FREOPP.org
The Foundation *for* Research *on* Equal Opportunity

TESTIMONY BEFORE THE UNITED STATES CONGRESS

House Select Committee on the Climate Crisis

TRANSPORTATION INVESTMENTS FOR SOLVING THE CLIMATE CRISIS

ROBERT BRYCE

Visiting fellow, The Foundation for Research on Equal Opportunity

June 30, 2021

The Foundation for Research on Equal Opportunity (FREOPP) is a non-partisan, non-profit, 501(c)(3) organization dedicated to expanding economic opportunity to those who least have it. FREOPP does not take institutional positions on any issues. The views expressed in this testimony are solely those of the author.

INTRODUCTION

Good afternoon. Thank you for inviting me to testify.

I have been writing about the energy sector for more than 30 years. I am pro-energy and pro-electricity.

Over the past 15 months, I've published a book, co-produced a feature-length documentary, and launched a podcast, all of which focus on the importance of electricity to humans and society.[1] The defining inequality in the world today is the enormous gap between the electricity rich and the electricity poor. Darkness kills human potential. Electricity nourishes it.

Increased electricity use means higher living standards, always, everywhere. Increased electricity use in developing countries is essential for human flourishing, and in particular, for women and girls. While I am adamantly pro-electricity, I am also a student of energy transitions and I'm adamantly opposed to the notion that we should attempt to "electrify everything." Enacting such a sweeping policy must be preceded by careful analysis, including the economic and strategic implications of the policy, to avoid unintended disruptions or societal harm.

Electrifying parts of our transportation system may result in incremental reductions in greenhouse gas emissions. But a look at history, as well as an analysis of the supply-chain issues involved in manufacturing EVs, the resource intensity of batteries, and the increasingly fragile state of our electric grid – which is being destabilized by bad policy at the state and national levels – shows that a headlong drive to convert our transportation systems to run on "green" electricity could cost taxpayers untold billions of dollars, increase greenhouse gas emissions, be bad for societal resilience, make the U.S. more dependent on commodity markets dominated by China, make us less able to respond to extreme weather events or attacks on our infrastructure, and impose regressive taxes on low and middle-income Americans in the form of higher electricity prices.

Many challenges must be addressed as policymakers consider the electrification of our vast transportation networks. In this testimony, I will focus on three issues: affordability, resilience, and supply chains.

Before going further, I will stipulate two obvious facts: electricity is making real and valuable contributions in "micromobility" and EV sales are growing rapidly.[2]

---

[1] See, respectively: *A Question of Power: Electricity and the Wealth of Nations; Juice: How Electricity Explains the World;* and the Power Hungry Podcast.

[2] https://www2.deloitte.com/us/en/insights/focus/future-of-mobility/micro-mobility-is-the-future-of-urban-transportation.html

The use of e-bikes, e-scooters, and e-skateboards is making a significant difference in cities at the neighborhood level. Between 2019 and 2020, electric bicycle sales in the U.S. increased by 145%.[3] I have seen how e-micromobility has changed transit on the streets near my home in Austin, Texas. But it is essential to remember that the rapid growth in e-micromobility has not been fueled by government mandates or subsidies. Instead, companies like Trek, Specialized, Lime, Boosted Boards, and others have deployed high-quality products that consumers want and they are buying or renting the mobility solutions that fit their needs. Further, EV sales are growing. Between 2016 and 2020, the number of EVs on U.S. roads tripled and now stands at about 1.8 million vehicles.[4]

But policymakers must be cautious. While that growth in EV sales is notable, EVs still account for less than 1% of the 276 million registered vehicles in the U.S.[5] Of all the EVs on U.S. roads, about 42% of them are in California.[6] By contrast, states like South Dakota, North Dakota, Montana, and Wyoming each have less than 1,000 registered EVs.[7] Furthermore, in 2020, fewer than 300,000 EVs were sold in the U.S.[8] For comparison, Ford Motor Company sold nearly 800,000 F-series pickup trucks last year.[9]

So, yes, EV sales are growing rapidly. But the history of EVs is littered with big claims and false starts. Indeed, the history of electric vehicles is a century of failure tailgating failure. Despite decades of positive media coverage, the takeover of the auto fleet by EVs has long been parked just beyond the next traffic signal. For instance:

- In 1901, the *Los Angeles Times* declared "The electric automobile will quickly and easily take precedence over all other" types of motor vehicles. "If the claims which Mr. Edison makes for his new battery be not overstated, there is not much doubt that it will make a fortune for somebody."[10]

- In 1911, the *New York Times* said that the electric car "has long been recognized as the ideal solution" because it "is cleaner and quieter" and "much more economical."[11]

