



Updates to ACEEE's Greenercars Rating System for Model Year 2017
American Council for an Energy-Efficient Economy
December 2016

This document details our updates for the analysis of model year 2017 cars and light trucks, which will be reflected in the release of ACEEE's Greenercars rankings available at greenercars.org. Aspects of the methodology not discussed in this memo will remain as described in the report *Rating the Environmental Impacts of Motor Vehicles: ACEEE's Green Book Methodology, 2016 Edition* (Vaidyanathan, Slowik & Junga 2016).

Compared to model year 2016, the only change in methodology is an update to in-use gasoline SOx emission rates.

Changes To be Implemented for MY2017 Greenercars Ratings

UPDATES TO TIER 3 GASOLINE AND IN-USE SO_x EMISSIONS

The Tier 3 gasoline standard takes effect in January 2017, decreasing the annual average sulfur content from 30 parts per million (ppm) to 10 ppm. The decrease in sulfur content should decrease tailpipe SO_x emissions of all gasoline vehicles regardless of age, which can have a significant impact on human health. SO_x has the second-highest damage cost of all pollutants considered in the Greenercars methodology (\$29.42 per kilogram in 2004\$).

To reflect this reduction, we obtained estimates of SO_x emissions using EPA's Motor Vehicle Emissions Simulator (MOVES) model (version MOVES2014a). MOVES does not directly calculate SO_x emissions but does calculate sulfur dioxide (SO₂) emissions. SO₂ accounts for almost all of atmospheric SO_x emissions from combustion (CARB 2010). As such, we use SO₂ to wholly represent tailpipe SO_x emissions. MOVES calculates tailpipe SO₂ based on fuel consumption, fuel sulfur content, and the fraction of fuel sulfur not converted to sulfate (SO₄) emissions (EPA 2016a). MOVES documentation provides the following equation:

$$SO_2(g) = FC(g) \times [S](ppm) \times MW \times fSO_2 \times \left(\frac{10^{-6}}{ppm}\right)$$

where $FC(g)$ is the fuel consumption (grams), $[S](ppm)$ is the relative fuel-sulfur concentration (ppm), MW is the ratio of molecular weight of sulfur dioxide to sulfur, and fSO_2 is the fraction of fuel sulfur converted to SO₂ emissions.

To confirm the method by which MOVES calculates SO₂ emissions, we ran the model to obtain emissions inventories for various years at the national scale. SO₂ emission outputs are provided in grams per mile and were converted to grams per gallon using energy use outputs.

Table 1. MOVES2014a SO_x Emission Factors, grams per gallon gasoline

Operating Year	SO _x Emission Factor g/gal
Greenercars	0.194
2016	0.155
2017	0.056
2025	0.056

MOVES results for 2017 and 2025 confirm the appropriate inclusion of the Tier 3 gasoline standard. The above equation indicates that SO_x emissions from a vehicle running on Tier 2 fuel should be 0.170 grams per gallon rather than 0.155 as calculated by MOVES for 2016. The difference may be attributable to existing use of low sulfur fuels during 2016, or early compliance with the Tier 3 standard. The equation does yield SO_x values for MY 2017 and 2025 identical to the MOVES output, confirming the presence of Tier 3 gasoline specifications within MOVES.

The change in a vehicle's EDX (cents per mile) that results from using Tier 3 fuel relates to the change in emission factor using the following equation

$$\frac{(EF_{SOx})(DC_{SOx})}{FE_{MPG}} = \Delta EDX$$

where EF is the emission factor in grams per gallon, DC is the damage cost in cents/gram, and FE is the fuel economy of the vehicle in miles per gallon. The change from 0.194 grams per gallon to 0.056 grams per gallon results in a decrease of approximately 0.02 ¢/mile in the in-use EDX for a vehicle of average fuel economy. The EDX for a vehicle which achieves a combined 40 mpg increases by 0.5%. For a vehicle with much lower fuel economy (15 mpg combined), the EDX increases by 1.3%.

We consider this change to be both methodological and real-world. The methodological change is the difference between the existing EF (0.194 g/gal) to the MOVES-calculated EF for Tier 2 gasoline (0.170 g/gal). The real-world change (0.170 g/gal to 0.056 g/gal) is from the actual decrease of fuel sulfur content. The methodological portion is much less than 1% of the total EDX, so we did not calculate a new C value.¹

All gasoline vehicles, regardless of model year, will realize a decrease in tailpipe SOx emissions. Prior MY gasoline vehicles were scored under the assumption of operating on Tier 2 fuel for the lifetime of the vehicle. As a result, these vehicles were penalized by the extent of time that the vehicle operates on Tier 3 gasoline. MY 2016 was penalized the most, as the vehicles operated on Tier 2 gasoline for one year or less. The total change in EDX as discussed above accounts for approximately 1.2% of the total EDX; we have not made retroactive scoring adjustments.

¹ The C value adjusts the Green Score to reflect methodological changes. This allows for year-to-year comparison of vehicle scores.

References

- CARB (California Air Resources Board).2010. *Recommendations and Area Designations for the 2010 Federal Sulfur Dioxide (SO₂) Standard*. Sacramento, CA: California Environmental Protection Agency.
- DOE (Department of Energy).2014. *Alternative Fuels Data Center – Fuel Properties Comparison*. Washington, DC: U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy.
- EPA (U.S. Environmental Protection Agency). 2014. *Control of Air Pollution from Motor Vehicles: Tier 3 Motor Vehicle Emission and Fuel Standards Final Rule – Regulatory Impact Analysis*. Washington, DC: U.S. Environmental Protection Agency, Office of Transportation and Air Quality.
- _____.2016a. *Fuel Effects on Exhaust Emissions from On-Road Vehicles in MOVES2014*. Washington, DC: U.S. Environmental Protection Agency, Office of Transportation and Air Quality.
- _____.2016b. *Population and Activity of On-road Vehicles in MOVES2014*. Washington, DC: U.S. Environmental Protection Agency, Office of Transportation and Air Quality.
- EPA & DOT (U.S. Environmental Protection Agency and Department of Transportation).2010. *Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule*. Washington, DC: U.S. Environmental Protection Agency, Office of Transportation and Air Quality.