ENVIRONMENT

Analyzing the EV Rule

Will the proposed rule save Americans $1.6 trillion as the EPA claims?

BY PAUL BONIFAS AND TIM CONSIDINE

Electric Vehicles (EVs) are great on paper. But in practice, Ford Motor Company CEO Jim Farley had a "reality check" when he took his company's F-150 Lightning EV Truck on a road trip and realized a 40-minute charge only gave him 40 percent battery life. Environmentalists envision a dawning age of "zero-emissions" electricity generation and EVs that overcome both charging limitations and high prices. They believe EVs are a key way to reduce harmful carbon emissions. It's an enchanting vision, to be sure.

The U.S. Environmental Protection Agency shares that vision. The EPA has proposed a vehicle emissions rule that would so tightly constrict tailpipe emissions that compliance will require around two-thirds of cars and nearly half of medium-duty trucks sold in the year 2032 to be EVs. The agency claims this EV rule would yield $1.6 trillion in "net benefits" for society through 2055. However, after reading through the 263 pages of the EPA's proposed rule and the accompanying 688 pages of its draft Regulatory Impact Analysis (RIA), we conclude that these estimated benefits are wildly inflated. Replacing the EPA's assumptions with realistic values grounded in economic fundamentals and actual consumer spending data, we estimate the rule would yield a net $1.4 trillion *loss*.

The most important differences between our analysis and the EPA's are that the EPA miscategorizes the $7,500 federal tax rebate as a benefit rather than a cost, it overestimates gasoline savings, and it underestimates electricity costs. The following sections describe specific differences between the EPA's analysis and our own. Table 1 summarizes the differences.

FUEL "SAVINGS" TURN INTO COSTS

The EPA claims the rule would save consumers money on fuel costs. The agency defines fuel cost savings as the estimated electricity costs associated with charging EVs minus the avoided costs of liquid fuel consumption. But the EPA overestimates savings in liquid fuel costs and underestimates electricity costs.

The EPA estimates that by 2055, the rule would result in a 49 billion gallon decrease in annual liquid fuel consumption because of the expanded adoption of EVs. This reduction in liquid fuel demand would lower equilibrium prices for liquid fuels by about 50 percent, assuming an oil supply elasticity of 0.6. During the COVID pandemic, for example, liquid fuel demand also dropped significantly and, as a result, so did oil prices. We agree that a savings on liquid fuel would result, but we estimate it would be $620 billion rather than the $1.3 trillion the EPA projects.

The EPA also assumes unrealistically low electricity rates for EV charging. But not all households have access to home charging ports, so many EV users would have to rely on commercial charging stations. The average rate for charging at a Tesla super-charger is 25¢ per kilowatt hour (kWh). In contrast, the EPA assumes electricity rates for EV charging will be 10.3¢ per kWh in 2027 and fall to 9.3¢ per kWh by 2055. Only 63 percent of households in the United States have garages or car ports, which provides an upper bound for home charging. Accordingly, 37 percent of households would be paying much higher commercial rates for EV charging. If we assume Tesla's price, this implies that the EPA underestimated electricity rates paid for EV charging by 57 percent.

The EPA also did not consider the effect of a proposed power plant emissions rule that would essentially force all remaining coal and natural gas power plants to cut emissions by 90 percent. This rule would be like the Clean Power Plan proposed by the Obama administration. A U.S. Energy Information Administration (EIA) study of the Clean Power Plan found that average retail electricity rates would increase by 3–7 percent. Taking the mid-range (5 percent) of this price increase, the proposed power plant rule would raise the EPA's projected electric rate increase an additional 8 percentage points to 65 percent, raising electricity costs for EV charging from the EPA's estimate of $460 billion to $759 billion. Furthermore, there is evidence that the EIA severely underestimated upcoming electricity rate increases; generator Pacificorp recently proposed a 30 percent rate increase, dwarfing the low-ball 3–7 percent predicted by the EIA.

This $759 billion in higher electricity expenditures more than offsets the savings in reduced liquid fuel spending of $620 billion.

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On balance, we project that there will be a fuel cost increase of $139 billion because of the rule, in contrast to the EPA's estimated pre-tax fuel savings of $890 billion. This is over a $1 *trillion* difference. So, under rather conservative but realistic assumptions and basic economic analysis, the proposed EV rule would not save consumers money on energy but instead would lead to higher electricity costs, especially for those households living in rental units.