- In 1915, the *Washington Post* reported that "prices on electric cars will continue to drop until they are within reach of the average family."[12]

---

[3] https://cyclingindustry.news/e-bike-sales-3-7m-17m-2030-industry-experts/
[4] https://www.pewresearch.org/fact-tank/2021/06/07/todays-electric-vehicle-market-slow-growth-in-u-s-faster-in-china-europe/
[5] https://www.statista.com/statistics/183505/number-of-vehicles-in-the-united-states-since-1990/
[6] https://afdc.energy.gov/data/10962
[7] https://afdc.energy.gov/data/10962
[8] https://www.spglobal.com/platts/en/market-insights/latest-news/electric-power/012821-us-ev-sales-tumble-in-2020-but-ev-load-increases-with-more-charging-stations
[9] https://www.torquenews.com/9539/ford-f-series-finishes-2020-where-it-s-been-last-44-years-best-selling-truck-america
[10] *Los Angeles Times*, "Edison's New Storage Battery," May 19, 1901, 8.
[11] *New York Times*, "Foreign Trade in Electric Vehicles," November 12, 1911, C8.
[12] *Washington Post*, "Prophecies Come True," October 31, 1915, E18.

- In 1959, the *New York Times* said that the "Old electric may be the car of tomorrow." The story said that electric cars were making a comeback because "gasoline is expensive today, principally because it is so heavily taxed, while electricity is far cheaper" than it was back in the 1920s.[13]

- In 1979, the *Washington Post* reported that General Motors has found "a breakthrough in batteries" that "now makes electric cars commercially practical." The new zinc-nickel oxide batteries will provide the "100-mile range that General Motors executives believe is necessary to successfully sell electric vehicles to the public."[14]

The history of EVs in California provides context for the rest of the country. In 1990, the California Air Resources Board passed a measure that required 10% of all auto sales in the state be zero-emission vehicles by 2003.[15] But today, 31 years after California implemented the ZEV mandate, the state has nearly 15 million automobiles, and of that number, less than 900,000, or about 6%, have an electric plug.[16] [17]

Over the past century, the history of the EV sector in California and the rest of the country can be summarized as lots of government push, but not enough consumer pull.

Of course, things may have changed. EVs may be near a tipping point and will soon dominate the auto market. Battery technology has improved dramatically over the past 100 years and battery makers continue making improvements in cost and energy density. But 90% of all U.S. transportation energy still comes from refined oil products. Another 9% comes from biofuels and natural gas. Meanwhile, according to an April 2021 report by the U.S. Energy Information Administration, "Electricity provided less than 1% of total transportation sector energy use and nearly all of that in mass transit systems."[18]

Policymakers must also be aware that future EV adoption rates depend heavily on the ability of automakers to continue cutting costs and improving the utility of EVs. Earlier this month, Jeremy Michalek of the Vehicle Electrification Group at Carnegie Mellon University, questioned the ability of the industry to continue slashing costs. In an article titled, "I'm an EV expert, and I'm skeptical about how quickly electric cars will go mainstream in the U.S." Michalek explained that:

> *economies of scale drove early reductions in battery costs, but now they are all but exhausted, and we shouldn't expect big factories or growing demand alone to make EV batteries much cheaper. Second, production process improvements have also*

[13] Joseph C. Ingraham, "Old Electric Car May Be the Car of Tomorrow," *New York Times*, July 26, 1959, X19.
[14] Jerry Knight, "GM Unveils Electric Car, New Battery," *Washington Post*, September 26, 1979, D7.
[15] https://docs.google.com/document/d/1g8bOvDAMeWkAcuMt3_E1M6r6zKQYW3XePTISEUFxjJ0/edit
[16] https://www.statista.com/statistics/196010/total-number-of-registered-automobiles-in-the-us-by-state/
[17] https://insideevs.com/news/506502/california-plugin-car-sales-2021q1/
[18] https://www.eia.gov/energyexplained/use-of-energy/transportation.php

driven cost reductions, but even a utopian production process can't push battery prices below material costs. Third, prices can temporarily dip below costs when firms leverage subsidies, take temporary hits to establish a foothold in the market, or cross-subsidize to comply with regulation, but prices can't stay below costs for long.

He concluded that we should, "remain skeptical about predictions of exactly how fast battery costs will drop and how quickly EVs will be adopted in the future."[19] Michalek's conclusion brings me to my first point: affordability.

