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Hon. Michael Regan
Administrator
U.S. Environmental Protection Agency
EPA Docket Center
OAR
Docket EPA-HQ-OAR—2022—0829
Mail Code 28221T
1200 Pennsylvania Avenue NW
Washington, DC 20460

Attention: Multi-Pollutant Emissions Standards for Model Years 2027 and Later, Light-Duty and Medium-Duty Vehicle

Docket ID No. EPA–HQ–OAR–2022–0829

Dear Administrator Regan:

We write to comment on the Environmental Protection Agency's Rule on Multi-Pollutant Emissions Standards for Model Years 2027 and Later, Light-Duty and Medium-Duty Vehicle, Docket ID No. EPA–HQ–OAR–2022–0829**,** pursuant to the notice-and-comment process outlined in and protected by 5 U.S.C. § 553(c). The proposed rule is arbitrary and capricious, and the analysis has major flaws. The Agency should abandon it. The rule would take away the choice of gasoline-powered vehicles, raise the costs of driving, and make the United States dependent on China for transportation, an important economic function. For these reasons, the Agency should not and cannot go forward with this rule. Our full comment follows. Thank you for your consideration of this pressing matter.

I. The Rule Would Raise Driving Costs and Inconvenience Americans

New proposed regulations[1] on automobile emissions from the Environmental Protection Agency (EPA) would require new car sales to be 60% battery powered electric by 2030 and 67% by 2032, compared to fewer than 6% in 2022. EPA has also proposed new rules for power plants,[2] driving up the costs of the electricity needed to charge these vehicles. These rules would raise driving costs for Americans, and poor and middle-class Americans disproportionately would pay the price. EPA has not fully accounted for these price increases.

New electric vehicles cost more than gasoline-powered vehicles. The electric version of the base version of the Ford 150 pickup truck, the best-selling vehicle in America, costs an additional $26,000.[3] Tesla's base prices start at about $40,000 for a Model 3 and go up to almost $100,000 for a Model X.[4] These are staggering costs to impose on American families. Cars are part of the American Dream for many Americans, a dream that for too many American families is put out of reach by these new regulations. EPA has not analyzed the effects of the increased costs of these vehicles.

Charging will also cost more. The new power plant rules will regulate carbon dioxide and other so-called greenhouse gas emissions from both new and existing natural gas and coal-fired power plants, and require carbon capture systems or a switch to hydrogen fuels.[5] These commercially unproven systems for capturing carbon are costly and will be passed on to consumers in the form of higher electricity rates. Drivers will find it more expensive to use

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[1]U.S. Environmental Protection Agency. "Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles." Federal Register, 5 May 2023, www.federalregister.gov/documents/2023/05/05/2023-07974/multi-pollutant-emissions-standards-for-model-years-2027-and-later-light-duty-and-medium-duty (accessed June 20, 2023).

[2] Environmental Protection Agency, "Greenhouse Gas Standards and Guidelines for Fossil Fuel-Fired Power Plants," May 15, 2023, https://www.epa.gov/stationary-sources-air-pollution/greenhouse-gas-standards-and-guidelines-fossil-fuel-fired-power (accessed May 18, 2023).

[3] Ford Motor Company, Models & Specs, 2023 F-150 XL, https://www.ford.com/trucks/f150/models/?gnav=vhpnav-specs (accessed April 28, 2023); and Ford motor Company, Models & Specs, 2023 F-150 Lightning PRO, https://www.ford.com/trucks/f150/f150-lightning/models/?gnav=vhpnav-specs (accessed April 28, 2023).

[4] Tesla, Model 3, Purchase Price, https://www.tesla.com/model3/design#overview (accessed April 28, 2023); and Tesla, Model X, Purchase Price, https://www.tesla.com/modelx/design#overview (accessed April 28, 2023).

[5] Environmental Protection Agency, "Greenhouse Gas Standards and Guidelines for Fossil Fuel-Fired Power Plants," May 15, 2023, https://www.epa.gov/stationary-sources-air-pollution/greenhouse-gas-standards-and-guidelines-fossil-fuel-fired-power (accessed May 18, 2023).

electricity for all purposes, including charging their electric vehicles, harming poor and middle-class drivers the most. EPA does not address its new power plant rules in this rule.

