Union of Concerned Scientists

Q&A

CLEANER CARS FROM CRADLE TO GRAVE

Frequently Asked Questions about Electric Cars' Lifetime Global Warming Emissions

HIGHLIGHTS

New UCS analysis has found that, in every region of the country, driving on electricity produces lower global warming emissions than the average new gasoline car (rated at 29 miles per gallon). Moreover, nearly two-thirds of Americans live in regions where an electric vehicle's emissions are lower than those of a 50-miles-per-gallon gasoline vehicle. This fact sheet answers frequently asked questions regarding hybrids, plug-in, and battery-electric vehicles, the environmental impact of regional electricity sources, and how we modeled the cars for our analysis.

Are electric vehicles "cleaner"—lower in global warming emissions—over their lifetimes than gasoline vehicles?

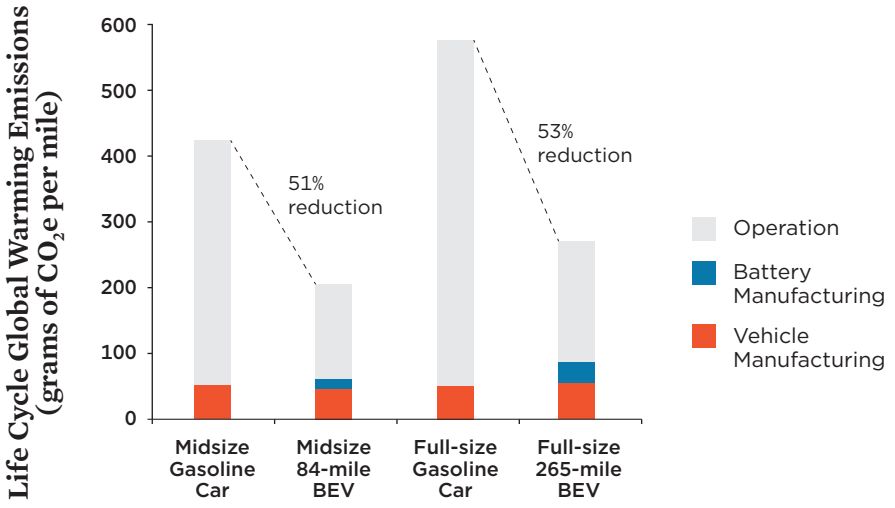
The two main stages of a car's life, emissions-wise, are its manufacture and its use—i.e., driving it.

We found that driving on electricity produces lower emissions than the average new gasoline vehicle (rated at 29 miles per gallon)—in any region of the country. Moreover, in regions where 66 percent of Americans live, driving on electricity produces lower emissions than those of a 50-miles-per-gallon gasoline vehicle.

But in manufacturing, a battery-electric vehicle (BEV) can have higher emissions, mostly from producing its lithium-ion battery. Assuming the average U.S. electricity grid mix, making an 84-mile-range midsize BEV typically results in 1 ton of global warming emissions—15 percent more than from manufacturing a similar-sized gasoline vehicle.

However, this manufacturing gap is more than offset by the BEV's emissions advantage when driving. The overall lifetime emissions of an 84-mile range midsize BEV, for example, are about 50 percent lower than its gasoline counterpart (see the figure). The two BEVs we modeled, midsize and full-size, are not specific

Life Cycle Global Warming Emissions from the Manufacturing and Operation of Gasoline and Battery-Electric Vehicles



Notes: We assume that the midsize vehicles are driven 135,000 miles over their lifetimes and the full-size vehicles 179,000 miles. The difference in the two mileages derives from the dissimilar uses of 84-mile-range and 265-mile-range battery-electric cars, as described in Chapter 2. We further assume that a consumer buying a BEV would drive it the same total of miles as a corresponding gasoline vehicle. We use U.S. average electricity grid emissions to estimate manufacturing emissions, while the average electricity grid emissions intensity during vehicle operation are based on a sales-weighted average of where EVs are being sold today.

to any particular manufacturer but are based on the two most popular BEV models sold in the United States today: the Nissan LEAF and the Tesla Model S. Our analysis reflects the BEVs available to American consumers and comparable gasoline vehicles.