AFFORDABILITY AND SOCIAL EQUITY

In 2019, the National Bureau of Economic Research published a study that found the average household income of EV buyers was about $140,000.[20] That's twice the median household income in the U.S., which was nearly $69,000 in 2019.[21] The average owner of a Tesla Model S has a household income of about $153,000.[22]

EVs have fallen in price. But they are still, for the most part, luxury cars that are too expensive for low and middle-income consumers. In 2020, a Costco store in Austin was advertising a Chevy Bolt EV with a sticker price of $46,450. As I noted in an article for *Real Clear Energy*, "For that much cash, consumers could buy a brand new BMW 3 series. Or they could pick up a Mercedes-Benz C-class for less than $39,000. In fact, for the price of a single Chevy Bolt, thrifty shoppers could *buy a pair* of Toyota Corollas, which sell for about $18,000."[23]

In addition to their high purchase price, EVs also impose other societal costs that are likely to exacerbate inequality and lead to more energy poverty. Those costs include taxpayer-funded subsidies given to EV buyers, publicly funded charging stations, and the grid upgrades that will be needed to support the electrification of light and heavy-duty vehicles. Those costs will impose a significant cost burden on low and middle-income consumers, even though those consumers are unlikely to purchase EVs.

Wealthy EV buyers are being subsidized by low and middle-income consumers. In 2016, two academics at the University of California at Berkeley, Severin Borenstein and Lucas W. Davis published a paper that concluded the majority of the money being collected under federal programs aimed at promoting energy efficiency and alternative transportation was going to wealthy Americans. They found "the most extreme disparity is in the program aimed at

---

[19] https://www.marketwatch.com/story/im-an-ev-expert-and-im-skeptical-about-how-quickly-electric-cars-will-go-mainstream-in-the-u-s-11623770187

[20] https://cityobservatory.org/electric-vehicle-subsidies-inefficient-inequitable/

[21] https://www.census.gov/library/publications/2020/demo/p60-270.html

[22] https://www.evunite.com/blog/tesla-owner-demographics/

[23] https://www.realclearenergy.org/articles/2020/11/29/five_reasons_why_internal_combustion_engines_are_here_to_stay_651051.html

electric vehicles, where we find that the top income quintile has received about 90% of all credits." They continued saying that taxpayers who had adjusted gross incomes "in excess of $75,000 have received...about 90% of all credit dollars aimed at electric cars."[24]

Another example of the regressive nature of EV subsidies can be seen by looking at the distribution of those subsidies. Last year, I published an article in *Forbes* which analyzed data published by the Clean Vehicle Rebate Project. That analysis found that residents of California's Senate District 13 in the Bay Area, had collected more than 23,000 rebates from the state worth a total of some $55.3 million. That sum was more than what was rebated to residents of *seven other California senate districts, combined*.[25] Last August, Assemblyman Jim Cooper, a Democrat from the Sacramento area, published a letter in which he said the EV rebates reflect years of environmental racism in the state and that the state's environmental groups are not paying attention to the needs of low and middle-income residents because "promoting policies that benefit coastal Tesla drivers has been more important."[26]

In addition to helping pay for the subsidies given to EV buyers, consumers are also facing increases in electricity rates to pay for the public charging stations. That can be seen, again, by looking at California, which has banned the sale of gasoline-fueled vehicles by 2035 and is pushing hard for EV adoption.[27]

On June 9, the California Energy Commission (CEC) released a report which found that the state "will need nearly 1.2 million public and shared chargers by 2030 to meet the fueling demands of the 7.5 million passenger plug-in electric vehicles (EVs) anticipated to be on California roads." It went on to say that "157,000 chargers will be required by 2030 to support 180,000 medium and heavy-duty electric trucks and buses."[28] Therefore, the state's ratepayers will likely be required to pay for the cost of roughly 1.3 million new EV charging stations. (The state currently has about 73,000 stations.) If we assume a cost of $10,000 for each new charging station, California ratepayers could soon be on the hook for some $13 billion in new infrastructure costs.[29]

Low and middle-income ratepayers will also be forced to pay for the generation capacity and grid upgrades needed to accommodate electrification of transportation. The same CEC report found that by 2030, "electricity consumption from passenger EV charging could reach about 5,500 megawatts (MW) around midnight and 4,600 MW around 10 a.m. on a typical weekday, increasing electricity demand by up to 20–25 percent at those times."[30] To put that

---

[24] https://www.journals.uchicago.edu/doi/full/10.1086/685597

[25] https://www.forbes.com/sites/robertbryce/2020/09/24/california-assemblyman-says-states-push-for-electric-vehicles-fuels-environmental-racism/?sh=7773fbeb2b9a

[26] https://twitter.com/AsmJimCooper/status/1290431726221578240/photo/2

[27] https://www.greentechmedia.com/articles/read/california-to-ban-all-internal-combustion-engine-vehicles-by-2035

[28] https://www.energy.ca.gov/news/2021-06/report-shows-california-needs-12-million-electric-vehicle-chargers-2030

[29] https://afdc.energy.gov/files/u/publication/evse_cost_report_2015.pdf

[30] https://www.energy.ca.gov/news/2021-06/report-shows-california-needs-12-million-electric-vehicle-chargers-2030

5,000 MW or so of new generation capacity in perspective, *it is roughly equal to the rated output of all of California's existing geothermal and nuclear plants, combined.*[31] It must be noted here that the state is slated to close its last remaining nuclear plant, the Diablo Canyon Power Plant, by 2025.

