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Are electric vehicles definitely better for the climate than gas-powered cars?



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Yes: although electric cars' batteries make them more carbon-intensive to



by Andrew Moseman, MIT
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featuring guest expert Sergey
Paltsev, Deputy Director of

manufacture than gas cars, they more than make up for it by driving much cleaner under nearly any conditions.

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Although many fully electric vehicles (EVs) carry “zero emissions” badges, this claim is not quite true. Battery-electric cars may not emit greenhouse gases from their tailpipes, but some emissions are created in the process of building and charging the vehicles. Nevertheless, says Sergey Paltsev, Deputy Director of the MIT Joint Program on the Science and Policy of Global Change, electric vehicles are clearly a lower-emissions option than cars with internal combustion engines. Over the course of their driving lifetimes, EVs will create fewer carbon emissions than gasoline-burning cars under nearly any conditions.

“We shouldn't claim victory that with this switch to electric cars, problem solved, we are going to have zero emissions,” he says. “No, that's not the case. But electric cars are actually much, much better in terms of the impact on the climate in comparison to internal combustion vehicles. And in time, that comparative advantage of electric cars is going to grow.”

One source of EV emissions is the creation of their large lithium-ion batteries. The use of minerals including lithium, cobalt, and nickel, which are crucial for modern EV batteries,



the MIT Joint Program on the Science and Policy of Global Change

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requires using fossil fuels to mine those materials and heat them to high temperatures. As a result, building the 80 kWh lithium-ion battery found in a Tesla Model 3 creates between 2.5 and 16 metric tons of CO₂ (exactly how much depends greatly on what energy source is used to do the heating).¹ This intensive battery manufacturing means that building a new EV can produce around 80% more emissions than building a comparable gas-powered car.²

But just like with gasoline cars, most emissions from today's EVs come after they roll off the production floor.³ The major source of EV emissions is the energy used to charge their batteries. These emissions, says Paltsev, vary enormously based on where the car is driven and what kind of energy is used there. The best case scenario looks like what's happening today in Norway, Europe's largest EV market: the nation draws most of its energy from hydropower, giving all those EVs a minuscule carbon footprint. In countries that get most of their energy from burning dirty coal, the emissions numbers for EVs don't look nearly as good—but they're still on par with or better than burning gasoline.

To illustrate how EVs create fewer emissions than their counterparts, Paltsev points to MIT's Insights Into Future Mobility study from 2019.⁴ This study looked at comparable vehicles like the Toyota Camry and Honda Clarity across their gasoline, hybrid, plug-in hybrid, battery electric, and hydrogen fuel cell configurations. The researchers found that, on average, gasoline cars emit more than 350

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grams of CO₂ per mile driven over their lifetimes. The hybrid and plug-in hybrid versions, meanwhile, scored at around 260 grams per mile of carbon dioxide, while the fully battery-electric vehicle created just 200 grams. Stats from the U.S. Department of Energy tell a similar story: Using the nationwide average of different energy sources, DOE found that EVs create 3,932 lbs. of CO₂ equivalent per year, compared to 5,772 lbs. for plug-in hybrids, 6,258 lbs. for typical hybrids, and 11,435 lbs. for gasoline vehicles.⁵

MIT's report shows how much these stats can swing based on a few key factors. For example, when the researchers used the average carbon intensity of America's power grid, they found that a fully electric vehicle emits about 25 percent less carbon than a comparable hybrid car. But if they ran the numbers assuming the EV would charge up in hydropower-heavy Washington State, they found it would emit 61 percent less carbon than the hybrid. When they did the math for coal-heavy West Virginia, the EV actually created more carbon emissions than the hybrid, but still less than the gasoline car.

In fact, Paltsev says, it's difficult to find a comparison in which EVs fare worse than internal combustion. If electric vehicles had a shorter lifespan than gas cars, that would hurt their numbers because they would have fewer low-emissions miles on the road to make up for the carbon-intensive manufacture of their batteries. Yet when the MIT study calculated a comparison in which EVs lasted only 90,000 miles on the road rather than

180,000 miles, they remained 15 percent better than a hybrid and far better than a gas car.

And while internal combustion engines are getting more efficient, EVs are poised to become greener by leaps and bounds as more countries add more clean energy to their mix. MIT's report sees gasoline cars dropping from more than 350 grams of CO₂ per mile to around 225 grams by the year 2050. In that same span, however, battery EVs could drop to around 125 grams, and perhaps even down to 50 grams if the price of renewable energy were to drop significantly.