Comparing that average midsize 84-mile-range BEV with its gasoline counterpart, just 4,900 miles (less than one year) of driving are needed to "pay back"—i.e., offset—the extra emissions from producing the BEV's battery. Similarly, it takes 19,000 miles (16 months) with a full-size 265-mile-range BEV.

What about other electric vehicles (EVs)—the hybrids and plug-in hybrids?

Because plug-in hybrid EVs typically have smaller-capacity batteries than BEVs, they likely produce lower global warming emissions during manufacturing. But by drawing on a combination of gasoline and electricity during use, their emissions on the road likely will be higher. Previous life cycle studies of cars' emissions place plug-in hybrids between fully gasoline and fully battery-electric vehicles with respect to global warming emissions (Hawkins, Gausen, and Strømman 2012).

The battery and electric motor of a conventional hybrid vehicle, which does not plug in at all, cause greater manufacturing emissions than a gasoline car (though less than a plug-in hybrid or BEV). However, the electric-drive motor increases the vehicle's efficiency, offsetting the additional manufacturing emissions through lower fuel use.

What is the most important factor in determining the global warming emissions from EVs?

Most critical is the electricity source used to charge the battery. The emissions from a BEV can be reduced by not only driving the car using cleaner sources of electricity, but also manufacturing it using cleaner sources of electricity. Therefore the widespread adoption of policies that encourage more generation from renewable sources, such as the Environmental Protection Agency's (EPA's) recently finalized Clean Power Plan (EPA 2015a), can make EVs even cleaner both in manufacturing *and* driving.

How did you estimate emissions for electric and gasoline vehicles?

With respect to driving an EV, we determined the average emissions of each U.S. grid region as a function of its mix of power plants, having obtained the most recent data from the EPA's eGrid database (EPA 2015b). We also included the emissions from extraction and transportation of fuels used in electricity production. For example, the emissions from mining and then transporting coal to the power plant were considered, as well as the inefficiencies of transmitting electricity from the power plant to the vehicle. We treated gasoline in a similar manner, accounting for extraction, refining, and the product's transportation to filling stations.

To estimate the global warming emissions of manufacturing the vehicles, we employed Argonne National Laboratory's GREET 2014 model available online (ANL 2014).

REFERENCES

Argonne National Laboratory (ANL). 2014. GREET model: The greenhouse gases, regulated emissions, and energy use in transportation model. Argonne, IL. Online at *https://greet.es.anl.gov/main*, accessed on September 19, 2015.

Environmental Protection Agency (EPA). 2015a. Clean Power Plan for existing power plants. Washington, DC. Online at *http://www2.epa.gov/cleanpowerplan/clean-power-plan-existing-power-plants*, accessed on September 15, 2015.

Environmental Protection Agency (EPA). 2015b. The emissions & generation resource integrated database (eGRID): Tenth edition with year 2012 data (eGRID20015 Version 1.0). Washington, DC. Online at *http://www2.epa.gov/energy/egrid*, accessed October 12, 2015.

Hawkins, T.R., O.M. Gausen, and A.H. Strømman. 2012. Environmental impacts of hybrid and electric vehicles—A review. *The International Journal of Life Cycle Assessment* 17(8):997–1014. Online at *http://link.springer.com/article/10.1007/s11367-012-0440-9*, accessed August 28, 2015.

Union of Concerned Scientists

FIND A FULLY REFERENCED VERSION ONLINE: www.ucsusa.org/EVlifecycle

The Union of Concerned Scientists puts rigorous, independent science to work to solve our planet's most pressing problems. Joining with citizens across the country, we combine technical analysis and effective advocacy to create innovative, practical solutions for a healthy, safe, and sustainable future.

NATIONAL HEADQUARTERS
Two Brattle Square
Cambridge, MA 02138-3780
Phone: (617) 547-5552
Fax: (617) 864-9405

WASHINGTON, DC, OFFICE
1825 K St. NW, Suite 800
Washington, DC 20006-1232
Phone: (202) 223-6133
Fax: (202) 223-6162

WEST COAST OFFICE
500 12th St., Suite 340
Oakland, CA 94607-4087
Phone: (510) 843-1872
Fax: (510) 843-3785

MIDWEST OFFICE
One N. LaSalle St., Suite 1904
Chicago, IL 60602-4064
Phone: (312) 578-1750
Fax: (312) 578-1751

WEB: www.ucsusa.org