The California grid will have difficulty providing electricity from midnight until the early morning hours because it is heavily dependent on solar energy to meet demand. Thus, it is highly likely that to meet the power demand needed to charge EVs, the state will have to deploy more natural gas-fired capacity. The timing of EV charging will have a big effect on greenhouse gas emissions. If the state has to rely on gas-fired generators to charge EVs at night, the climate benefits of widespread EV adoption may be negated.

In addition, the cost of building 5,000 MW of new generation capacity, as well as the transmission and distribution infrastructure needed to deliver that juice to customers, will add many billions of dollars to California ratepayers' bills at a time when electricity prices in the state are in the words of energy analyst Mark Nelson of the Radiant Energy Fund, "absolutely exploding."[32]

In 2020, California's electricity prices jumped by 7.5%, making it the biggest price increase of any state in the country last year and nearly seven times the increase that was seen in the United States as a whole. According to data from the Energy Information Administration, the all-sector price of electricity in California last year increased to 18.15 cents per kilowatt-hour, which means that Californians are now paying about 70% more for their electricity than the U.S. average all-sector rate of 10.66 cents per kWh.[33]

Between 2010 and 2020, the state's electricity prices jumped by 39.5%, which was, the biggest increase of any state in the U.S. Even more worrisome: California's electricity rates will soar over the next decade. In a report issued in February, the California Public Utility Commission (CPUC) warned that the state's energy costs are growing far faster than the rate of inflation, and that "energy bills will become less affordable over time." The surging cost of electricity will increase the energy burden being borne by low and middle-income Californians.[34] High energy costs have a particularly regressive effect in California, which has the highest poverty rate – and some of the highest electricity prices – in the country.[35] In 2020, California's all-sector electricity prices were the third-highest in the continental U.S., behind only Rhode Island (18.55 cents per kWh) and Connecticut (19.19 cents per kWh.)

---

[31] In 2020, California had 2,700 MW of geothermal and about 2,400 megawatts of nuclear capacity. See: https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/electric-generation-capacity-and-energy

[32] https://robertbryce.com/episode/mark-nelson-managing-director-at-radiant-energy/

[33] https://www.realclearenergy.org/articles/2021/06/24/blackouts_loom_in_california_as_electricity_prices_are_absolutely_exploding_782903.html

[34] https://www.energy.gov/eere/slsc/low-income-community-energy-solutions

[35] https://www.thecentersquare.com/california/california-continues-to-have-the-highest-poverty-level-in-the-nation/article_45a6e2fc-f9f8-11ea-a19d-cf1649965470.html

What's driving up prices? The report says that "electrification goals and wildlife mitigation plans are among the near-term needs...that place upward pressure on rates and bills." The "electrification goals" mentioned by the CPUC include the added cost of charging stations. In addition, California consumers could face significant costs to rewire their homes and businesses to accommodate the growing number of bans on natural gas in the state. According to the Sierra Club, about 46 communities in the state have imposed bans or restrictions on new natural gas connections.

The same CPUC report projects that residents living in hotter regions (that is, those who can't afford to live close to the coast) who get their electricity from San Diego Gas & Electric (SDG&E) could see their monthly power bills increase by 47% between now and 2030. When future gasoline-price increases are included, overall energy costs for that same consumer are projected to increase by 60%. Furthermore, the CPUC expects residential ratepayers in SDG&E's service territory will be paying close to 45 cents per kilowatt-hour by 2030.[36] For reference, that is more than three times the current average price of residential electricity.

