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Electric Vehicles, Potholes, and Taxes: Who Pays the Price?

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Summary:

Automobile manufacturers and even some states have ambitious goals to phase out gas-powered cars. Currently, a primary source of automobile infrastructure funding is gasoline taxes. But as electric vehicles replace gasoline-powered cars, less gasoline will be purchased and revenues from the gasoline tax will fall short of what is needed to maintain roads. Consumers who do not purchase electric vehicles—perhaps because they can't afford them—are left to bear the burden of the gasoline tax. This *Policy Hub* article illustrates the inherent regressivity of the gasoline tax and then simulates the distributional impact of replacing the current gas tax with a lump-sum tax with different assessment rules designed to replace revenue generated by the gasoline tax. For example, many states are considering switching from a gas tax to a tax based on miles driven to shore up infrastructure funding. Alternatively, the required revenue could be paid based on income. Not surprisingly, the degree of regressivity of replacing the gasoline tax depends on how the tax is assessed across the income distribution.

Key findings:

1. The gasoline excise tax is highly regressive.
2. Gasoline tax revenues are falling due to the increased use of electric vehicles.
3. Replacing the gasoline tax with a lump-sum tax improves the welfare of all consumers.
4. How a lump-sum tax is assessed may be more or less regressive than a gasoline tax.
5. Replacing the gasoline tax with a tax on miles driven may be most equitable across income.

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Key words: gas tax, equity, incidence, consumer demand system, income distribution

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Automobile manufacturers and even some states have ambitious goals to phase out gas-powered cars. Currently, a primary source of automobile infrastructure funding is gasoline taxes. But as electric vehicles replace gasoline-powered cars, less gasoline will be purchased and revenues from the gasoline tax will fall short of what is needed to maintain roads. Consumers who do not purchase electric vehicles—perhaps because they can't afford them—are left to bear the burden of the gasoline tax. This *Policy Hub* article illustrates the inherent regressivity of the gasoline tax and then simulates the distributional impact of replacing the current gas tax with a lump-sum tax with different assessment rules designed to replace revenue generated by the gasoline tax. For example, many states are considering switching from a gas tax to a tax based on miles driven to shore up infrastructure funding. Alternatively, the required revenue could be paid based on income. Not surprisingly, the degree of regressivity of replacing the gasoline tax depends on how the tax is assessed across the income distribution.

