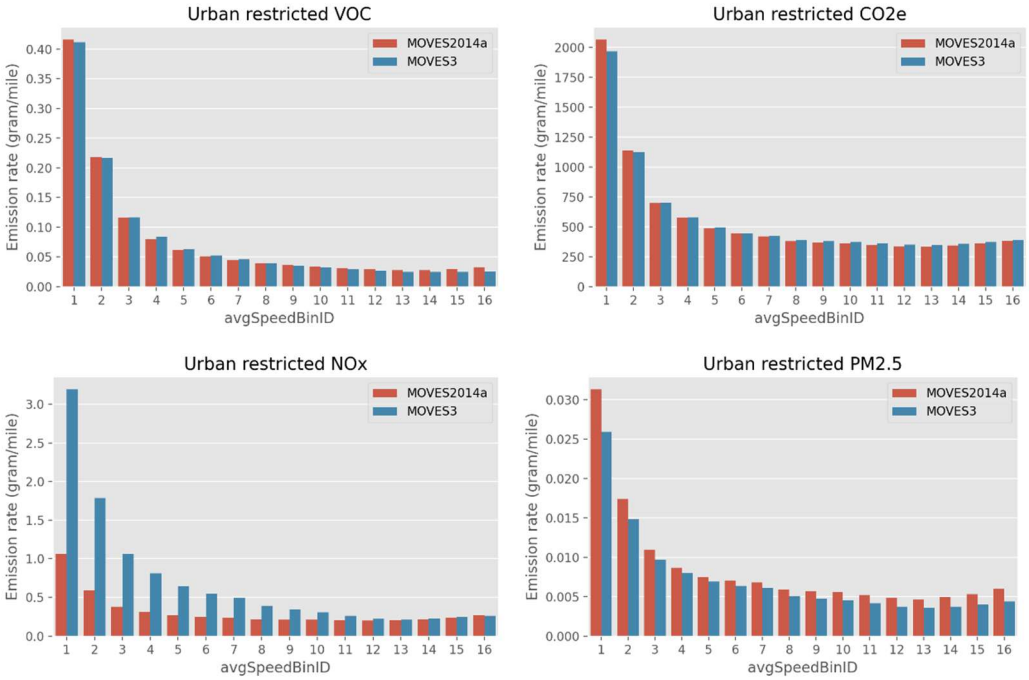


Figure 8. Comparison of Emission Rates per Distance for Urban Restricted Road

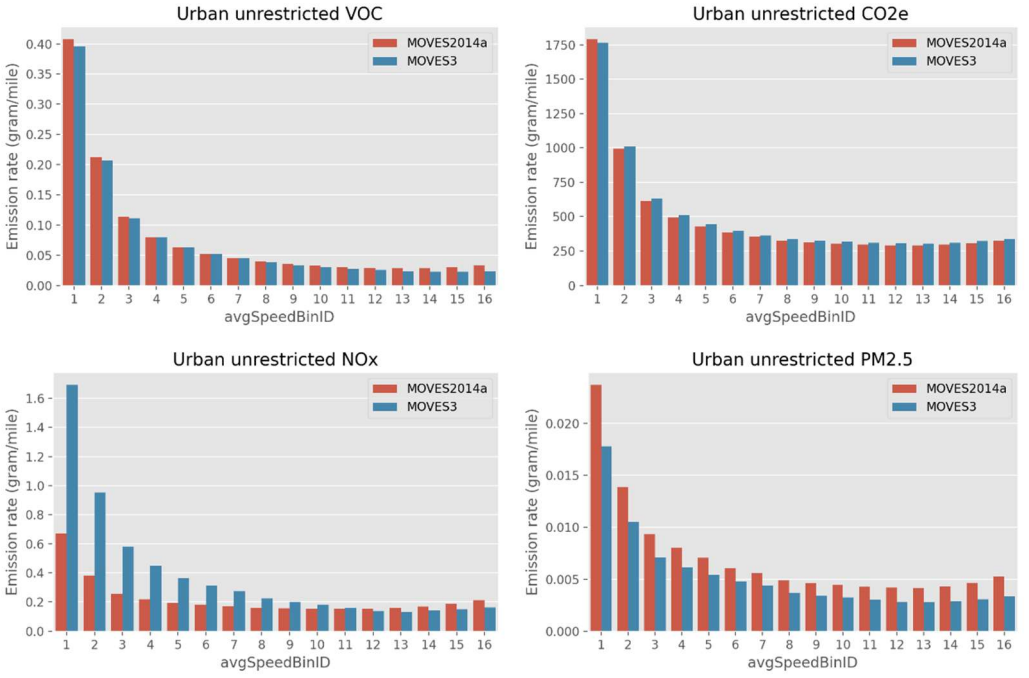


Figure 9. Comparison of Emission Rates per Distance for Urban Unrestricted Road

b. Emission Rate per Hour

The emission rate per hour output combines emission rates from extended idling, crankcase extended idling, and auxiliary power unit for long-haul combination trucks (MOVES source type = 62). The comparison results are demonstrated in Figure 10. The emission rates from MOVES3 are lower than MOVES2014a for all the selected pollutants.

