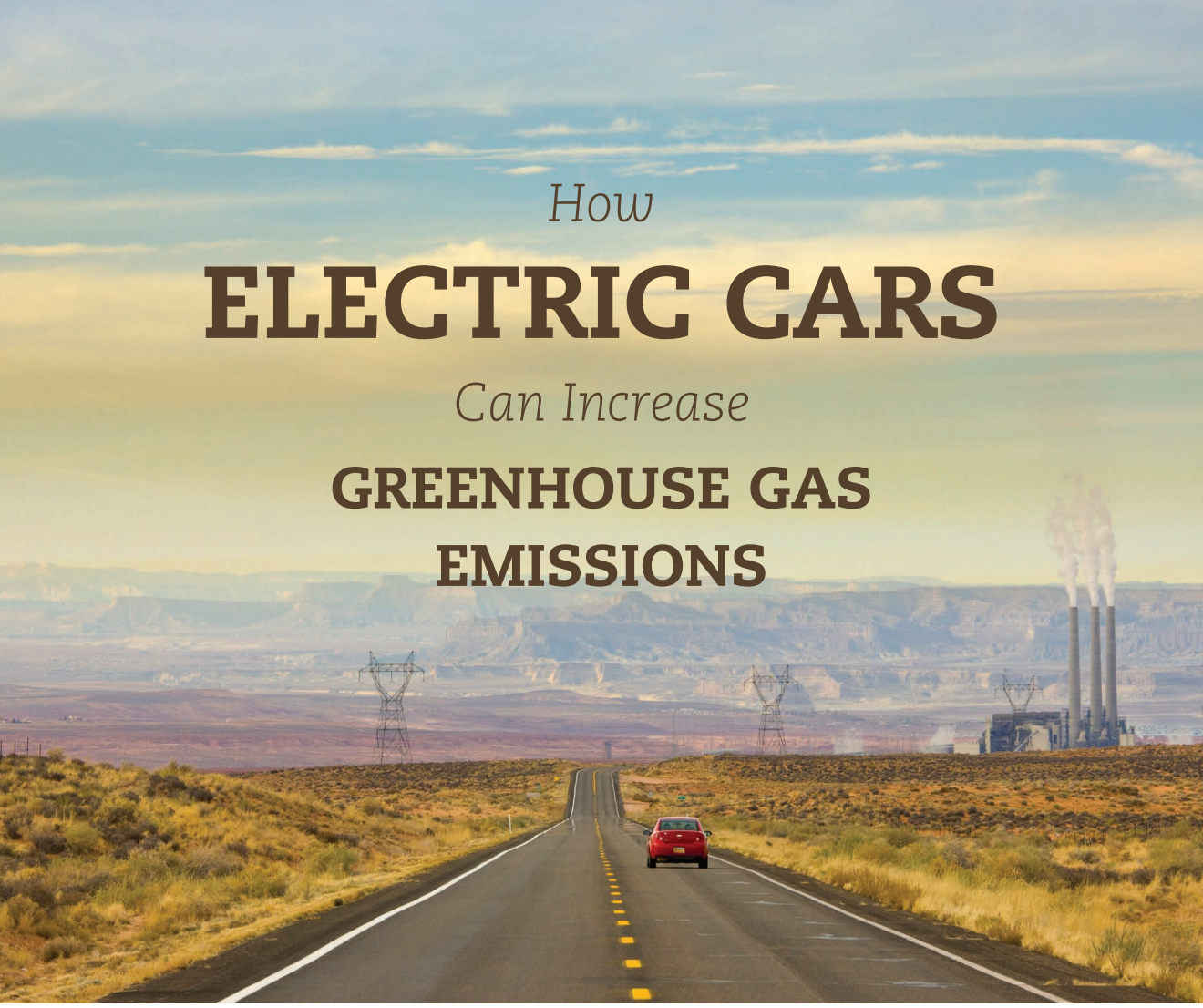

How ELECTRIC CARS *Can Increase* GREENHOUSE GAS EMISSIONS

Under existing fuel economy and electricity policies, subsidies for plug-in vehicles may have the opposite effect on vehicle emissions than intended, warn ***Joshua Linn*** *and* ***Virginia McConnell****.*

Substantial subsidies exist for vehicles that use electricity from the power grid, which includes vehicles that either run entirely on electricity (such as the Nissan Leaf) or are capable of using gasoline or electricity (the Chevy Volt, for example). The subsidies take the form of tax credits of $7,500 to more than $10,000 per vehicle, government incentives for home charging equipment, and access to high-occupancy vehicle lanes.