We know that these effects are serious and costly. Some states, such as California and Texas, have experienced many brownouts and blackouts in recent years as the existing electric grid cannot meet existing demand. Few new net sources of electricity generation are coming online. Electricity is not a fully reliable source of energy in these states. Moreover, it is becoming increasingly expensive. Pacific Gas and Electric has advised its customers that the average electricity bill will be $187 a month as of March 1, 2023, and increase of 5% from January 1, 2023. Over the past two years rates have risen by almost a third.[6] Upper-income residents can afford backup generators to deal with blackouts, but poor and middle-income residents cannot. Food spoils in their refrigerators and their children cannot do homework without electricity for lights and computers.

Almost three-quarters of vehicles sold are previously owned cars.[7] In 2022, the last year for which complete data on used car sales are available, Americans bought 36 million used cars[8] and 14 million new cars.[9] But people do not want to buy used electric vehicles, because it is difficult to evaluate how long the battery will last. Replacing an EV battery can cost anywhere from $5,000 to $20,000.[10] The poor and middle class will suffer most from higher prices for used vehicles, because they cannot afford the new electric vehicles. EPA has not fully discussed the effects on the used car market.

Mandating electric vehicles would reduce Americans' standard of living. Back in the early 1900s, when Henry Ford started producing cars, only rich Americans could afford them. Throughout the 20th century cars became less expensive, and many households can afford not one but two. Cars are already becoming more expensive, and the proposed rule accelerates that trend, taking America back a century, where new cars will be only for the rich. EPA does analyze declines in standards of living.

Recharging an electric vehicle from empty can take over an hour, compared to 5 minutes to fill up with gas.[11] If there is a line to use the charging station the wait can double. Most people

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[6] California Public Utilities Commission, Rate Change Advisories, https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/electric-rates/rate-change-advisories (accessed April 30, 2023).
[7] Mathilde Carlier, Statista, New and Used Light Vehicle Sales in the United States, 2010 to 2021, https://www.statista.com/statistics/183713/value-of-us-passenger-cas-sales-and-leases-since-1990/ (accessed April 28, 2023).
[8] C.J. Moore, Used Car Sales Hit Lowest In Decade, Automotive News,January 13, 2023, https://www.autonews.com/used-cars/used-car-volume-hits-lowest-mark-nearly-decade (accessed June 6, 2023).
[9]Edmunds, 2023 Predictions: Edmunds Experts Forecast 14.8 Million New Vehicles Will Be Sold in New Year, https://www.edmunds.com/industry/press/2023-predictions-edmunds-experts-forecast-14-8-million-new-vehicles-will-be-sold-in-new-year.html (accessed June 6, 2023).
[10] Recurrent, "Updated: Electric Car Battery Replacement Costs," March 26, 2023, https://www.recurrentauto.com/research/costs-ev-battery-replacement (accessed April 28, 2023).
[11] Lazar, "How Long Does It Take to Refuel a Gasoline Car? GasAnswer, https://gasanswer.com/how-long-take-refuel-gasoline-car/ (accessed April 28, 2023).

do not want to let their EV battery go below 20%, and the charging rate goes down when it is charged over 80%.[12] Throughout America the poor rarely have access to indoor garages for overnight charging, and in most large cities, such as New York City, the middle-class also have no access to indoor charging. Using charging stations on the street, if available, risks theft of expensive charging cables. EPA does not account for this lack of convenience.

Battery-powered vehicles lack sufficient range to satisfy some customers. Although 60 to 70 miles of range is enough for most trips, people buy cars for all circumstances, including vacations and cold weather. Moreover, batteries lose up to 40% of their range in cold climates.[13] A study by Autocar[14] shows that electric vehicles lose, on average, a third of their range in the winter, which reduces the typical 240-mile range to 160 miles. If a heat pump is added to the car, the loss is less, but still the 240-mile range would shrink to 180. The effects of the cold are not sufficiently accounted for by EPA.

Car results varied. The Fiat 500 42kWh Icon lost 40% of its range in the winter.[15] The Ford Mustang Mach-E Extended Range RWD lost 35%, and the Porsche Taycan 4S Performance Battery Plus, with heat pump, lost 22% (the Taycan costs between $83,000 and $166,000).[16] The loss of range in cold weather is one reason why, at the end of 2021, the latest full year available, North Dakota had 380 electric vehicle (EV) registrations, the fewest in the United States, according to the Energy Department.[17]

Minerals such as lithium and cobalt are essential for batteries. EPA does not account for the difficulty of getting these minerals. Mining for these minerals is energy-intensive, and the Chinese Communist Party (CCP) has facilitated access to domestic and foreign minerals for battery production. Lithium is mined in western China's Qinghai Province, aided by government funding, and China purchases cobalt for electric batteries from Kisanfu, in the Democratic Republic of Congo.[18] The United States makes opening new mines virtually impossible, even though the jobs generated would help all Americans, particularly the poor and middle class. Thus, the rule will result in a massive increase in mining in countries that have no respect for the environment or human welfare. The sorts of mining that will be conducted as a result of the rule