Another problem with the EPA analysis is that it does not consider that the electrical grid may not be ready to accommodate the additional load from EV charging. The electricity supply curve looks like a backward "L," with low marginal costs for generation levels up to capacity constraints. But once demand reaches those constraints, the supply curve becomes nearly vertical, and prices can reach extraordinary heights with very little increase in quantity supplied until demand falls or new capacity becomes available. We have witnessed this phenomenon in Texas and other regional electricity markets from weather events. (See "The Texas Electricity Two-Step," Fall 2023.) The EPA's proposed EV rule would produce a similar demand shock; however, it would be persistent, unlike transitory weather demand shocks. Unless electricity providers respond in a timely manner, rates could increase much more than 65 percent.

VEHICLE TECHNOLOGY COSTS

The EPA admits the proposed rule would increase the cost of *manufacturing* EVs, but it claims costs would only increase by an average of $1,200 per vehicle, resulting in $280 billion (present value at 3 percent discount rate). However, we project the cost to the American economy is more than four times greater.

When producing its estimate, the EPA did not recognize how "vehicle technology costs" for EVs will affect consumers. The agency understands that "repair" and "maintenance" are costs paid by consumers; however, it categorizes EV "vehicle technology costs" as being paid by the manufacturers. The EPA's rule states, "These projected vehicle technology costs represent the incremental costs to manufacturers," and the EPA's RIA states, "The costs in this section represent compliance costs to the industry and are not necessarily the same as the costs experienced by the consumer when purchasing a new vehicle." The agency gives no explanation for this categorization.

To find the true cost paid by consumers, one does not have to look for third-party information. The EPA provides the purchase prices of new EV and similar conventional internal combustion engine (ICE) vehicles in its RIA. The EPA shows that:

- An EV sedan/wagon will cost $5,200 more than an equivalent ICE vehicle.
- An EV sport utility vehicle or crossover will cost $7,100 more than an equivalent ICE vehicle.
- An EV pickup will cost $3,500 more than an equivalent ICE vehicle.

This results in an average new EV cost of $5,256 more than an equivalent ICE vehicle, a price increase 338 percent more than the $1,200 claimed by the EPA. Adding a 338 percent increase to the EPA's estimated "vehicle technology costs" results in more than $1.2 *trillion* in costs rather than just $280 billion. This single category nearly wipes out the proposed rule's entire "net benefit" of $1.6 trillion claimed by the EPA.

The EPA also assumes "the [EV vs ICE] price difference is likely to narrow or become insignificant as the cost of batteries falls." But market research provider BloombergNEF's annual lithium-ion battery price survey shows a "7 percent increase in average pack prices in 2022 in real terms. This is the first increase in the history of the survey." This raises questions as to what direction battery prices will move in the future.

Tax rebate / The EPA notes that the federal tax rebate for EVs of $7,500 would reduce the price paid *by consumers*. However, tax rebates are not magic wands that make the $7,500 cost disappear. The money must originate from somewhere, and that somewhere is the U.S. economy and taxpayers. The tax rebate neither increases nor decreases the "net benefit" to the U.S. economy; it only shifts who in the economy bears it. In addition, there are income limits to the EV tax rebate, and the current EV owner demographic—on the high end of the income scale—would not qualify for any tax rebate when purchasing a new EV.

Table 1

Estimated Effects of EPA's EV Rule (Billions of dollars)

Cost Category	EPA estimate	Realistic estimate	Difference between EPA and Realistic
Pre-Tax Fuel Savings	$890	-$139	EPA underestimated by $1,029 billion
Vehicle Technology Costs	-$280	-$1,228	EPA underestimated by $948 billion
Maintenance Savings	$410	$72	EPA underestimated by $338 billion
Climate Benefit (SCC at 3% discount rate)	$330	$22	EPA underestimated by $308 billion
EVSE Port Costs (charging stations) + Grid Upgrades	-$120	-$330	EPA underestimated by $210 billion
Repair Savings	$170	-$4	EPA underestimated by $174 billion
Energy Security Benefits	$41	$41	Did not quantify
Air Pollutant Benefits	$249	$249	Did not quantify
Increased Refueling Time & Misc. Costs	-$90	-$90	Did not quantify
Estimated Net Benefit/Cost	**$1,600**	**-$1,407**	**The EPA's EV rule would cost the U.S. economy and taxpayers $1,407 billion, an underestimation of $3,007 billion.**

MAINTENANCE SAVINGS

The EPA overestimates the maintenance cost savings in the proposed rule. The agency bases its maintenance cost estimates for the 15-year life of a vehicle (assuming 15,000 miles driven per year) on a 2021 Argonne National Laboratory study. The EPA claims a lifetime maintenance cost for an ICE vehicle of $20,050 compared to $12,675 for an EV. This corresponds to a maintenance cost for the first five years of ownership of $3,710 for an ICE vehicle and $2,555 for an EV.