In short, California's aggressive decarbonization policies, and in particular, its EV policies, are imposing significant regressive taxes on the state's low and middle-income consumers. Add in the proposed closure of the Diablo Canyon Power Plant – which by itself produces nearly 10% of all the juice consumed in the state – and the fact that the state's grid operator, CAISO, is already warning of electricity shortages this summer, and it becomes clear that California *provides an object lesson in how not to manage an electric grid, particularly if the goal is to reduce greenhouse gas emissions by electrifying transportation.*[37] In addition to the closure of Indian Point, the state will also have to grapple with mandates that require the closure of its gas-fired power plants.[38]

Before finishing this section about affordability and equity, I must underscore the uneven distribution of EVs among the states and how that uneven distribution reflects the urban-rural divide and the class divide. California's large number of EVs (over 400,000 vehicles in 2020) reflects its wealth. The median household income in the state is over $80,000.[39]

Meanwhile, in Mississippi, where the median household income is less than $46,000, the state has fewer than 800 EVs on the road. West Virginia, where median household income is just under $49,000, the state has just 600 EVs on the road. If Congress is going to encourage EV adoption, it must consider this disparity and make sure that taxpayers in lower-income states are not subsidizing motorists in wealthy states.

---

[36] https://www.cpuc.ca.gov/uploadedFiles/CPUC_Website/Content/Utilities_and_Industries/Energy/Reports_and_White_Papers/Feb%202021%20Utility%20Costs%20and%20Affordability%20of%20the%20Grid%20of%20the%20Future.pdf

[37] https://www.pge.com/en_US/safety/how-the-system-works/diablo-canyon-power-plant/diablo-canyon-power-plant.page

[38] https://www.sacbee.com/news/local/environment/article235401372.html

[39] https://www.census.gov/library/visualizations/interactive/2019-median-household-income.html

SOCIETAL RESILIENCE

As I explained in a piece I wrote for *Forbes* in February during the deadly blizzard that hit Texas, "Electrifying everything is the opposite of anti-fragile."[40]

Attempting to halt the use of liquid motor fuels and replace them with electricity will make our transportation system more vulnerable to disruptions caused by extreme weather, saboteurs, equipment failure, accidents, or human error. Electrifying our transportation system will reduce societal resilience because it will put all our energy eggs in one basket. Electrifying transportation will reduce fuel diversity and concentrate our energy risks on a single grid, the electric grid, which will make it an even-more-appealing target for terrorists or bad actors.

Furthermore, and perhaps most important, attempting to electrify transportation makes little sense given the ongoing fragilization of our electric grid. The closures of our nuclear plants is reducing the reliability and resilience of the electric grid and making it more reliant on gas-fired power plants and weather-dependent renewables.

In April, the Indian Point Energy Center, which was providing about 25% of all the electricity used in New York City, was prematurely shuttered. Its output has since been replaced by power generated by gas-fired power plants. Later this year, two more nuclear plants, the Byron and Dresden plants in Illinois, are slated for premature closure. In California, the Diablo Canyon Power Plant is slated for premature closure in 2025.

Policymakers need not look far to observe the ongoing fragilization of our electric grid. The deadly blackouts that hit Texas in February, as well as the blackouts that hit California last year, are the latest indicators that our electricity supplies are increasingly vulnerable to disruptions. Those blackouts provide a preview of what may be in store as grid operators around the U.S. are forced to incorporate large amounts of new, heavily subsidized, weather-dependent renewable generation plants.

Data published by the Department of Energy's Office of Cybersecurity, Energy Security, and Emergency Response illustrates the declining reliability of our electric grid. In 2002, there were 23 "major disturbances and unusual occurrences" on the domestic electric grid. Those outages were caused by things like ice storms, fires, vandalism, and severe weather. By 2016, the number of disturbances and unusual occurrences had increased six-fold to 141. In 2020, the number of events jumped to 383 – an increase of 270% in just four years.[41] Even more alarming: through the first two months of 2021, there have been 122 of these outages.

---

[40] https://www.forbes.com/sites/robertbryce/2021/02/15/this-blizzard-exposes-the-perils-of-attempting-to-electrify-everything/

[41] https://www.oe.netl.doe.gov/OE417_annual_summary.aspx

Last month, the Colonial Pipeline, which delivers motor fuel to the Eastern Seaboard, was shut down by Russian hackers. The shutdown immediately snarled transportation networks. Four states declared states of emergency.[42] Fortunately, the pipeline was able to resume delivery of motor fuel after a few days. But the shutdown demonstrated the delicacy of one of our most important energy networks – the underground pipeline system – and how even a brief interruption in transportation fuel supplies can paralyze our society. If such a brief interruption of a motor fuel pipeline can have such devastating effects, it is not difficult to imagine what would happen if a society that has electrified its transportation sector was hit with an extended electrical blackout. The results could be catastrophic.

Shortly before World War I, Winston Churchill, who was then serving as the First Lord of the Admiralty, discussed the need for energy security as Britain was switching its warships from coal-fired propulsion to oil-fired engines. He famously said, "Safety and certainty in oil lies in variety and variety alone."[43] While Churchill was talking about warships, the same sensibility applies to our energy supplies and energy grids. Concentrating our transportation fuel needs onto a single grid will achieve the opposite of what Churchill was warning about more than a century ago. A society that has a variety of energy sources – for transportation as well as electricity generation – will be more resilient than one that relies on a single source.