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[12] Sebastian Blanco, "How to Maximize EV Range," J.D. Power, July 20, 2022, https://www.jdpower.com/cars/shopping-guides/how-to-maximize-ev-range (accessed April 28, 2023).
[13] Ellen Edmonds, "Icy Temperatures Cut Electric Vehicle Range Nearly in Half," AAA News Room, February 7, 2019, https://newsroom.aaa.com/2019/02/cold-weather-reduces-electric-vehicle-range/ (accessed April 28, 2023).
[14] Move Electric, "Electric Vehicle Range Test Reveals Up to 20% Drop in Winter," Autocar, March 17, 2022, https://www.autocar.co.uk/car-news/move-electric/electric-vehicle-range-test-reveals-20-drop-winter (accessed April 28, 2023).
[15] Ibid.
[16] Ibid.
[17] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Electric Vehicle Registrations by State Data Set, updated June 2022, https://afdc.energy.gov/data/10962 (accessed April 28, 2023).
[18] Dionne Searcey, Michael Forsythe, and Eric Lipton, "A Power Struggle Over Cobalt Rattles the Clean Energy Revolution," *New York Times*, December 7, 2021, https://www.nytimes.com/2021/11/20/world/china-congo-cobalt.html (accessed April 28, 2023).

will be bad for the environment and are frequently performed by child workers. EPA does not mention potential human rights violations.

Electric vehicles are not emissions free. In addition to batteries made with fossil fuels, increased electricity demand places additional stress on the electrical grid, as California has found out from rolling blackouts. In its proposal, EPA discusses the benefits of reducing pollutants from cars,[19] but higher emissions will come from the electricity generated to recharge the cars. This electricity is made with natural gas and coal, because wind and solar powers a small share of America's power. EPA admits that "We expect that in some areas, increased electricity generation would increase ambient SO2, PM 2.5, ozone, or some air toxics."[20]

II. The EPA Rule Would Make Cars Less Safe

Almost 43,000 people died on the roads in 2022,[21] the equivalent of 215 plane crashes a year killing 200 people each time. EPA's tailpipe emissions proposal would, if implemented, make Americans even less safe on the road. EPA does not sufficiently analyze these effects. The prior 2022 fuel economy proposal[22] from the National Highway Transportation and Safety Administration (NHTSA) raises the 2026 Corporate Average Fuel Economy standard to 49 miles per gallon (MPG) from the current standard of 40 MPG. The rule sets a new minimum standard of 59.4 MPG for passenger cars and 42.4 MPG for light trucks made in the United States by model year 2026, with fines for non-compliant carmakers. NHTSA concludes that the higher price of cars would increase fatalities because fewer people would be able to afford the safer, newer, cars, "The slowing of fleet turnover due to higher vehicle prices has the largest impact of the three factors on fatalities."[23]

NHTSA estimates that the decline in new vehicle sales would result in up to 812 additional deaths on the road each year, 16,206 more injuries, and almost 50,000 more crashes involving property damage.[24] This is because fewer people would be able to afford new and later-model used cars, which are safer than old cars. EPA's proposed regulations would make the situation worse. EPA does not account for this in the rule.

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[19] U.S. Environmental Protection Agency. "Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles." Federal Register, 5 May 2023, www.federalregister.gov/documents/2023/05/05/2023-07974/multi-pollutant-emissions-standards-for-model-years-2027-and-later-light-duty-and-medium-duty (accessed June 20, 2023).
[20] Ibid., p. 48.
[21] National Highway Transportation Safety Administration. "Early Estimate of Motor Vehicle Traffic Fatalities in 2022", Apr. 2023, Crash Stats: Early Estimate of Motor Vehicle Traffic Fatalities in 2022 (dot.gov) (accessed 22 June 2023).
[22] *Federal Register*, Vol. 87, No. 84, (May 2, 2022), pp. 25710-26092, https://www.govinfo.gov/content/pkg/FR-2022-05-02/pdf/2022-07200.pdf (accessed May 1, 2023).
[23] Ibid., p. 25896.
[24] Ibid., pp. 25894-5.