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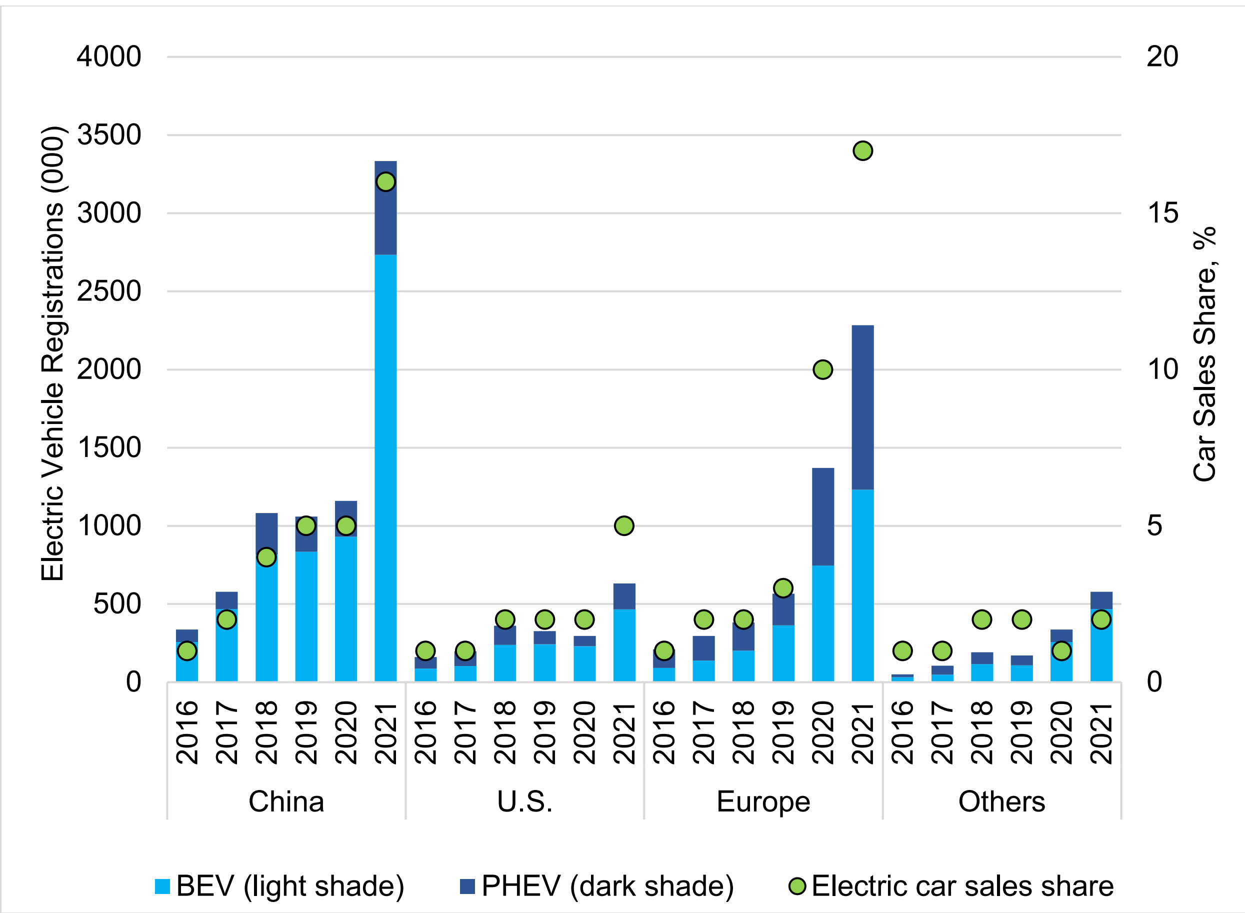
1 Introduction

Even though sales of electric vehicles have increased in recent years, they still only accounted for 5 percent of cars sold in 2021 (see figure 1). However, automobile manufacturers and some state governments aim to significantly increase those numbers during the next decade. In January 2021, General Motors announced that it plans to completely phase out vehicles using internal combustion (gasoline) engines by 2035 (Eisenstein 2021), and GM isn't alone. Volkswagen, Nissan, Ford, Daimler (Mercedes-Benz), and Honda all have similar goals to be carbon neutral by some self-imposed deadline (Mills 2021). All major car manufacturers plan to have at least one plug-in electrical vehicle in their fleet offered by the end of 2024 (Bartlett and Preston 2023). Additionally, in August 2022, California's governor signed into law new regulations prohibiting sales of new gas-powered cars in the state after 2035 (Hoeven 2022). The state subsequently upped the ante by announcing in March 2023 that half of all heavy trucks sold in the state must also be all-electric by 2035 (Davenport 2023).

Figure 1: Electric Vehicle Registrations and Percent of Car Sales by Geographic Region



Note: BEV refers to battery electric vehicles (all electric with no combustion engine), and PHEV refers to plug-in electric vehicles, cars with a combustion engine that can charge the battery.
Source: Paoli, Dasgupta, and McBain (2022)

This planned growth in electric vehicles has potential implications for both infrastructure funding (which currently is largely paid for by gasoline taxes) and the distribution of the gas tax burden, as the relatively high price of plug-in electrical vehicles (PEVs) makes them unaffordable for many lower-income families.[1] This *Policy Hub* article illustrates the potential magnitude of shifting this tax burden and what it would look like under various scenarios of replacing the gasoline tax with an alternative designed to generate the needed revenue for infrastructure maintenance.