As this section is focused on resilience and reliability, I am compelled to make an additional point: if this committee is serious about reducing greenhouse gas emissions while improving societal resilience and the reliability of the electric grid, it should be laser-focused on keeping all of our existing nuclear plants open and operating for as long as possible. Instead, Congress is standing idly by as our nuclear plants – our most reliable, safest, and most power-dense form of electricity production – are being shuttered. Nuclear plants are, as writer Emmet Penney recently put it, our "industrial cathedrals."[44] If policymakers want to decarbonize our transportation system while enhancing the resilience of our society, the best option would be to have a grid that is heavily reliant on nuclear energy.

If we could engineer a system in which our cars were fueled with electricity produced by nuclear plants, I would be inclined to support it. That is not happening.

Instead, our nuclear (and coal-fired power plants) are being prematurely shuttered at the same time that powerful lobby groups are pushing for the electrification of transportation. They are doing so at the same time our electric grid is becoming less reliable and more dependent on renewables and power plants that depend on the delivery of just-in-time natural gas. This shift in the electric generation mix is not enhancing societal resilience, it is undermining it. Adding large amounts of new transportation-related load to the electric grid will further undermine our resilience.

---

[42] https://www.axios.com/colonial-pipeline-shutdown-fuel-shortages-lines-ef087928-de36-41b4-ba26-a7fc0bf74439.html

[43] https://www.foreignaffairs.com/articles/2006-03-01/ensuring-energy-security

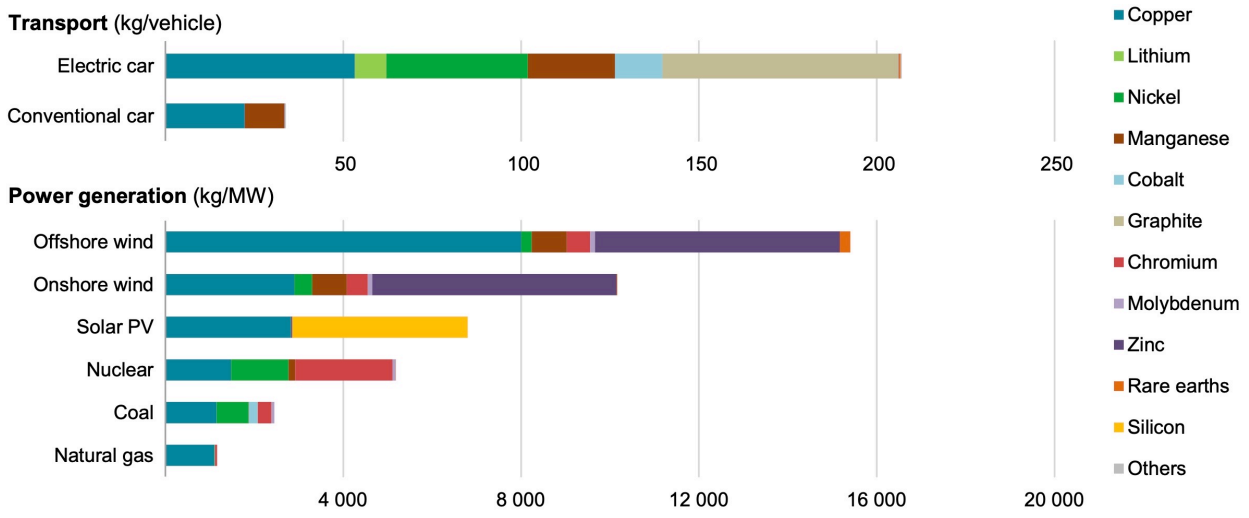
[44] https://www.theamericanconservative.com/articles/nuclear-power-plants-our-industrial-cathedrals/

SUPPLY CHAINS

Mass adoption of EVs will make the U.S. transportation sector more dependent on commodities like copper, cobalt, lithium, manganese, and rare earth elements. That fact presents a national security challenge because the markets for many of those critical minerals are dominated by China.