This increase in prices caused by successive reductions in emissions contradicts NHTSA's core values,[25] namely leading "the Nation by setting the motor vehicle and highway safety agenda," and serving "as the catalyst for addressing critical safety issues that affect the motor vehicle and highway safety communities." Deaths and injuries from the new rules would be concentrated among low-income Americans, disproportionately minorities, who would pay the price of the new rule: due to the price increases, they would buy fewer new cars and fewer later-model used cars.

The push towards expensive electric vehicles as will be required by the EPA rule, directly contradicts the Department of Transportation's focus on "Health and Equity." According to the Department,[26] "households in low-income areas typically own fewer vehicles, have longer commutes, and have higher transportation costs." These are the people who will pay the price for new EPA regulations. Their cars will be older, less safe, and break down more frequently, resulting in higher repair and maintenance costs.

In addition, if people choose not to buy the mandated electric vehicles, carmakers will have to reduce their prices and raise prices of popular pickup trucks and SUVs to stay profitable.[27] Lower-income and Americans in rural areas will be paying more for their preferred vehicles, subsidizing better-off residents in cities and California, who are the main purchasers of electric vehicles. EPA does not account for this.

Automakers will be harmed both by higher prices of the new cars, which will reduce vehicle sales, and by the subsidies for electric vehicles. The increased deaths, injuries, property damage, and offshored carmakers' jobs should concern President Biden and others who value road safety and employment. Deaths from car accidents are as tragic as deaths from pollution.

III. The Proposed Rule Would Strengthen China

The EPA rule will strengthen China's economy, because China makes nearly 80% of the world's electric batteries,[28] EPA does not sufficiently examine the ramifications of this geopolitical shift. This is especially troubling because the Chinese Communist Party (CCP) is a totalitarian regime which has a poor record both on the environment and on human rights. Beijing is engaged in genocide against the minority Uyghur people of Xinjiang and has imposed draconian restrictions on political freedoms in Hong Kong.[29] The CCP has reduced or eliminated

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[25] U.S. Department of Transportation, National Highway Traffic Safety Administration, "NHTSA's Core Values," https://www.nhtsa.gov/about-nhtsa/nhtsas-core-values (accessed May 1, 2023).
[26] U.S. Department of Transportation, "Health and Equity," updated December 17, 2013, https://www.transportation.gov/mission/health/health-equity (accessed May 1, 2023).
[27] For a detailed analysis, see Steve Bradbury, "Observation: Cliff Notes," Substack: Adespotoi, September 16, 2022, https://adespotoi.substack.com/p/observation-cliff-notes (accessed May 1, 2023).
[28] Veronika Henze, "China's Battery Supply Chain Tops BNEF Ranking for Third Consecutive Time, with Canada a Close Second," BloombergNEF, November 12, 2022, https://about.bnef.com/blog/chinas-battery-supply-chain-tops-bnef-ranking-for-third-consecutive-time-with-canada-a-close-second/ (accessed April 28, 2023).
[29] James J. Carafano et al., "Winning the New Cold War," p. 24.

religious liberties for Christians and Buddhist worshippers of the Dalai Lama throughout Tibet.[30] Empowering the Chinese government is fundamentally at odds with "good corporate governance."

Rather than using its own oil and natural gas resources, America will depend on batteries from China to run its fleet of cars. Countless other renewable energy components and technologies also depend to a large extent on Chinese supply chains. For instance, many of the components of batteries will either be sourced, processed, or manufactured in China for the foreseeable future. Middle-class Americans are losing jobs at Stellantis, Ford, and GM due to the forced switch to electric vehicles. Recent efforts to require battery manufacturing in the U.S. mask the source of the components. In contrast, none of the gasoline or diesel fuels for transportation are from China.

In order to produce supplies of renewables, China is increasing its construction of coal-fired power plants. This increases carbon emissions and reduces EPA's benefits from U.S. emissions reduction. America has 225 coal-fired power plants, and China has 1,118 (half of all the coal-fired plants in the world).[31] That is one reason why China has increased carbon emissions by over 5,000 million metric tons over the past 16 years.[32] In contrast, America's carbon emissions have declined by over 1,000 million metric tons over the same period due to the use of clean natural gas.[33] (See Figure 1.)

China has not committed to reducing emissions until 2027. Research has shown that even completely eliminating all fossil fuels from the United States would result in less than 0.2 degrees Celsius in temperature mitigation by 2100.[34] Americans, particularly poor and middle class, would be bearing major costs in higher electricity prices, higher food prices, and a forced switch to costly electric vehicles without benefits for the environment. They would pay the price for President Biden's energy agenda.