Using results from Burns and Hotchkiss (2023), who estimate a model of household expenditures, we illustrate the distributional implications of increasing the gasoline tax. We simulate the introduction of electric vehicles into the consumer's expenditure set by assuming declines in gasoline expenditures, with relative declines increasing as family income increases. We then use the estimated model to simulate changes in consumer welfare that result from replacing the current gasoline tax with different versions of a lump-sum tax designed to generate the same (or greater) tax revenue. Although a lump sum tax is not how usage or income-based taxes would be implemented in practice, the simulations nonetheless illustrate how alternative tax structures can have differential tax-burden impacts on families at different income levels.

2 Simulating an increase in the gasoline tax

The national tax for gasoline is currently 18.4 cents per gallon (Energy Information Administration 2023), a rate that has remained constant for decades. In fiscal year 2020, nearly $22 billion was collected in federal highway tax revenue (Federal Highway Administration 2021, table FE-10).[2] Though the national gas tax primarily goes to construction and maintenance of national highways and bridges, states pay for the majority of road surface maintenance, which is funded largely by state-levied gas taxes and fees (Federal Highway Administration 2017; Fritts 2019).

As PEVs become more widespread, states and the federal government will have to adopt funding strategies that don't depend on gasoline purchases. The Congressional Budget Office projects that with no change in funding strategy, the federal Highway Trust Fund will face a $140 billion deficit by 2031 (Congressional Budget Office 2021).

Higher gas taxes under at current PEV adoption

One way to increase funds available to maintain roads is to raise the gasoline tax. West and Williams (2007) estimate that the optimal tax that would account for infrastructure

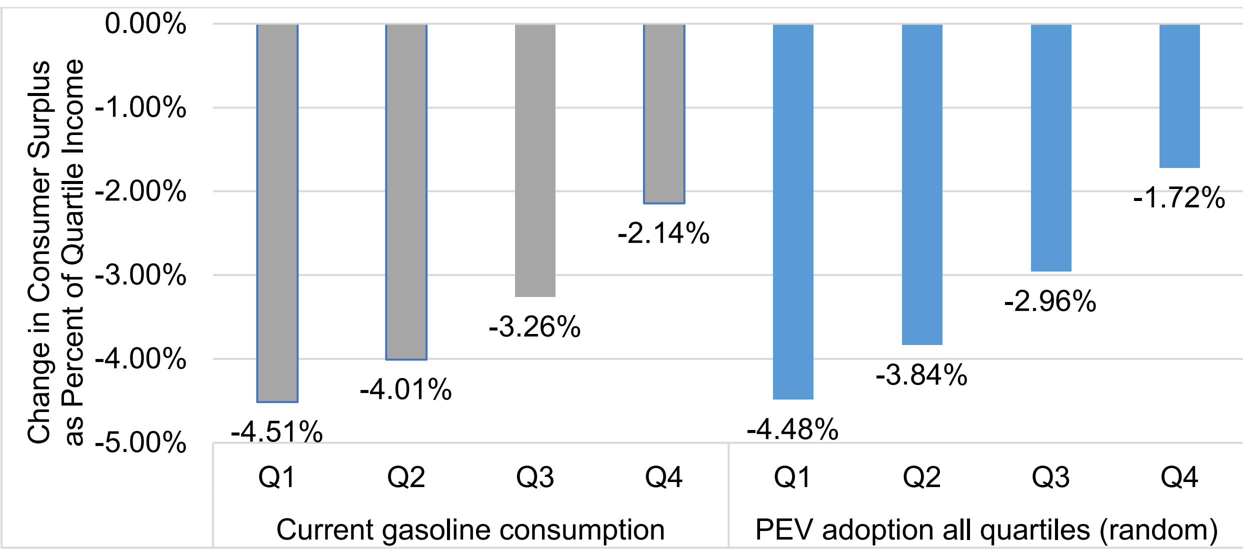
[1] Plug-in electric vehicles (PEV) encompass all-electricity/battery electric vehicles (BEV), such as Teslas or the Nissan Leaf, and plug-in hybrid electric vehicles (PHEV), such as the Toyota Prius or Chevy Volt.

