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MOVES 4.0 Updates for the Fuel and Emissions Calculator (FEC)

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16. Abstract
This project employs the outputs from MOVES-Matrix 4.0 to generate a data set that can be employed by users of the 2018 Fuel and Emissions Calculator (Version 3.0) to update energy use and emission rates to reflect the latest outputs from the U.S. Environmental Protection Agency's (USEPA's) MOVES 4.0 energy use and emission rate model for the Atlanta, Georgia summer scenario. The data employed in this project were generated as part of the National Center for Sustainable Transportation project entitled MOVES-Matrix 4.0 for High-Performance On-road Energy Use and Emission Rate Modeling Applications (Lu, et al., 2025). As described in this report, the team queried more than 90 billion cells within full MOVES-Matrix 4.0 data set to generate MOVES 4.0 data that can be substituted for the older MOVES 2014 data in Fuel and Emissions Calculator (FEC) Version 3.0 for Georgia. The query output data are contained in an Excel spreadsheet, allowing users to update their personal copies of the FEC. Should technology transfer funds become available in 2025 from another source, the research team will update and release the next full version of the FEC model, which will be accompanied by an updated user manual.

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MOVES 4.0 Updates for the Fuel and Emissions Calculator (FEC)

A National Center for Sustainable Transportation Status Report

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List of Acronyms

CH_4	Methane
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
EPA	Environmental Protection Agency
Georgia Tech	Georgia Institute of Technology
MOVES	MOtor Vehicle Emission Simulator
NMHC	Non-Methane Hydrocarbons
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
N_2O	Nitrous Oxide
PM10	Particulate Matter ≤10 µm
PM2.5	Particulate Matter ≤2.5 µm
SO_2	Sulfur Dioxide
THC	Total Hydrocarbons
VOC	Volatile Organic Compounds

MOVES 4.0 Updates for the Fuel and Emissions Calculator (FEC)

Executive Summary

This project employs the outputs from MOVES-Matrix 4.0 to generate a data set that can be employed by users of the 2018 Fuel and Emissions Calculator (FEC) (Version 3.0) to update energy use and emission rates to reflect the latest outputs from the U.S. Environmental Protection Agency's (USEPA's) MOVES 4.0 energy use and emission rate model for Atlanta, Georgia. The data employed in this project were generated as part of the NCST Project entitled MOVES-Matrix 4.0 for High-Performance On-road Energy Use and Emission Rate Modeling Applications (Lu, et al., 2025). As described in this report, the team queried more than 90 billion cells within full MOVES-Matrix 4.0 data set to generate MOVES 4.0 data that can be substituted for the older MOVES 2014 data in FEC Version 3.0. The query output data are contained in an Excel spreadsheet, allowing users to update their personal copies of the FEC. User-integration of the replacement Georgia data allows the user to run scenarios in a teaching setting that employ MOVES 4.0 energy use and emission rates, and to compare MOVES 4.0 modeling result to those generated using the older MOVES 2014 energy use and emission rates. Should technology transfer funds become available in 2025 from another source, the research team will update and release the next full version of the FEC model along with an updated user manual.

Introduction

The Georgia Tech National Center for Sustainable Transportation (NCST) research team released the latest complete version of the Fuel and Emissions Calculator (FEC Version 3.0) in 2018. The model employs a subset of MOVES2014 energy use and emissions rates, taken from the U.S. Environmental Protection Agency's (USEPA) model (which is required for use in regulatory analyses). Given its spreadsheet structure and simple user interface, the FEC can be used for rapid assessment of energy use and emissions from a variety of vehicles classes and any input driving cycle. The FEC is ideal for case study analysis of changes in vehicle fleet composition or changes in fleet operations (i.e., for modeling changes in energy use and emissions due to a reduction on on-road congestion or increased operating speeds). In 2023, the USEPA released MOVES 4.0, providing a two-year grace period for use in regulatory analysis, meaning that MOVES 4.0 must be used in all new transportation planning and conformity analyses after September 12, 2025. The goal of this project was to derive updated MOVES 4.0 energy use and emission rates for integration into the FEC (i.e., a replacement subset from MOVES-Matrix 4.0), so that case study analyses could be performed using the most recent data for Atlanta, Georgia.