However, the EPA and Argonne base their calculations on "factory-recommended actions at periodic mileage or calendar intervals." These maintenance schedules are set by automobile manufacturers. How many people follow the exact schedule of recommended maintenance for their vehicle? The EPA admits "in practice, not everyone follows the recommended service intervals."

The widely trusted Kelley Blue Book (KBB) company provides a "5-year cost to own" figure for various vehicles based on continuously updated real-world consumer data instead of "factory-recommended actions." KBB reports that during the first five years, ICE owners spend an average of $4,583 and EV owners spend $4,246 on maintenance—only an 8 percent difference. Compare that to the EPA's claimed 45 percent increase from EV to ICE. Using KBB's 8 percent figure dramatically reduces the estimated maintenance benefit from $410 billion to $72 billion.

Most mechanics do not have the training or technology to work on EVs, causing a supply constraint. Though the market will adjust over time, there will be a transition period.

The EPA's maintenance projection does not use real-world consumer data. It also ignores that EV tires are more expensive and more advanced because of the heavy battery weight of EVs, their faster initial acceleration, and their need for noise reduction. The EPA draft RIA states:

> Specific to tires and tire replacement…, the authors noted that their analysis assumed that tire life and replacement costs are the same for all powertrains.… Some EVs are equipped with tires that differ from those on typical ICE vehicles to address tread wear and the instant torque of EVs, making the issue raised by the authors a valid issue for consideration.… The authors did reiterate a Goodyear claim that traditional tires wear 30 percent faster when installed on [EVs].

Therefore, though the EPA is aware of the increased maintenance cost for EV tires, it does not include that in its analysis.

Though there are fewer moving parts in an EV than an ICE vehicle, EVs still require maintenance. Most mechanics do not have the training or technology to work on EVs, causing a supply constraint on EV mechanics. Though the market will adjust to this over time, there will be a transition period when mechanics that provide EV maintenance will charge a price premium, have long wait-times, and not be located within proximity of some EV owners.

For these reasons and more, overall EV owner customer service satisfaction currently is 42 points lower than ICE owner satisfaction. *Automotive News* reports that recall rates are double among EVs and a lack of service adviser knowledge contributes to the lower satisfaction rating.

CLIMATE BENEFIT

The EPA estimates that the EV rule would yield $330 billion in climate benefits. Most of those benefits would accrue to the global community. The social cost of carbon (SCC) used in the draft RIA reflects this global focus but not the domestic SCC, which is far lower. (See "Climate Damages, Globalism, and Federal Regulation," Summer 2023.) For a 3 percent discount rate, the U.S. domestic SCC is $3–$8 per ton, according to the Institute for Energy Research, a market-oriented D.C. think tank. Taking the mid-range of the IER's domestic SCC of $5.50 per ton instead of the EPA's global $80 per ton reduces the climate benefit estimate by more than 93 percent. Hence, U.S. domestic consumers would realize only $22 billion in net climate benefits from the proposed rule, with the remaining benefits accruing to consumers outside the United States.

The SCC is estimated from integrated assessment models (IAMs). These models project future emissions and atmospheric concentrations of carbon dioxide, average global temperatures, the economic effects from these temperature changes, the costs of abating greenhouse gas emissions, and the tradeoffs from cutting pollution today to avoid environmental damages in the future. Each IAM is different, depending on assumptions made about abatement costs, damage costs, and many other parameters. As a result, various IAM studies have strikingly different estimates for the SCC. A longtime student of these models, Massachusetts Institute of Technology economist Robert Pindyck, notes:

> And here we see a major problem with IAM-based climate policy analysis: the modeler has a great deal of freedom in choosing functional forms, parameter values, and other inputs, and different choices can give wildly different estimates of the SCC and the optimal amount of abatement. You might think that some input choices are more reasonable or defensible than others, but no,

> "reasonable" is very much in the eye of the modeler. Thus, these models can be used to obtain almost any result one desires.