[2] In addition to the gasoline tax, federal highway tax revenue comes from taxes assessed on diesel, gasohol, tires, truck and trailer sales, extra heavy vehicles, and a variety of special fuels (Federal Highway Administration 2017).

externalities generated by gasoline-powered vehicles is $1.39 per gallon—this rate would represent a 600 percent increase from the current federal tax rate of $0.184. (Of course, a smaller percentage increase of the combined federal and state taxes would go toward highway maintenance.) As a flat percentage, the gasoline tax is naturally regressive at face value (that is, the same dollar expenditure on gasoline represents a higher share of income for poorer household than for richer households).

Figure 2 illustrates the decline in the estimated consumer surplus that would result for the average family across income quartiles from raising the gasoline tax to $1.39 per gallon at current levels of gasoline consumption (see the gray bars). Consumer surplus is a measure of the welfare, or benefit, that consumers receive from purchasing a product. The more consumers have to pay for something, all else equal, the lower their consumer surplus. Increasing the price of gasoline (by raising the tax), then, means a loss in consumer surplus from gasoline consumption.

Figure 2: Loss in Consumer Surplus across Family Income Quartiles from Raising the Gasoline Tax and Current versus Increased PEV Adoption



Note: Loss in consumer surplus is calculated using uncompensated elasticities of demand for gasoline estimated by Burns and Hotchkiss (2023). Current gasoline consumption corresponds to reported gasoline consumption by families between 2016 and 2018 in the Current Expenditure Survey. Q1, Q2, Q3, and Q4 correspond to households in the first, second, third, and fourth income quartiles.
Source: Burns and Hotchkiss (2023)

As others have also documented, figure 2 shows that the gasoline tax is highly regressive. Because gasoline purchases make up a greater share of total expenditures at the lower end of income distribution, any increases in the gas tax also increase the loss of consumer surplus by a greater amount, relative to losses in the upper end of the distribution. The average household in the first income quartile loses consumer surplus equivalent to 4.5 percent of its income due to the higher gasoline tax, whereas the average household in the highest income quartile loses consumer surplus equivalent to a little more than 2 percent of its income.

Higher gas taxes with increased PEV adoption

The blue bars in figure 2 reflect the relative losses in consumer surplus from the same gas tax increase, but they depict a world where more households have replaced their gasoline vehicle with a PEV. Increased PEV adoption is simulated by decreasing household gasoline consumption to 1 percent of previous consumption for 2 percent, 5 percent, 10 percent, and 20 percent of households (selected at random from the sample) in the first, second, third, and fourth quartiles, respectively. These increasing PEV adoption percentages in income reflect the higher rates of purchase of PEVs as income increases.[3]

As figure 2 shows, in a world with adoption of electric vehicles, all else equal, the gasoline tax is even more regressive. While the loss in consumer surplus is smaller in every income quartile, it falls even more among richer households—largely based on the assumption that more rich people than poor people purchase electric vehicles, allowing them to avoid paying the higher gasoline prices.

Also note that less revenue is being collected in the blue-bar scenario than in the gray-bar scenario, since the tax rate is the same under both scenarios, but gasoline consumption is lower as a result of a simulated increase in PEV purchases. Declining revenue from gasoline sales is a problem policy makers now face when trying to pay for infrastructure maintenance in an environment of declining gasoline tax revenues.

3 Alternatives to the gasoline tax

As with many policies in the United States, change at the state level often precedes change at the federal level. This pattern seems to be continuing with consideration of alternative ways to fund infrastructure maintenance in the face of declining revenues from increased use of electric vehicles. Many states are looking to alternative taxes and registration fees to fill the expected revenue shortfall. As of October 2022, many states (California and Oregon being among the earliest) have started, or are considering, charging drivers based on miles driven rather than on gasoline purchased (see Povich 2022; Igleheart 2022). Other states have started charging annual registration fees that increase, for example, with vehicle weight or the number of miles a car can run on electricity (Igleheart 2022).