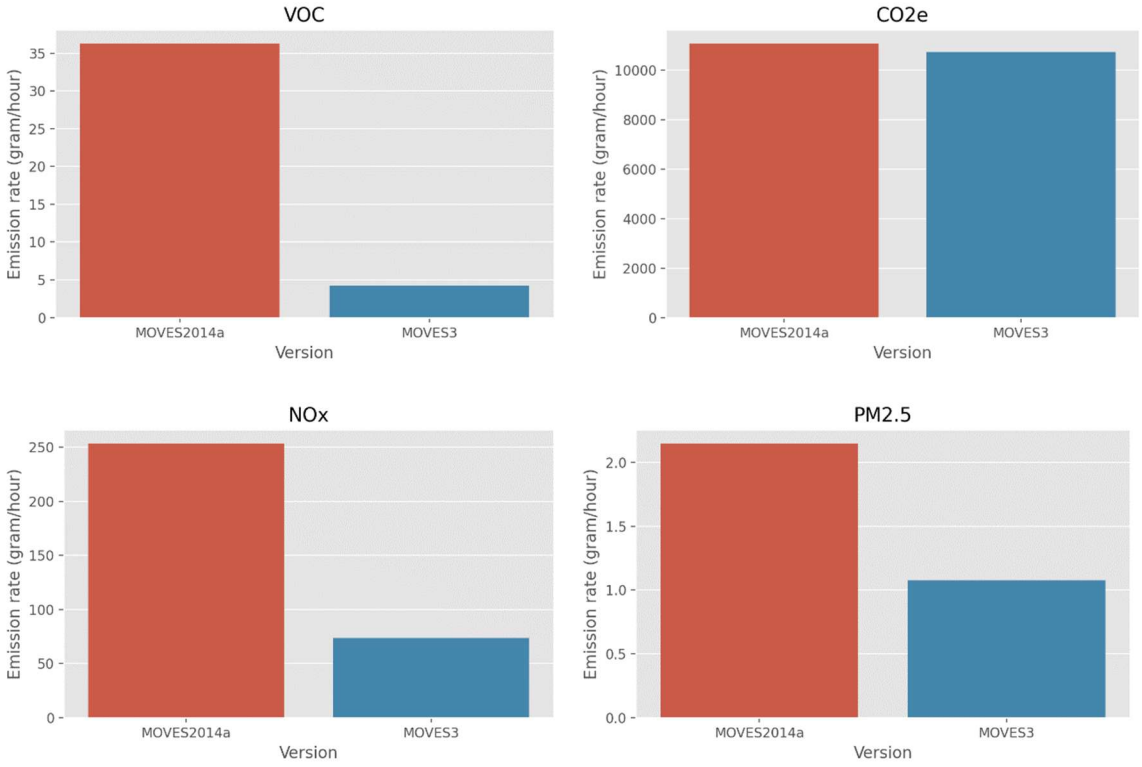


Figure 10. Comparison of Emission Rates per Hour

c. Emission Rate per Start

The emission rate per start output combines engine start and crankcase start emissions. The comparison results are provided in Figure 11 below. The VOC and NO_X emission rates per start are lower in MOVES3 compared to MOVES2014a, while CO_2e and $PM_{2.5}$ emission rates are higher.

