How Carbon Taxes Reduce CO2 Emissions in Transportation
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Summary
Any effective climate policy must credibly address transportation, which emits more greenhouse gases than any other sector of the U.S. economy. Fortunately, research indicates that drivers faced with higher fuel prices—either from specific fuel taxes or broader carbon taxes—use significantly less gasoline and diesel over time as they adjust their driving behavior to save money. Most important in the long run, rising carbon fees will also incent more rapid customer acceptance of electric vehicles, as well as more innovation and cost-reduction by makers of EVs. The result will be much cleaner air and fewer climate emissions.

Introduction
Critical discussions of carbon pricing often assert that imposing rising fees on the sale of climate-polluting fossil fuels would do little to reduce emissions in several key sectors of the economy, most notably transportation. Fuel prices, many believe, have little impact on driving behavior because fuel is a small part of many people’s budgets and many drivers have few alternatives to using their cars for commuting and errands.¹

These claims, if true, would be damning. Transportation accounts for about 30 percent of all energy-related carbon dioxide emissions in the United States, more than any other economic sector. Emissions from motor gasoline and diesel-powered vehicles—the focus of this brief report—contributed about 84 percent of total emissions from the sector in 2020.²

In this document, we present evidence that carbon pricing in the transportation sector can reduce emissions far more than some have claimed.

How fuel taxes and carbon fees take a bite out of fuel consumption
Drivers do have choices. They can respond to higher fuel prices by combining errands and taking shorter discretionary trips. They can conserve substantial fuel simply by avoiding excessive highway speeds and by inflating their tires to proper pressures.³ They can switch to public transportation or carpool where available. Over time, they can even move closer to work to avoid long commutes. Following the Russian invasion of Ukraine in February 2022,
the International Energy Agency identified 10 such demand-reducing measures to largely offset the potential loss of Russian oil supplies on world markets in the short term.4

Why, then, are critics pessimistic about the effectiveness of carbon taxes? Several influential studies in the early 2000s suggested that the measured response of U.S. drivers to changes in gasoline price has declined over time. Typically they concluded that a 10 percent increase in the price of gasoline would cut short-term consumption by less than 1 percent; in the longer run (usually not defined), as people acquire more efficient vehicles or adjust their commuting behavior, such a price change might induce a drop in gasoline demand of 2 to 4 percent—still nothing dramatic.5 Analysts argued that rising incomes, better vehicle mileage, and sprawling land use patterns have made drivers relatively insensitive to fuel costs.

But newer empirical studies offer solid grounds for more optimism. They report that consumers are much more responsive to price changes caused by new taxes than by ordinary market fluctuations. One reason may be that most tax changes are accompanied by considerable publicity, making consumers more sensitive to what they are paying. Consumers realize that taxes raise costs over the long term, unlike short-term price hikes they can “ride out.”

An important 2011 paper by Lucas Davis and Lutz Kilian found that state and federal fuel tax changes had nearly five times as much short-term impact as ordinary price changes on demand for gasoline. A 10 percent price increase driven by a tax would cut gasoline use (and carbon dioxide emissions) by nearly 5 percent. “The long-run response is likely to be considerably larger as drivers substitute toward more fuel-efficient vehicles,” they added. This effect is of the same magnitude as the impact of tobacco taxes in discouraging cigarette smoking in high-income countries.6

In the transportation sector, carbon taxes look much like fuel taxes. For perspective, a carbon fee of $30 per ton of CO₂ would raise gasoline prices almost $0.30 per gallon, or roughly 10 percent if gasoline were still selling for $3.00 per gallon. Based on new studies of consumer behavior inspired in part by Davis and Kilian, Columbia’s Noah Kaufman used Rhodium Group modeling to estimate that a $50 per ton carbon tax would cut U.S. gasoline consumption up to 9 percent after five years, reducing annual emissions of carbon dioxide by 100 million tons.7 That’s a great start. It’s clearly not sufficient to decarbonize the transportation sector, which is why a carbon tax must continue to rise. Fortunately, as we will see, the prospect of such a rising tax will almost certainly cause consumers and manufacturers to find even cleaner options for mobility over time.

The international record

Studies of other advanced economies have also reported impressive changes in demand for transportation fuels in response to fuel and carbon taxes.8 Economists at the University of Ottawa reported that a modest revenue-neutral carbon tax introduced in British Columbia, starting at C$10 per ton in 2008 and rising to C$30 in 2012, strongly affected driver behavior. At a rate of $25 per ton of CO₂, the tax drove down short-term gasoline demand more than 12 percent, far more than predicted by traditional studies of consumer behavior. Over the first
four years, they calculated, “the BC carbon tax led to a total reduction in emissions from gasoline consumption of over 3.5 million tCO₂e when compared with a counterfactual scenario of no tax.”