CHARGING PORT COSTS AND GRID UPGRADES

One of the most imposing hurdles to the widespread adoption of EVs is charging. The EV rule RIA does not consider the colossal costs to upgrade the nation's electrical grid to accommodate EV charging. When the EPA discusses Electric Vehicle Supply Equipment (EVSE), it only considers the costs to install the physical "plugs" or "ports" that provide electricity to a vehicle and charge its battery. That cost is substantial: $120 billion (present value at 3 percent discount rate). But it is scarcely the only large expense for charging.

In its draft RIA, the EPA states:

> Charging infrastructure is different from the electric power utility distribution system infrastructure, which is comprised of distribution feeder circuits, switches, protective equipment, primary circuits, distribution transformers, secondaries, service drops, etc.

The EPA proposed rule, itself, also states:

> The buildout of public and private charging stations (particularly those with multiple high-powered [direct current] fast charging units) could in some cases require upgrades to local distribution systems. For example, a recent study found power needs as low as 200 kW could trigger a requirement to install a distribution transformer.... There is considerable uncertainty associated with the uptake of these technologies as well as with future distribution upgrade needs, and we do not model them directly as part of our infrastructure cost analysis.

These mandatory grid upgrades made by utility companies should be included in the analysis because they will be a large cost burden on consumers of electricity, even for those that do not own EVs. Using the EPA's "EV Penetration Rates" as a proxy for eventual nationwide EV adoption, the proposed rule would induce the ownership of 76 million more EVs by 2032 compared to the "no change" scenario. The economic consultancy Boston Consulting Group estimates, "Depending on charging patterns, [a utility] will need to invest between $1,700 and $5,800 in grid upgrades per electric vehicle (EV) through 2030." The midpoint of that cost range ($3,750 per EV) yields an incremental electric grid upgrade cost of $286 billion for the eventual 76 million additional EVs. Another study, by the consultancy Brattle Group, estimates $60 billion in electric grid upgrades (generation, storage, transmission, and distribution) for every $40 billion in EVSE port costs. Extrapolating, this would result in an electric grid upgrade cost of $180 billion to accommodate the EV charging.

Assuming the costs are evenly spread over the next eight years, using an average of the Boston Consulting Group's and Brattle's data for grid upgrades, the resulting combined present-value costs for EVSE ports and electric grid upgrades is $330 billion, a 175 percent incremental increase from the EPA figure of $120 billion.

According to a recent independent report by several electric grid experts, the mass charging of EVs as penetration levels increase "may have catastrophic consequences for grid reliability" and may cause "cascading blackouts and widespread power interruptions." Widespread EV charging may trigger a fault-induced delayed voltage recovery (FIDVR) that arises from large electric loads occurring simultaneously. FIDVRs can ripple from local neighborhood distribution systems through transmission lines into other distribution systems. A result can be "cascading voltage collapse" and "widespread blackouts." According to *U.S. News & World Report:*

Widespread EV charging may trigger a fault-induced delayed voltage recovery that ripples from local systems through transmission lines to other distribution systems.

> Imagine a college dorm, where every student switches their 1,800-watt blow dryers on at exactly 8:00 in the morning. Breakers are going to blow. Lights are going to go out. That's similar to the potential nightmare for local electricity providers. If just one or two people on a street have EVs, the load on the local transformers and wires can be met without issues. However, if everyone on the street has an EV, there might be a problem.
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> That's especially true in older neighborhoods, where existing demand may already be straining the infrastructure.

REPAIR SAVINGS

The EPA also claims there would be "repair savings" from the switch to EVs. For this, the agency relies on the aforementioned Argonne study. The EPA estimates that ICE vehicles are 44 percent more expensive to repair than EVs, $1,530 compared to $1,065 for EV owners. In contrast, KBB uses real-world consumer data and reports five-year repair costs for ICE owners averaging $1,695 compared to $1,712 for EV owners. This means that ICE owners *save* money (1 percent) on repairs versus EV owners, and *don't* pay 44 percent more like the EPA claims. Scaling back the EPA's claimed ICE repair cost from 44 percent to -1 percent changes the repair value of the EPA's proposed rule from a $170 billion savings to a $4 billion cost.

