Updates to ACEEE's Greenercars Rating System for Model Year 2024

American Council for an Energy-Efficient Economy

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This document details our updates for the analysis of model year 2024 cars and light trucks, 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) or in previous methodology updates.

Changes from the model year 2024 methodology:

- Updating the Electricity Upstream Emissions Factors
- Updating the Gasoline and Diesel Upstream Emissions Factors

Updating the Electricity Upstream Emissions Factors

Under our current methodology, established for model year 2021, the electricity upstream emissions factors (measured in grams of pollutant per kilowatt-hour) are calculated based on a weighted average of the grid emissions and plug-in (PEV) sales share by state. First, we calculate the grid emissions for each state using grid mix from EPA's eGrid database and the GREET models emissions factors. GREET provides emission factors for both generation (combustion) at the power plant and from the production of the material (feedstock emissions, i.e. from coal mining and oil extraction and refining). Greenercars includes the impacts from NMOG, CO, NO_x, PM10, SO_x, methane, N_2O, and CO_2. Then we use this information to calculate combustion and feedstock factors for each state and multiple them by the percent of nationwide PEV sales for each state to generate nationwide combustion and feedstock factors for each pollutant. The PEV sales data comes from the Automotive Alliance electric vehicle sales dashboard. The change in state sales shares since our last update was significant and is presented in table 1 below.

Table 1. Percent of Nationwide PEV Sales by State

State	**Old Methodology:** Nov 2018 – Oct 2019 Sales %	**New Methodology:** 2022 Sales %
California	45.4%	33.8%
New York	4.7%	4.5%
Florida	4.5%	7.3%
Washington	4.0%	3.4%
New Jersey	3.0%	4.1%
Colorado	2.7%	2.4%
Massachusetts	2.6%	2.4%
Illinois	2.4%	3.0%
Oregon	2.2%	1.8%
Maryland	2.2%	2.1%
Arizona	2.2%	2.3%
Virginia	2.1%	2.4%
Pennsylvania	2.1%	2.4%
Texas	1.9%	5.9%
Ohio	1.8%	1.5%
Georgia	1.6%	2.3%
North Carolina	1.6%	2.0%
Minnesota	1.2%	1.0%
Connecticut	1.1%	1.1%
Nevada	1.0%	1.3%
All other states	9.7%	12.9%

States organized by percent of total sales from November 2018 to October 2019.

The electricity generation emission factors are for the present day so they need to be to be projected outward over time to generate average emissions levels for each pollutant based on miles driven in each year of the vehicles life until scrappage. To do this we adjust each pollutants factor (grams/kWh) overtime to match the decline in CO_2 emissions from the electricity grid projected by the Department of Energy's Annual Energy Outlook (AEO).

This methodology requires four different datasets to generate the final emissions factors and these sources get updated regularly, either annually or biannually. Therefore, it is prudent to update the data used in this calculation, which has been done this year. There has been no change in the methodology. The years of the data for Greenercars model year 2023 and the updated methodology are detailed below in table 2.

Table 2. Data Sources and Years

Data Source	Data Year, Greenercars MY 23	Data Year, new methodology
EPA eGrid	2018	2021 values (latest)
Automotive Alliance EV Dashboard	Nov 2018 – Oct 2019 sales	2022 sales
GREET	2018	2022
AEO	2020	2022

Updating these data sources changed the upstream emissions factors for all the pollutants and the changes are detailed in table 3.

Table 3. Previous and Updated Emissions Factors

(g/kWh)	CO	NMOG/	NOX	PM10	SOx	CH4	N2O	CO2
MY 23 Values	0.227	0.045	0.272	0.025	0.323	0.807	0.007	262.115
New Values	0.152	0.046	0.168	0.024	0.109	0.825	0.006	274.030
change	-0.075	0.001	-0.104	-0.001	-0.214	0.019	-0.002	11.914
Percent change	-33%	2%	-38%	-4%	-66%	2%	-24%	5%

Half the pollutants had small changes of a few percent increase or decrease while the other half had quite significant changes. Notably, however, the factor for CO_2 increased 5% which impacted the results of the model. These changes are due in part to California accounting for a much smaller percent of total PEV sales in this round given the greater acceptance of these vehicles nationwide. California has a fairly low-polluting grid of predominately natural gas and renewables while states like Florida and Texas, with dirtier grids, accounted for a larger share of PEVs in this round. In addition, SO_x dropped considerably because there was a 56% drop in the rate of SO_x emissions that results from the combustion of coal in GREET 2022 compared to 2018 and coal was the predominant source of this pollutant. There were also significant drops in the combustion and feedstock emissions factors of NOX and CO from coal and the

combustion emissions of NOX and CO from natural gas between GREET 2022 and 2018. These are all due to methodology updates by GREET, likely largely stemming from changes made for GREET 2020 where a large update was made to emissions factors from electricity generation.

These changes resulted in small reductions in EDX (cents per mile in damage from emissions) because the reductions (on net) in criteria emissions outweighed the increase in greenhouse gas emissions (GHG). The average reduction in total EDX (which happened solely because of upstream emissions changes) is -0.016 cents per mile or about a 1.4% reduction. This is as a result of an average -0.026 cents per mile change in criteria emissions contribution to EDX and a 0.01 cents per mile increase in GHG contribution to EDX. The change did not vary across electric vehicles after accounting for efficiency because the only determining factor for an EV's upstream emissions is its efficiency.

Updating the Gasoline and Diesel Upstream Emissions Factors

Similarly, to electricity, we use GREET to calculate the emissions that result from the processes involved in bringing the gasoline or diesel to internal combustion engine (ICE) vehicles. These "well-to-pump" emissions are calculated on a per-gallon basis and were last updated for the MY 2020 edition of Greenercars using GREET 2018. The current emissions factors and proposed factors, from GREET 2018 and 2022 respectively, are presented in the following table.

Table 4. Well-to-pump emissions factors (grams/gallon), GREET 2018 vs. GREET 2022

		CO	NMHC	NOX	PM10	SOx	CH4	N2O	CO2
GREET 2018	Gasoline	1.936	3.344	4.095	0.394	2.456	13.165	0.315	1641
	Diesel	1.766	1.040	3.783	0.263	1.932	14.722	0.032	1842
GREET 2022	Gasoline	1.892	3.427	3.085	0.338	0.887	13.721	0.337	1644
	Diesel	1.596	0.964	2.450	0.175	0.670	14.357	0.031	1700
Percent change	Gasoline	-2%	2%	-25%	-14%	-64%	4%	7%	0%
	Diesel	-10%	-7%	-35%	-34%	-65%	-2%	-2%	-8%

These changes are the result of a change in the underlying research around refinery emissions for GREET 2019 that has been maintained since. The underlying research uses updated data sources for real-world emissions from refineries and resulted in a large decline in SOx emissions in addition to significant reductions in NOx and PM10 emissions. The resulting changes in EDX are presented below.

Table 5. Average EDX of ICE vehicles, existing and proposed methodology

	Existing methodology	Proposed methodology	Change	Percent Change
Diesel	1.672	1.616	-0.056	-3.4%
Gasoline	1.564	1.517	-0.048	-3.0%