This project pulls a FEC-compatible data subset from MOVES-Matrix 4.0 that users can insert into the 2018 FEC 3.0 model, replacing the older MOVES 2014 energy use and emission rates. Hence, after substituting these updated data into the spreadsheet (with a simple cut and paste), the FEC spreadsheet can provide MOVES 4.0 case study results for applications in Atlanta, Georgia. The data employed in this project were generated as part of the NCST project entitled "MOVES-Matrix 4.0 for High-Performance On-road Energy Use and Emission Rate Modeling Applications" (Lu, et al., 2025). As described in this report, the team queried more than 90 billion cells within full MOVES-Matrix 4.0 data set to generate MOVES 4.0 data that can be substituted for the older MOVES 2014 data in FEC Version 3.0. The query output data are contained in an Excel spreadsheet, allowing users to update their copies of the FEC. User-integration of the replacement Georgia data into a copy of FEC 3.0 also allows user to run scenarios in a teaching setting that allows users to compare MOVES 4.0 case study modeling result to those generated using the older MOVES 2014 energy use and emission rates. Should technology transfer funds become available in 2025 from another source, the research team will update and release the next full version of the FEC model along with an updated user manual.

FEC MOVES 4.0 Inputs for Georgia Scenarios

FEC Version 3.0 provides the ability to run a specific set of scenarios for city, season, and calendar year. In 2018, when the FEC was last updated, the energy use and emissions rates came from MOVES2014, which the Georgia Tech research team had run for nearly the entire county, as part of an ongoing NCST research program. In FEC Version 3.0, users select the scenario from the options below that most closely matches their analytical needs. FEC 3.0 allows the user to model every calendar year from 2015 to 2025. The team had planned to increase the modeling capability through 2040 for the summer release of FEC 4.0 but federal support was withdrawn in May 2025.

- Atlanta, Georgia - Summer
- Boston, Massachusetts - Winter
- Dallas, Texas - Winter
- Houston, Texas - Summer
- Miami, Florida - Winter
- Minneapolis, Minnesota - Winter
- Phoenix, Arizona - Summer
- Richmond, Virginia - Summer
- San Francisco, California - Summer
- Seattle, Washington - Winter

The recent MOVES-Matrix 4.0 project (Lu, et al., 2025) completed for NCST updated the MOVES-Matrix supercomputing procedures so that all modeling regions in the U.S. could be modeled (approximately 120 regions). The team also prepared final MOVES-Matrix 4.0 energy use and emission rates for the state of Georgia, which are available through the NCST website. For this report, the team has prepared the updates for the Atlanta, Georgia, Summer scenario across all the FEC 3.0 calendar years (2015 to 2025). User-integration of the replacement Georgia data allows the user to run scenarios in a teaching setting that employ MOVES 4.0 energy use and emission rates, and to compare MOVES 4.0 modeling result to those generated using the older MOVES 2014 energy use and emission rates.

As noted above, the team had planned to expand the scope of the model and release FEC 4.0 this summer to cover all current scenarios with MOVES 4.0 outputs and an expanded number of calendar years, once MOVES 4.0 runs were completed on the supercomputing cluster. However, without adequate support for modeling on the cluster, FEC 4.0 will not likely be released until mid-2026 (the team continues to run MOVES-Matrix 4.0 scenarios for other modeling regions on the Partnership for an Advanced Computing Environment (PACE) computing cluster, but access to computing cores has been necessarily reduced given the lack of federal funding).

Before integrating the data generated by this project into the FEC Version 3.0 model spreadsheet, users should first read the technical documentation for the FEC (Xu, et al., 2018). The variables employed in the FEC (see Appendix A of this report) are explained in detail in the FEC 3.0 technical documentation. The FEC 3.0 spreadsheet contains rows for the Atlanta Summer scenarios, with columns are clearly labeled with the variable names and in the same order) as indicated in Appendix A. Each row provides a unique combination of sourceTypeID, operating mode bin, calendar year, and fuel type for the Atlanta Metro Area summer analyses (4,224 rows). To update the model, users should filter the FEC 3.0 table to show only the Atlanta Metro Area summer scenarios and paste the replacement MOVES 4.0 rows into FEC 3.0 over the top of the Atlanta Metro Area summer scenarios (which will replace the MOVES 2014 data with the new MOVES 4.0 data). Until such time as a comprehensive FEC 4.0 replacement is released by the Georgia Tech research team, users are cautioned to save their updated FEC model with a new file name and caveat the methodology descriptions of any published case study results accordingly.