In the early 1990s, Sweden replaced existing transport fuel taxes with a carbon tax and a value-added tax. These higher taxes drove down CO₂ emissions in Sweden’s transportation sector by 11 percent, *more than three times* what would be expected from ordinary price increases.¹⁰ Costly fuel, combined with tax incentives for the purchase of clean vehicles, have helped make Sweden one of the world’s leading adopters of electric vehicles.¹¹

German economist Thomas Sterner reported in a 2007 study focused on European countries with high gasoline and diesel taxes that “fuel taxes are the single most powerful climate policy instrument implemented to date. . . . Had the whole OECD instead had fuel (gasoline and diesel) prices like the US then consumption would be . . . 30% higher than actual current use.”¹²

His point can be seen at a glance from the striking international correlation between high national fuel taxes and lower carbon dioxide emissions from vehicles per dollar of GDP, captured in the [OECD chart](#) below.
The long-run impact of carbon taxes on transportation will be far more significant

The biggest opportunity for tackling harmful greenhouse gas and toxic air emissions from cars and trucks lies not in changing the short-term behavior of drivers but their choice of vehicles, which may operate for two decades before being scrapped. Fuel prices have great bearing on their choices. A long stretch of relatively low gasoline prices thus contributed to a sharp rise in the market share of heavy SUVs in California, driving its transportation emissions up in recent years despite all the state’s well-meaning environmental programs. Reversing that dynamic will be critically important for bringing national greenhouse gas emissions under control.

The good news is that carbon fees can help promote such a healthy reversal. Studies have repeatedly shown that drivers buy more fuel-efficient vehicles in the face of persistently higher fuel prices. Today, drivers no longer have to settle for marginal increases in fuel economy from vehicles dependent on fossil fuels. A proliferation of new zero-emission electric vehicles is transforming the global consumer marketplace (see chart). With equivalent fuel economy exceeding 100 miles per gallon, high-performance plug-in vehicles cost more up front but can save consumers money over time through lower fuel and maintenance costs.

Millions of potential new customers woke up to that fact during the gasoline price spike that accompanied the Russian invasion of Ukraine in February 2022. Electric vehicle sales in the United States soared 76 percent in the first quarter of 2022, as purchases of traditional cars and trucks slumped. Volkswagen, the second largest supplier of EVs in the U.S. market behind Tesla, reported that several of its plug-in models sold out their entire 2022 production run by March.
While many factors affect national rates of EV purchases, including buyer subsidies and charging station availability, it is striking that the top EV markets worldwide are all countries with high fuel taxes, as shown here.\(^{18}\)

Higher fuel or carbon taxes encourage consumer adoption of EVs in several ways. They give drivers a strong nudge to scrap their old clunkers and look for more fuel-efficient replacements. They help close the cost-of-ownership gap between internal combustion and electric vehicles. They incentivize manufacturers to pursue cost-saving innovations in EV production and charging-station deployments.\(^{19}\) Carbon taxes offer the additional benefit of hastening the transition to emissions-free electricity on grids that power plug-in cars and trucks.

Two recent studies, among the first of their kind, quantify the impact of rising gasoline prices on consumer purchases of electric vehicles. One 2022 study by three economists at UC-Davis concludes that a 40 cent per gallon increase in the price of gasoline in California translates into “a whopping 57 percent” increase in demand for EVs. Another study out of Norway, which has the world’s largest market share of EVs, reports that every 10 percent increase in liquid fuel prices translates into a 6 percent increase in demand for all-electric vehicles.\(^{20}\)

Owing to their high efficiency and ability to charge from zero-carbon electricity, plug-in models have a far smaller climate footprint than gasoline- and diesel-powered vehicles. “The average EV produces global warming pollution equal to a gasoline vehicle that gets 88 miles per gallon (mpg)—significantly better than the most efficient gasoline car available in the United States today (58 mpg) and far cleaner than the average new gasoline car (31 mpg) or truck (21 mpg),” according to the Union of Concerned Scientists.\(^{21}\) As the U.S. power grid grows ever cleaner with the replacement of coal plants by wind and solar energy, the EV advantage will only grow.

A significant rise in EV market share would thus have dramatic effects on carbon emissions. Indeed, a summary report on major economic models of carbon tax impacts noted that virtually none considers the coming technological revolution in road transportation. “If electric vehicles or advanced biofuels gain market share,” the report stated, “then oil use in the transportation sector may become much more responsive to a carbon price than models currently predict.”\(^{22}\)

Other social benefits of EVs will also become enormous over time. According to the American Lung Association, a rapid transition from new sales of traditional cars and trucks to electric
vehicles over the next 15 years, along with cleaner generation to power them, would slash greenhouse gas emissions from road transportation 93 percent by 2050. It would also dramatically cut deadly fine particulates and smog-forming compounds, resulting in 110,000 fewer deaths, 2.8 million fewer asthma attacks, and 13.4 million fewer sick days by mid-century. Over three decades, the savings in public health costs would exceed $1 trillion.\textsuperscript{23}