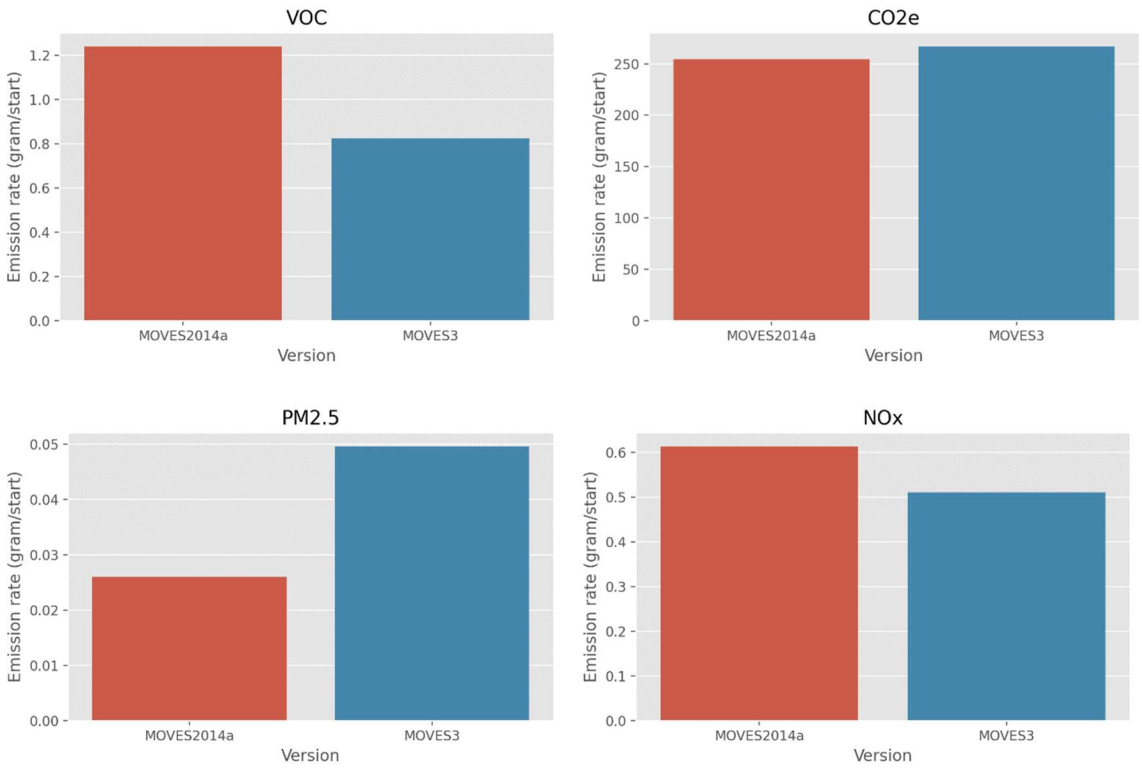


Figure 11. Comparison of Emission Rates per Start

d. Emission Rate per Profile

Finally, the average emission rates per profile from MOVES output include the off-network evaporative emissions for hydrocarbon (HC) only. The comparison of VOC emission rate per profile is provided in Figure 12 below. The VOC emissions from evaporative processes in MOVES3 is slightly higher than MOVES2014a results. However, the VOC rates from off-network evaporative process are much smaller in scale compared to other emission sources, so the small difference in emission rates will likely have a negligible impact on regional emissions analyses.

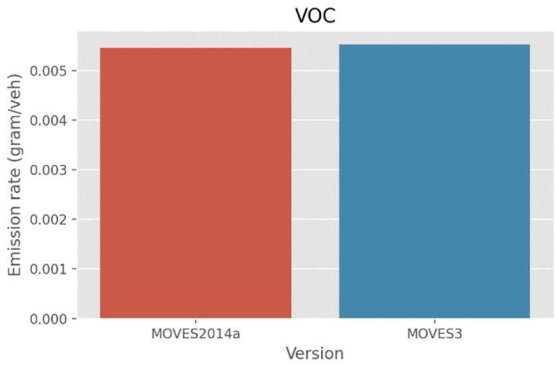


Figure 12. Comparison of Emission Rates per Profile

From the results in this section, it is seen that MOVES3 emission rates generated for the test case vary from MOVES2014a. The direction of changes and the ultimate impact on an inventory or in other analyses will depend on the emission process, local inputs, and types of pollutants.

CONCLUSIONS

This report has documented technical updates to EPA's latest emission model MOVES3 relative to MOVES2014b. MOVES3 incorporates substantial changes in emissions data and algorithms based on the latest data sources and changes in regulations. Despite these updates, MOVES3 maintains a similar model structure to previous MOVES models and should enable most practitioners to transition to the new model relatively easily.

This report provides Texas practitioners an overview of MOVES3 and an insight into the potential impacts of the new model on emission results, by supplementing EPA's comparisons of MOVES 2014 and MOVES3 with additional analyses using Texas-specific data. The comparisons in this report provide preliminary indications of the potential impact of MOVES3 on regional emission inventories and other air quality analyses. From a transportation conformity perspective, since conformity processes follow the SIP process, the adoption of MOVES3 will not occur immediately. In the interim, TTI's ongoing updates to the MOVES Utilities will also provide opportunities for more refined analyses and comparisons between MOVES2014 and MOVES3 in a conformity context.

The results indicate that there are differences between emissions estimated in MOVES2014 and MOVES3, though the direction and level of impact may vary based on the analysis context and local data. MOVES3 also provides opportunities for developing new Texas-specific inputs, such as for alternative fuel vehicles and for LDV idling.

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