A recent report by the International Energy Agency (IEA) found that EVs require roughly six times more of what it calls "critical minerals" than conventional vehicles. In particular, the report says that every EV needs about 55 kilograms of copper, 10 kilograms of lithium, nearly 40 kilograms of nickel, 25 kilograms of manganese, and about 70 kilograms of graphite. In a summary, the agency explained that the rapid deployment of EVs "implies a significant increase in demand for minerals."[45]

Figure 1. Energy Transition Minerals in Transport and Power Generation



(Source: IEA)

The vast scale of the potential demand for critical minerals in the U.S. can be understood by looking at a 2019 analysis done by Professor Richard Herrington of the Natural History Museum in London. Herrington and his colleagues looked at the U.K.'s climate goals and the requirement that all its vehicles be converted to electricity by 2050. They then calculated the volume of commodities that would be needed to convert all the U.K.'s 31 million motor

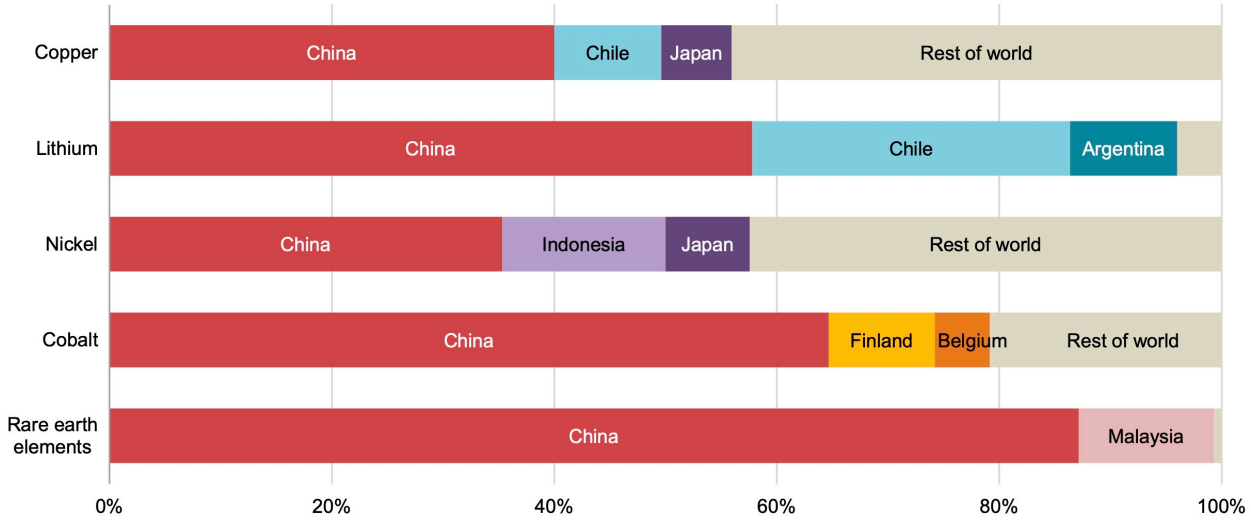
[45] https://iea.blob.core.windows.net/assets/24d5dfbb-a77a-4647-abcc-667867207f74/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf, 26.

vehicles to electric drive. (Rare earths are a group of 17 elements that includes neodymium, which is an essential ingredient in electric motors.) They found that doing so would require "two times the total annual world cobalt production, nearly the entire world production of neodymium, three quarters the world's lithium production and at least half of the world's copper production during 2018."[46] Recall that these numbers only cover the auto fleet in the U.K.

The U.S. has about 276 million registered motor vehicles or roughly nine times as many vehicles as the U.K. If Herrington's numbers are right, *electrifying just half of the U.S. motor vehicle fleet* (roughly 140 million vehicles) would require about nine times the world's current cobalt production, about four times global neodymium output, about three times global lithium production, and about two times world copper production.

Those eye-popping numbers matter because deploying millions of new EVs will require close cooperation with China, which, according to the IEA, controls nearly 40% of global copper processing, 60% of global lithium processing, about 35% of global nickel processing, 65% of global cobalt processing, and nearly 90 percent of rare earth element processing.[47]

Figure 2. Share of Processing Volume for Selected Minerals, 2019



(Source: IEA)

[46] https://thehill.com/opinion/energy-environment/460496-electric-vehicles-wont-save-us-from-climate-change

[47] https://iea.blob.core.windows.net/assets/24d5dfbb-a77a-4647-abcc-667867207f74/TheRoleofCriticalMineralsinCleanEnergyTransitions.pdf , 31.

CONCLUSION

The dominance of refined petroleum products in the transportation market is largely due to a basic metric in physics: energy density.