![Annual Health Benefits (Billions)](image)

**Carbon taxes are more cost-effective than regulations**

Carbon taxes alone may not supercharge the EV market fast enough to meet national and global climate goals. Additional policies such as income-based purchase subsidies and subsidies for the build-out of charging stations show promise of stimulating consumer demand for these clean vehicles with reasonable efficiency and equity.\textsuperscript{24} Broader measures to address transportation emissions will need to encourage alternative forms of transportation (such as bicycling and walking), public transit, and land-use planning to support them.\textsuperscript{25}

But regulations and subsidies lack many of the benefits of carbon taxes. Consider, for example, fuel efficiency standards like CAFE as alternative tools to lower greenhouse gas emissions in the vehicle fleet. Unfortunately, they apply only to new vehicles. They do nothing to lower emissions from existing vehicles. They fail to stimulate consumer demand for clean vehicles. Indeed, by raising the price of new cars, they may induce consumers to delay scrapping their older, less efficient cars. Last but not least, they suffer from what economists call the “rebound effect”: more efficient vehicles reduce the per-mile cost of driving, inducing some people to drive more, which in turn offsets some of the predicted drop in emissions.

Higher fuel taxes, on the other hand, encourage customers to replace their old cars, purchase cleaner vehicles, \textit{and} to drive less. To quote the unhedged conclusion of two experts on how to make cars greener, “No regulatory alternative achieves the efficiency of a fuel tax.”\textsuperscript{26}

A 2013 study published in \textit{Energy Economics} by four economists at MIT determined that increased CAFE standards would cost the US economy six to 14 times more than a federal gas tax to achieve the same reduction in fuel use over a period of four decades. As the lead author explained, “That is because a gas tax provides immediate, direct incentives for drivers to reduce gasoline use, while the efficiency standards must squeeze the reduction out of new vehicles only. The new standards also encourage more driving, not less.”\textsuperscript{27} UC Davis economist Mark Jacobsen calculated that owing to their high compliance costs and modest effectiveness, national fuel economy standards cost roughly $307 to eliminate one ton of CO\textsubscript{2}
emissions—a price far higher than any mainstream carbon tax proposal. Finally, studies show that fuel economy standards fall relatively harder on the poor (are more regressive) than carbon taxes, particularly when compared to carbon tax revenues that are returned to individuals as lump-sum payments.

**Conclusion**

One must agree with critics who point out that “at the tax levels that have been politically feasible thus far, carbon taxes alone are unlikely to solve the climate change problem.” The problem, of course, lies not with carbon taxes, but with the lack of political will in the United States and many other countries to set taxes high enough in the face of entrenched opposition. However, a predictable and rising carbon fee, coupled with a dividend back to individual consumers and a border adjustment to avoid disadvantaging US businesses internationally, may win widespread public support in today’s political climate.

Most proponents of carbon taxes also agree they should not be the *only* means of tackling climate disruption. Many economists endorse well-designed government subsidies and standards to spur research and development, reduce costs for early-stage clean technologies, and cut emissions from sources that carbon taxes do not address.

But as the empirical evidence cited here demonstrates, higher carbon taxes should be the foundation of any program to reduce greenhouse gas emissions in transportation, the sector most responsible for them. Claiming otherwise will only slow political momentum for adopting this most promising and cost-effective policy to curb global climate disruption.

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3 The typical passenger car’s rated fuel efficiency at 55 miles per hour drops 17 percent at 70 mph, and even more at higher speeds ([MPGForSpeed.com](http://www.MPGForSpeed.com) and “Driving More Efficiently” at fueleconomy.gov).


10 Julius J. Andersson, “Cars, Carbon Taxes and CO2 Emissions,” March 2017, London School of Economics and Political Science. Andersson estimated a price elasticity of demand of -0.51 and a tax elasticity of demand of -1.57 over an “intermediate” period of several years. Sweden’s carbon tax would likely have had a much more dramatic effect on fuel consumption if the country had not already had substantial fuel taxes averaging about 4 SEK per litre of gasoline (Andersson, 7).


Department of Energy, “eGallon: Compare the costs of driving with electricity”; “These charts show how much it costs to charge an EV vs. refueling a gas vehicle,” CNBC, March 19, 2022; “Will owning an electric vehicle save you money?” NBC News, March 16, 2022.

“US Electric Vehicle Sales Soared in First Quarter, while Overall Auto Sales Slid,” InsideClimateNews.com, April 28, 2022; “Volkswagen says high demand is helping its EVs turn a profit sooner than expected,” CNBC, March 15, 2022.

“Chart: These countries have the most electric vehicles,” CanaryMedia.com, March 18, 2022


30 Steven Nadel, ACEEE, op. cit.