The motivation for these policies is that many consider electric vehicles to be essential for achieving the long-term goals of dramatically reducing vehicles' oil consumption

and greenhouse gas (GHG) emissions. In reality, GHG reductions are not a given. The net effect of electric vehicles on emissions will depend on the mix of electric vehicles and other vehicles in the fleet—which are influenced by the Corporate Average Fuel Economy (CAFE) standards—and on emissions from the electricity used to power the vehicles (upstream emissions), which are influenced by policies at federal and state levels.

Accounting for these interactions, subsidies for electric vehicles have the potential to increase, not decrease, the average emissions rates of new passenger vehicles. Offsetting this increase would require strong complementary policies to reduce electricity-sector emissions. Subsidies for electric vehicles to increase their penetration into the fleet therefore need to be justified on other grounds, such as manufacturers or consumers learning about new electric vehicle technologies, which could have spillover effects to other manufacturers or consumers.

How the CAFE Program and Electric Vehicle Crediting Work

As part of the CAFE program, the US Environmental Protection Agency (EPA) essentially sets an average GHG emissions rate for cars and light trucks sold each year. For each manufacturer subject to the program, the sales-weighted average emissions rate must equal a particular level that depends on the size mix of the vehicles sold by the manufacturer. The GHG emissions rate is inversely proportional to the vehicle's fuel economy—so setting a lower emissions rate standard is equivalent to setting a higher fuel economy standard.

The fact that the program fixes the average emissions rate at a stricter level than auto companies would attain on their own implies that vehicle subsidies have an unexpected effect. Consider a simple hypothetical, in which a manufacturer sells an equal number of two types of vehicles: one that has an emissions rate below the standard, such as an electric vehicle, and another that has an emissions rate above

the standard. The sales-weighted average emissions rate of the two models exactly equals the standard. If the government then decides to subsidize sales of the low-emissions vehicle—say, by offering a tax credit—the sales of that vehicle would increase. However, the manufacturer's sales-weighted emissions rate would now lie below the level of the standard. Recent research (by RFF Senior Fellow Virginia McConnell and Tom Turrentine of the University of California, Davis, and by RFF University Fellow Lawrence Goulder and colleagues) makes the case that the manufacturer would respond by increasing the emissions rates on the high-emissions vehicles, increasing sales, or both to exactly meet the standard.

But under the most recent extension of the CAFE program, EPA allows an additional subsidy to electric vehicles, beyond the federal tax credit and other subsidies, which could actually cause the average emissions rate of new vehicles to increase. Under the reformed CAFE standards for 2017–2021, manufacturers can count each all-electric vehicle they sell as two vehicles for computing the sales-weighted average emissions rate. (This multiple will decline to 1.7 over time to the 2021 model year.) The actual sales-weighted average emissions rate is therefore higher than the standard even though the manufacturer is in compliance, and the overcrediting could increase the average emissions rate. Whether it does depends on electricity-sector emissions.

Electricity-Sector Emissions

The new CAFE policy is complex, but it basically allows manufacturers to effectively assume zero upstream GHG emissions from electricity generation to power electric vehicles. But actual GHG emissions from the electricity sector will differ based on electricity-sector emissions policies around the country. The three cases below demonstrate the different ways that electric vehicles can contribute to electricity-sector GHG emissions.

Case 1: No Greenhouse Gas Policy in the Electricity Sector

Because actual electricity-sector emissions for all-electric vehicles are greater than zero, selling an additional electric vehicle raises the average emissions rate of new vehicles—and this increase occurs above the increase caused by overcrediting that was discussed earlier.