The National Automobile Dealers Association (NADA) states that EV owners pay more for repairs than their ICE counterparts. Though EVs are in the shop less frequently, they are more expensive to repair when they do go in. As previously noted, today's mechanics generally do not have the training or technology to work on EVs. The supply of EV mechanics is limited. Mechanics that do repair EVs have long wait times and high prices. Again, market forces would change this over time, but there would be a transition period.

Batteries are the most expensive part of an EV, comprising up to 50 percent of its price. Most EV batteries come with a 5- to 10-year warranty, but the battery is deemed to be in working order even if its capacity falls to 70–75 percent. Any replacement that occurs outside the warranty is the financial responsibility of the owner.

The battery technology in EVs is very similar to that found in smartphones. And smartphone batteries degrade over time. Regardless of how well a phone's battery is maintained, the battery life will inevitably worsen and eventually reach zero. The same is true for EV batteries. While some studies show that most EVs lose 5–10 percent of their battery life in the first five years, there are many reputable reports of brand-new EVs not living up to their supposed battery life. For example, *MotorTrend* tested Ford's F-150 Lighting Platinum EV that has an EPA-rated range of 300-miles on a new battery. A test at 70 mph resulted in a range of 255 miles, 15 percent less than the EPA rating. *MotorTrend* warns drivers to

> expect driving range to fall with extreme [hot or cold] temperatures, higher speeds, or significant elevation changes. Alternatively, you can extend that range by driving slower, limiting air-conditioning and other accessory usage, and minimizing hard braking.

Though the number of miles on an ICE engine is a good indicator of the health of the vehicle, the same cannot be said for EVs. Instead, EV battery capabilities are degraded by many factors, including extreme temperatures, too much "fast" charging, use during low-battery, or charging above 90 percent.

Batteries are not the only repair problem for EVs. The average price of EVs is 23 percent more than ICEs, thus repair costs after collisions are more expensive. And EV suspensions are likely to wear out faster because of EVs' battery-induced extra weight.

ENERGY SECURITY BENEFITS

Though the United States became a petroleum net exporter in 2020, the EPA claims that the proposed EV rule would increase the country's "energy security" by reducing its "dependance" on foreign oil. Putting aside the questionable "energy security" claims, the EPA notes but largely ignores supply chain issues for minerals used in EVs. The rule does acknowledge, "At the present time in the U.S. many of these minerals [used to produce EV batteries] are commonly sourced from global suppliers and do not yet benefit from a fully developed domestic supply chain." Yet, the agency's draft RIA notes, "Critical materials and the supply chains necessary for PEV production are, therefore, outside of our intended scope in this discussion of energy security."

The most critical minerals for battery production include cobalt, rare-earth elements, nickel, graphite, and lithium. As an example of the supply chain problems, in 2021 70 percent of cobalt originated from the Democratic Republic of Congo, whose Chinese-owned cobalt mines are plagued with accusations of slave labor and human rights violations.

To make EV supply chain and energy security matters worse, rare-earth minerals (specifically neodymium, praseodymium, dysprosium, and terbium) are required to manufacture the magnets used in EVs. China currently dominates all aspects of rare-earth mineral mining, refining, and magnet production. As of December 2022, China accounts for 63 percent of the world's rare-earth mineral mining, 85 percent of processing, and 92 percent of magnet production. Even if more raw materials were mined in the United States, rare-earth mineral processing and magnet production would still occur in China.

We do not alter the EPA's value for Energy Security Benefits. Even with the agency's questionable Energy Security Benefit value, the overall cost of the proposed rule is still overwhelmingly disadvantageous to the U.S. economy.

AIR POLLUTANT BENEFITS

The EPA also estimates that the proposed rule would generate $140–$280 billion in benefits from reduced air pollutants. But those emissions are falling with ICE vehicles. Improved ICE pollution controls have reduced exposures over time and will continue to decline as new vehicles replace older models. This suggests that the EPA's estimated benefits from reduced air pollutants may be overestimated. Even though we do not alter the agency's estimate of air pollution benefits, the rule still creates net costs.

CONCLUSION

As noted in the introduction, the EPA claims its proposed rule will push EV sales to around two-thirds of all U.S. new car sales and nearly half of all medium truck sales by 2032. This supposedly will not only help "save the planet" from climate change and make the United States more "energy secure," but also save Americans $1.6 trillion. A more realistic analysis suggests that the proposed EV rule will cost Americans $1.4 trillion. It is a serious question for policymakers and the public whether this cost is worthwhile. *R*

READINGS

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