In considering these alternatives, states are grappling with issues related to individual privacy, environmental concerns about potentially dampening enthusiasm for electric vehicles, and adequate pricing to cover infrastructure maintenance. For example, Oregon is charging

[3] Chakraborty et al. (2019) reports that 88 percent of electric vehicle owners in a California survey had incomes higher than the median for the state. Additionally, Tal and Nicholas (2016) find that most buyers of electric vehicles in 2014–15 across multiple states had annual household incomes of $50,000 or higher.

electric vehicle car owners 1.8 cents per mile (Igleheart 2022), which would generate approximately only 40 percent of what West and Williams (2007) estimate should be charged to account for infrastructure externalities.[4]

Introducing an alternative tax to the change in consumer surplus calculation

The standard formula used to calculate the change in consumer surplus from a price change is given by this equation (see West and Williams 2004):

$$\Delta CS_h = \left\{ \frac{\bar{x}_h^g \bar{p}_h^g}{\varepsilon_h^g + 1} \left[1 - \left(\frac{p_h^g}{\bar{p}_h^g} \right)^{\varepsilon_h^g + 1} \right] \right\} + T_h \ ,$$

where ΔCS_h is the change in consumer surplus for the representative household in a given income quartile, ε_h^g is the estimated uncompensated own price elasticity of demand for gasoline, $\bar{x}_h^g$ is the mean expenditure share of gasoline for household *h* before the price change, $\bar{p}_h^g$ is the mean price of gasoline before the price change, and p_h^g is the mean price of gasoline after the price change. The last term in the equation, T_h, is typically used to answer the question, “How much money would the household need to be paid to make up for the lost consumer surplus from higher gasoline prices?” We calculate the loss in consumer surplus illustrated in figure 2 by setting T_h equal to zero.

T_h can also be used to assess the impact of any tax credit or rebate given to simply soften the blow of a gasoline price increase, such as the PEV tax credit that the federal government has occasionally offered (IRS 2022). Here, this term will be used (as a negative number) as a means to simulate the replacement of the gasoline tax with an alternative lump-sum tax in various forms.

Lump-sum alternatives to the gasoline tax

To consider the distributional implications of an alternative tax structure, we replace the gasoline tax with a lump-sum payment (-T_h) that, in total across all households, will generate the same amount of revenue (*R*) that the higher \$1.39 gas tax would generate. In other words,

$$\sum_h T_h = \sum_h \bar{x}_h^g * \ \$1.39 = R \ .$$

We consider three different ways to determine how much each household pays:

1. Assess tax equally across all households:
   $T_h = \ R/H$, where *H* is the total number of households.
   This strategy assesses the household tax payment as an equal share across households of the total revenue needed to be raised.

[4] A tax of \$1.39 per gallon would generate \$0.046 per mile driven in tax revenues (assuming an average of 30 miles per gallon). Oregon’s tax of \$0.018/mile driven is only 40 percent of that amount (0.018/0.046).

2. Assess tax based on share of gasoline consumed by each household:
   $T_h = \left(\bar{x}_h^g \bar{p}_h^g / \sum_h \bar{x}_h^g \bar{p}_h^g\right) * R$
   In the absence of data on actual miles driven by each household, the household share of total gasoline expenditures across households is used to approximate an option being explored by a number of states that charges drivers based on their miles driven. Note that implementation of a tax based on miles driven (analogous to a use tax) would not typically take the form of a lump-sum tax.

3. Assess tax based on household's share of total income:
   $T_h = (y_h / \sum_h y_h) * R$, where y_h is income of household *h.*
   A household's share of the total revenue to be raised in this scenario is approximated by the household's share of total income across all households.

Each of these alternatives to the gasoline tax is designed to raise the same amount of revenue to fund road maintenance that the higher $1.39 gasoline tax would raise. Figure 3 compares the regressivity of each of these alternatives in a world with increased PEV adoption.