But just how large are these electricity-sector emissions? Let's consider a single driver plugging into the grid at a particular time and location. Doing so raises electricity demand. Some generator, somewhere in the grid, must then increase electricity generation. If that generator runs on coal, greenhouse gas emissions increase even more than if that generator is gas fired. Therefore, the electricity-sector emissions depend on when and where the driver plugs in the vehicle. For example, charging at an off-peak time in a coal-powered region will have a much different effect than during a peak time in an area that receives more power from natural gas. Recent research by University of California, San Diego, economist Joshua Graff Zivin and colleagues suggests that in most regions of the United States, the emissions rates of so-called zero-emissions electric vehicles are comparable to that of a Toyota Prius hybrid—and in some cases are higher than even the average gasoline-powered car.

Case 2: An Emissions Cap for the Electricity Sector

In the opposite extreme from the no-policy case, a cap-and-trade program sets a maximum level of emissions from the electricity sector. Plugging into the grid doesn't affect electricity-sector emissions at all. Electricity demand increases when a driver plugs into the grid, but some change in the power system—perhaps replacing coal–fired generation with natural gas–fired generation—must occur so that total emissions from the power sector do not change.

This principle underlies California's zero-emissions vehicle program, which requires a certain level of sales of vehicles with qualifying technologies, such as electric vehicles. Because California caps emissions from about 85 percent of its economy, the zero-emissions program does not count emissions associated with electricity generation. However, this accounting is correct only if there is no emissions leakage—that is, if none of the reduction in emissions counted toward California's cap is offset by an increase in emissions from sources not included in the cap. With some leakage, an increase in electricity demand caused by plugging in an electric vehicle could increase total greenhouse gas emissions.

Case 3: An Emissions Rate Policy for the Electricity Sector

When an electricity policy affects the average carbon dioxide emissions rate for electricity generation, how electric vehicles contribute to electricity-sector emissions becomes more complex. Some existing policies, most notably renewable portfolio standards (RPS), effectively reduce the average emissions rate of the electricity sector. Typically, an RPS requires that renewable technologies, such as wind and solar, account for a predetermined fraction of total electricity generation.

Why would an RPS or similar policy matter? The research on electricity-sector emissions cited earlier focused on the short run—that is, how plugging into the grid affects total emissions without accounting for investment in new generators. However, a long-term increase in electricity demand, such as that caused by the purchase and use of a single electric vehicle, causes a small amount of investment in new generation capacity. With an RPS,

renewables would have to account for at least some of this investment. This effect could cause the emissions associated with plugging into the grid to be less than suggested by the short-run analysis. How much less depends on the stringency of the RPS and other factors.

Conclusions

Because the CAFE program fixes the average GHG emissions rate of new vehicles sold, it is easy to assume that the sale of an additional electric vehicle will not affect this average rate. However, because the program overcredits electric vehicles and ignores electricity-sector emissions, each electric vehicle is likely to increase the average rate of emissions. Policies that reduce emissions rates from the electricity sector, such as an RPS, can mitigate this effect but do not completely eliminate it—only an emissions cap or its equivalent can do that. Although these conclusions do not imply that subsidies or preferred treatment for electric vehicles are unwarranted, they do mean that such policies must be justified by other possible market failures.

For example, one manufacturer may learn from another manufacturer's design of an electric vehicle. Such innovation spillovers could justify additional subsidies. Alternatively, if consumers have incomplete information about the performance or reliability of the vehicle, subsidies encouraging the use of such vehicles could stimulate learning about these vehicles across the broader population. ●

FURTHER READING

Goulder, Lawrence H., Mark R. Jacobsen, and Arthur A. Van Benthem. 2009. Impacts of State-Level Limits on Greenhouse Gases per Mile in the Presence of National CAFE Standards. Working paper. Stanford, CA: Stanford University.

Graff Zivin, Joshua S., Matthew Kotchen, and Erin T. Mansur. 2012. Spatial and Temporal Heterogeneity of Marginal Emissions: Implications for Electric Cars and Other Electricity-Shifting Policies. Working paper 18462. Cambridge, MA: National Bureau of Economic Research.

McConnell, Virginia, and Tom Turrentine. 2010. Should Hybrid Vehicles Be Subsidized? Backgrounder. Washington, DC, and Tulsa, OK: Resources for the Future and the National Energy Policy Institute.