References

Lu, H., H. Liu, Z. Liu, M.O. Rodgers, R. Guensler (2025a). MOVES-Matrix 4.0 for High-Performance On-road Energy Use and Emission Rate Modeling Applications. 104th Annual Meeting of the Transportation Research Board. Proceedings. Washington, DC. January 2025.

Lu, H., H. Fan, H. Liu, Z. Liu, M.O. Rodgers, and R. Guensler (2025b). MOVES-Matrix 4.0 for High-Performance On-road Energy Use and Emission Rate Modeling Applications. National Center for Sustainable Transportation. Final Report. July 2025

Xu, X., H. Liu, R. Passmore, T. Patrick, F. Gbologah, M.O. Rodgers, and R. Guensler (2018). Fuel and Emissions Calculator (FEC), Version 3.0, Summary Report. Georgia Institute of Technology, School of Civil and Environmental Engineering, Atlanta, GA. Prepared for the National Center for Sustainable Transportation, UC Davis, Davis, CA. October 2018.

Data Summary

The data employed in this project were generated as part of another NCST project, entitled "MOVES-Matrix 4.0 for High-Performance On-road Energy Use and Emission Rate Modeling Applications." As described earlier in this report, the team generated a data set to update the older MOVES energy use and emission rate data in the FEC tables by querying more than 90 billion cells within MOVES-Matrix 4.0. The output data are contained in an Excel spreadsheet so that users can update their current versions of the FEC. This spreadsheet is entitled "moves4 updated data for fec substitution 2025.xlw", available here: https://doi.org/10.5281/zenodo.16746158.

The research team was in the process of updating the FEC algorithms and user manual to incorporate some of the fundamental changes that USEPA made in the MOVES 4.0 model. A full updated FEC Version 4.0 would have been released in Summer 2025, but NCST funding was withdrawn by the USDOT on May 2, 2025. As such, FEC users will need to integrate the updated data into their own current model versions. If the Georgia Institute of Technology research team procures supplemental funding in 2025 from another source, the team will update and release the next full version of the model along with an updated user manual.

Products of Research

The subset of data generated for the FEC update was derived from the full MOVES-Matrix4.0 data set, which can be found as a component of the NCST project entitled "MOVES-Matrix 4.0 for High-Performance On-road Energy Use and Emission Rate Modeling Applications." No data were collected in this study.

Data Format and Content

The data are contained in a standard Excel spreadsheet. The variable names and data formats are the same as previously described in the FEC 3.0 final report (Xu, et al., 2018).

Data Access and Sharing

The data constitute outputs from the MOVES 4.0 model. The open-access data generated for this project may be shared freely.

Reuse and Redistribution

There are no restrictions on how the open-access data from this project may be reused and redistributed by the public. Use the following citation:

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Appendix A – MOVES 4.0 Parameters Updated

- SourceTypeID
- Location-season
- opModeBin
- year
- FuelId
- 1 HC (g/s)
- 2 CO (g/s)
- 3 Nox (g/s)
- 5 CH4 (g/s)
- 6 N2O (g/s)
- 31 SO2 (g/s)
- 33 NO2 (g/s)
- 79 NMHC (g/s)
- 87 VOC (g/s)
- 90 CO2 (g/s)
- 91 energy consumption (MMBtu/s)
- 98 CO2e (g/s)
- 100 PM10 (g/s)
- 101 (MOVES placeholder)
- 102 (MOVES placeholder)
- 105 (MOVES placeholder)
- 106 (MOVES placeholder)
- 107 (MOVES placeholder)
- 110 PM2.5
- 112 Elemental Carbon
- 115 Sulfate particulate
- 116 (MOVES placeholder)
- 117 (MOVES placeholder)