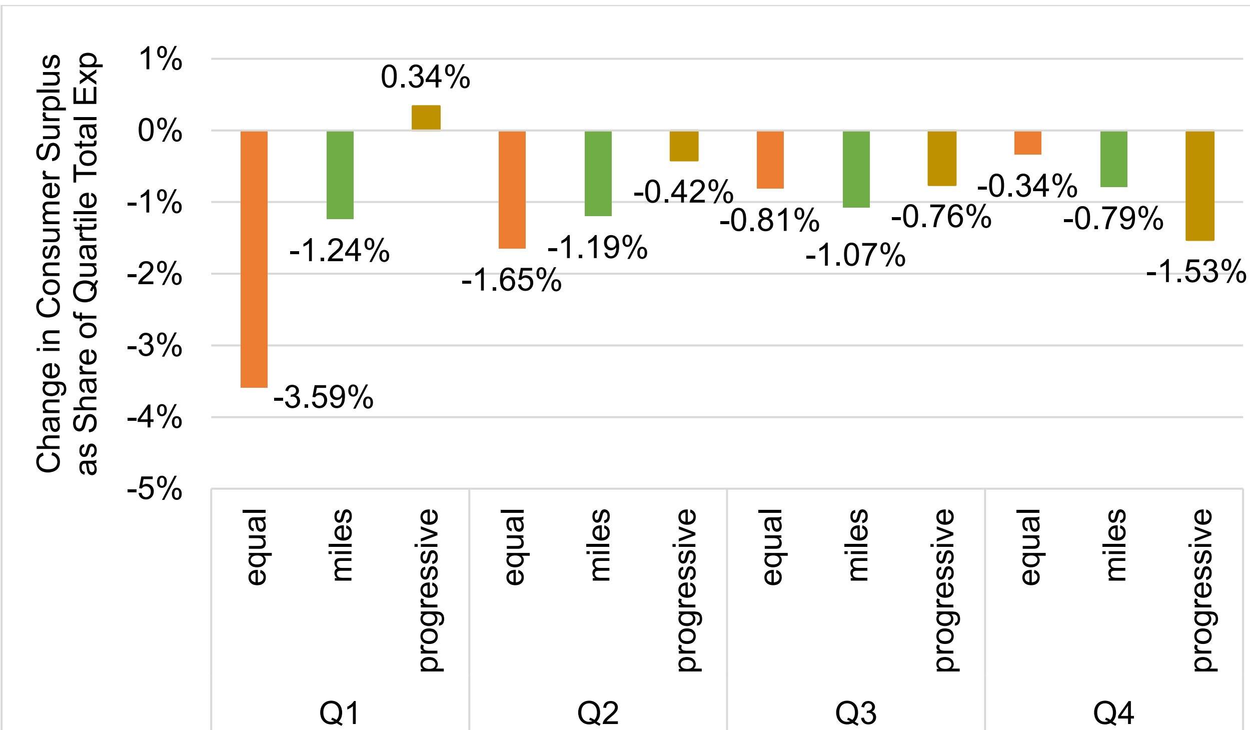
The first thing to notice from figure 3 is that, regardless of the tax assessment rule, any loss in consumer surplus—if households paid a lump-sum tax to raise the same amount of revenue—is less than what would result from raising the gasoline tax. (Compare welfare losses in figure 3 to the welfare loss reflected by the blue bars in figure 2.) This is a classic economic-welfare analysis result that is not unique to gasoline taxes: a lump-sum tax does not decrease consumer welfare as much as an excise tax. (Wald 1945 shows an early articulation of this result.) Of course, since a tax based on miles driven or income would not typically be assessed as a lump-sum tax, the comparison of the welfare differences between those options and the gasoline tax could look different than the lump-sum options we consider here.

As we might expect, the option that assesses the tax equally across households is most regressive, with households in all income quartiles losing consumer surplus but by decreasing amounts in income. Even though it results in lower losses in consumer surplus, this revenue-equivalent lump-sum option is even more regressive than the gasoline tax.