"Once we decarbonize the electric grid—once we get more and more clean sources to the grid—the comparison is getting better and better," Paltsev says.

Thank you to several readers for sending in related questions, including Ross Burlington of Riverside, California, Lloyd Olson of Webberville, Texas, and Thomas Marshall of Lake Charles, Louisiana. You can submit your own question to Ask MIT Climate [here](#).

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FOOTNOTES

¹ These figures are derived from comparison of three recent reports that conducted broad literature reviews of studies attempting to

quantify battery manufacturing emissions across different countries, energy mixes, and time periods from the early 2010s to the present. We discard one outlier study from 2016 whose model suggested emissions from manufacturing the battery in our example could total as high as almost 40 metric tons. The lowest estimates typically come from studies of U.S. and European battery manufacturing, while the highest come from studies of Chinese and other East Asian battery manufacturing—which is consistent with the different energy mixes in these regions. For more information, see:

Erik Emilsson and Lisbeth Dahllöf. "[Lithium-ion vehicle battery production: Status 2019 on energy use, CO₂ emissions, use of metals, products environmental footprint, and recycling](#)." IVL Swedish Environmental Research Institute, in cooperation with the Swedish Energy Agency, Report C444, November 2019.

Hans Eric Melin. "[Analysis of the climate impact of lithium-ion batteries and how to measure it](#)." Circular Energy Storage Research and Consulting, July 2019. Commissioned by the European Federation for Transport and Environment.

Dale Hall and Nic Lutsey. "[Effects of battery manufacturing on electric vehicle life-cycle greenhouse gas emissions](#)." The International Council on Clean Transportation, February 2018.

² This estimate comes from Argonne National Laboratory's [GREET](#)  (Greenhouse gases, Regulated Emissions, and Energy use in Technologies) Model, sponsored by the U.S. Department of Energy. It assumes comparable models of EV and gas-powered car, and that the EV has a battery with a range of 300 miles, similar to a Tesla Model 3. Different assumptions about battery manufacture would offer different comparisons; in this model, the battery of the EV entails close to 12 metric tons of CO₂ emissions.

³ Using the same GREET figures as above, manufacturing and end-of-life disposal account for around 9% of a gas car's emissions, and around 29% of an EV's (more than half of which comes from the battery alone). A plug-in hybrid EV is in the middle at around 17%. This analysis

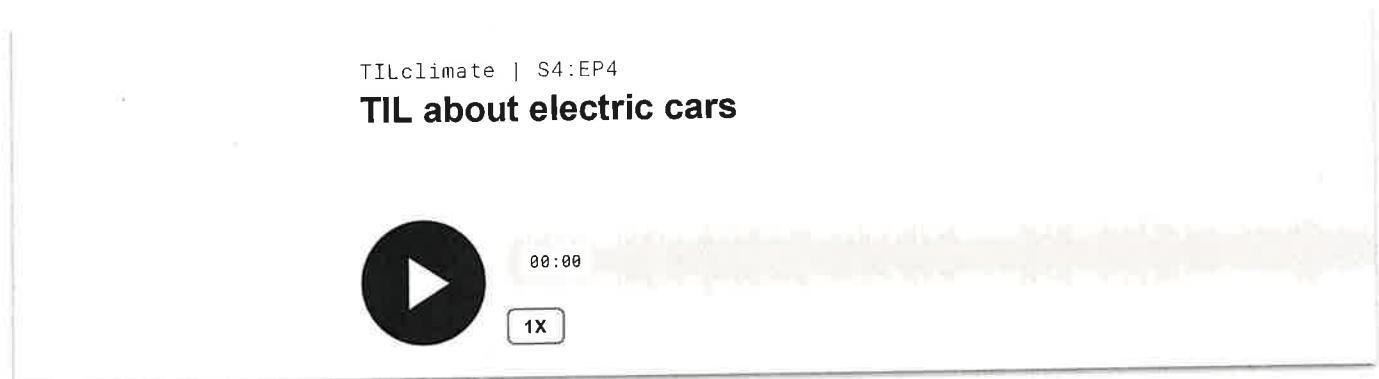
assumes the EV is charged with the average emissions intensity of the U.S. electric grid; that all cars drive around 173,000 miles in their lifetime; and that the gas car gets 30.7 miles to the gallon.

⁴ MIT Energy Initiative: [Insights Into Future Mobility](#) [↗](#), November 2019.

⁵ U.S. Department of Energy Alternative Fuels Data Center: [Emissions from Electric Vehicles](#) [↗](#). Accessed October 13, 2022.

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