Yes, batteries are getting better and so are the cars that use them. But today's batteries are still no match for oil when it comes to gravimetric energy density, which is the amount of energy contained per kilogram of fuel. Gasoline and diesel contain about 80 times more energy per unit of weight than the best lithium-ion batteries. Even if you assume that EVs are twice as efficient as internal combustion automobiles, the energy density of gasoline and diesel is still 40 times better than that of batteries. Oil has other advantages over electricity in transportation, including its relatively low cost, abundance, geographic distribution, ease of handling, and speed of refueling. That latter characteristic, quick refueling, is a critically important factor. Unlike EVs, which can take hours to recharge, conventional vehicles can be refueled in less than five minutes.[48]

If cutting transportation emissions is the goal, federal policymakers should – according to a recent analysis by John DeCicco, a research professor emeritus who recently retired from the University of Michigan – focus on increasing the efficiency of the entire automotive fleet. In a piece published in *Scientific American*, DeCicco explained that "the media spotlight on EVs can lend them outsize importance in discussions of the car-climate challenge." He continued, saying that despite their popularity, "EVs are not yet close to having a measurable net impact on CO2 reduction...even as EVs have gained market share, carbon-cutting progress has ground to a halt."

Why haven't EVs reduced emissions? The answer is simple: consumers are voting with their wallets. Instead of EVs, they prefer to drive pickups and SUVs. DeCicco explained that as more drivers are driving bigger vehicles, their adoption has "swamped potential CO2 reductions from electric vehicles by a factor of five." DeCicco concluded that "it is crucial to greatly improve the fuel economy of the gasoline vehicles that will still be sold in the years ahead."[49] Those incremental gains in efficiency, including the use of more hybrid vehicles, says DeCicco, will achieve greater greenhouse gas reductions than continuing the decades-long push for electrification.

Federal policymakers should also consider how they can foster e-micromobility, particularly in low-income neighborhoods. In a 2019 report, analysts at Deloitte found that "limited survey data suggests that support for e-scooters tends to be highest among lower-income users."[50] Consumers are embracing micromobility. Between 2017 and 2019, the number of

---

48 https://www.realclearenergy.org/articles/2020/11/29/five_reasons_why_internal_combustion_engines_are_here_to_stay_651051.html

49 https://www.scientificamerican.com/article/want-greener-cars-focus-on-fuel-efficiency/

50 https://www2.deloitte.com/us/en/insights/focus/future-of-mobility/micro-mobility-is-the-future-of-urban-transportation.html

"microtransit" trips in the U.S. jumped nearly four-fold to 136 million.[51] Those microtransit excursions reduce the number of automobile trips in a cost-effective way. In addition, e-bikes and e-scooters generally use low-voltage rechargers, which means micromobility programs can be expanded without costly upgrades to local electric grids.

Finally, and it is beyond the scope of the caption of this hearing, Congress must be looking at the lowest-cost options when it comes to reducing emissions. The lowest-cost way to do that – as shown by Reiner Kuhr, an adjunct professor at the University of Massachusetts Lowell who worked in the electric power sector for 45 years – is to keep existing nuclear plants open and operating. Kuhr, an energy technology economist, has determined that carbon-dioxide mitigation costs range "from under $20 per ton to keep existing nuclear running longer, to over $800 per ton for rooftop solar."[52] Given the enormous disparity in costs, Congressional leaders must consider the overall cost of mitigating emissions and support the methods that provide the most mitigation bang for the buck.

Congressional leaders must also be wary of adding yet more demand on an electricity grid that is being fragilized by increasing reliance on intermittent renewables and just-in-time delivery of natural gas. Attempting to electrify transportation will not, as the caption of this hearing boldly suggests, "solve the climate crisis." Instead, it could result in the waste of many billions of dollars on technologies and infrastructure that consumers don't use or don't want to buy while making our transportation network more dependent on commodities controlled by China.

In summary, efforts to decarbonize transportation are laudable. But as author Vaclav Smil has rightly pointed out, energy transitions "are protracted affairs" that occur over decades, not years.[53] Before allocating billions of dollars on infrastructure and more subsidies for EVs, policymakers must have frank and transparent discussions about how efforts to decarbonize transportation will impact low and middle-income Americans, many of whom are already struggling to pay their energy bills. Higher energy costs are a form of regressive taxation. At a time when policymakers are grappling with inequality and social justice issues, they must be careful not to impose regressive policies that will exacerbate inequality.

Over the past century, the American transportation network has flourished because market forces were allowed to provide the best solutions. Congress should not be picking winners in the transportation market. If EVs are, in fact, better than conventional vehicles, then policymakers should let consumers drive their adoption.

---

[51] https://usa.streetsblog.org/2020/08/31/micromobility-trips-explode-60-percent-in-one-year-but-bikeshares-lag/

[52] https://www.forbes.com/sites/robertbryce/2021/04/29/the-indian-point-closure-means-more-emissions---and-more-cynicism-about-climate-action/?sh=6a367f415349

[53] https://home.cc.umanitoba.ca/~vsmil/pdf_pubs/oecd.pdf