The tax assessment based on gasoline expenditure share spreads the tax more evenly across income quartiles, with the loss in consumer surplus decreasing at the lower half of the income distribution and increasing in the upper half, relative to the equal assessment. Although this approach is still regressive, it would appear to be the most equitable option. In fact, this result may understate the actual regressivity of a miles-driven option since this approximation doesn't allow for the finding by Kneebone and Holmes (2015) that low-income individuals and minorities experience low "job proximity," meaning they have to drive farther to find an appropriate job.

The last option, an income-based household tax, is actually a progressive tax, meaning that the loss in consumer surplus increases in income rather than decreases. While still raising the same amount of revenue, it has dramatically different implications for the distribution of loss in consumer surplus. For two reasons, the poorest households actually *gain* consumer surplus. First, the poorest households are still the largest relative consumers of gasoline (since they are the lowest adopters of PEVs) and they are now paying a lower price for that gasoline. Second, these families are assessed the lowest income-alternative revenue share. However, the chances of either states or the federal government adopting such a progressive alternative are very low (for example, see Stantcheva 2020).

Figure 3: Change in Consumer Surplus by Income Quartile from Differently Structured, Lump-Sum Gas Tax Alternatives Designed to Replace Revenue Generated by a $1.39 per Gallon Gas Tax in a World with Increased PEV Adoption



Note: Increased PEV adoption is simulated by decreasing household gasoline consumption to 1 percent of previous consumption for 2 percent, 5 percent, 10 percent, and 20 percent of households (selected at random from the sample) in the first, second, third, and fourth quartiles, respectively.
Source: Burns and Hotchkiss (2023)

4 Conclusion

Facing a dual reality that revenues from gasoline taxes will continue declining as more people adopt electric vehicles and that, even at current levels, gasoline tax revenues are insufficient to keep up with the demands of road infrastructure maintenance, states need to consider alternative revenue-generating policies to continue maintaining roads. This *Policy Hub* article illustrates the challenges of this effort by comparing the differential impact across the income distribution of several alternative tax structures designed to raise the same amount of revenue.

Specifically, we illustrate the overall welfare gains from replacing the gasoline tax with any lump-sum tax alternative. However, even though all income quartiles are better off under a lump-sum tax, the distribution of the tax burden across income quartiles can vary considerably.

To offset what will inevitably be higher taxes in some form to meet ongoing infrastructure spending needs, the expected burden on lower-income households could be offset by other electric vehicle tax incentives offered by the federal government. However, as Osaka (2021) points out, even the current tax credits tend to favor the wealthy. Merely converting the tax *credit* to a *refundable credit* would benefit low-income households who might not have a high enough tax liability to take advantage of the credit (see IRS 2022).

Some states seek to offer additional incentives to lower-income families to relieve the burden and provide an incentive to adopt electric vehicles. California's Enhanced Fleet Modernization Program, for example, pays low-income individuals who live in one of the program-targeted areas to replace their older, higher-polluting vehicle with a cleaner alternative.[5] Other states have teamed with local utility providers to provide income-based incentives.[6]

Other distributional considerations are also at work. An important one is the physical location of PEV charging stations. Whether stand-alone or as an amenity in residential or commercial buildings, charging stations are scarcer in rural areas.[7] Since median household incomes are lower in rural areas (Semega and Kollar 2022), the lack of charging stations adds another barrier (in addition to price) to owning a PEV for lower income families. And, in spite of the many assessments about how an electric vehicle purchase eventually pays off (for example, see Harto 2020), the high price and limited access to charging stations are likely to outweigh the longer-term benefits for households at the lower end of the income distribution.

As PEV consumption increases, not only will policy makers have to rethink their funding strategies for infrastructure spending, but they will also need to consider who is bearing the burden of those funding plans.

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[5] ww2.arb.ca.gov/our-work/programs/enhanced-fleet-modernization-program

[6] For example, see the state of Vermont's Drive Electric Vermont initiative, driveelectricvt.com/.

[7] See U.S. Department of Energy, Alternative Fuels Data Center, afdc.energy.gov/fuels/electricity_locations.html#/find/nearest?fuel=ELEC.

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