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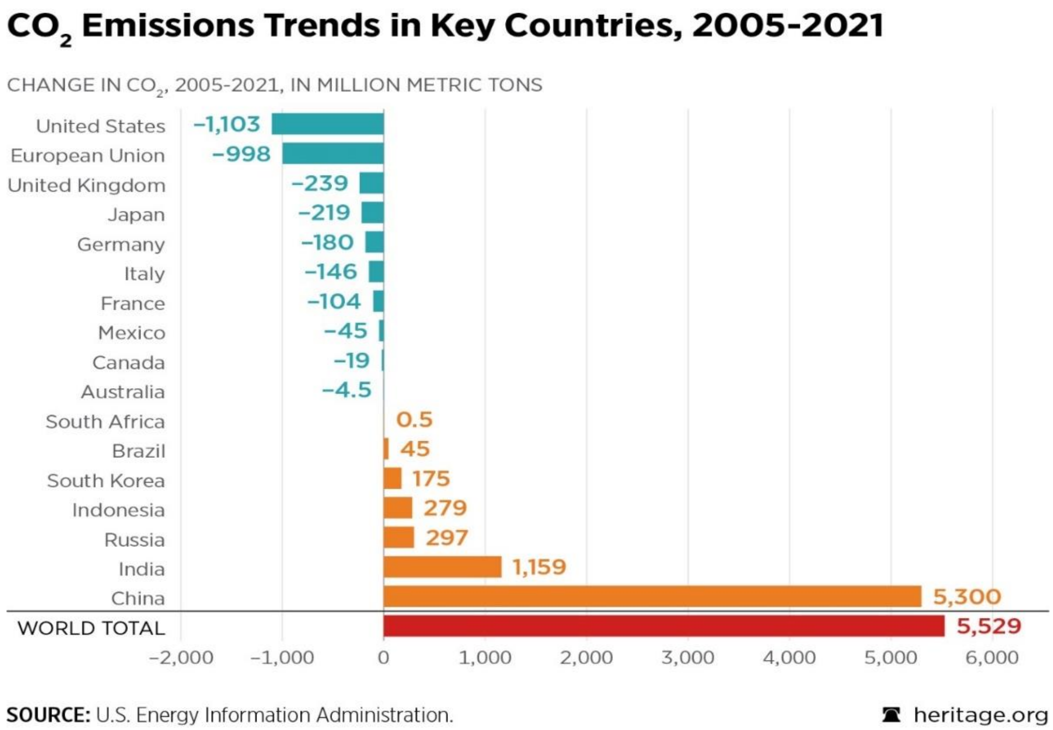
[30] Ibid., p. 3.
[31] Jessica Aizarani, Statista, "Global operational coal-fired power stations by country 2022," January 30, 2023, https://www.statista.com/statistics/859266/number-of-coal-power-plants-by-country/ (accessed April 28, 2023).
[32] "International Emissions." International - U.S. Energy Information Administration (EIA), www.eia.gov/international/data/world/other-statistics/emissions-by-fuel?pd=40&p=0000000000000000000000000000000000000000000000000000b0001&u=0&f=A&v=column&a=-&i=none&vo=value&t=C&g=none&l=71--71&s=1104537600000&e=1609459200000&amp (accessed 21 June 2023).
[33] Ibid.
[34] Kevin D. Dayaratna, PhD, Katie Tubb, and David Kreutzer, "The Unsustainable Costs of President Biden's Climate Agenda," Heritage Foundation *Backgrounder* No. 3713, June 16, 2022, https://www.heritage.org/sites/default/files/2022-06/BG3713_0.pdf, (accessed May 1, 2023).

Figure 1



IV. The Rule Contains Major Errors

The Environmental Protection Agency claims that costs of battery cell and pack manufacturing will continue to decline due to the learning curve, shared costs across larger volumes, and government subsidies. However, the introduction of government subsidies artificially reduces the cost of manufacturing and provides an unrealistic perspective of the actual costs should the government stop subsidizing battery manufacturing.

EPA has selected an arbitrary vehicle range, 300 miles, as the standard for the Omega model. This is carried over into the cost analysis since the analysis is based on $/kWh and the range of a BEV or PHEV is linked to battery capacity along with other factors.

The mileage regularly advertised is in best-case scenarios, such as flat highway driving conditions. The introduction of terrain, adverse weather, traffic, excess drag, or load from something such as a trailer can have a significant negative effect on the advertised range. This is not acknowledged and is detrimental to the EPA proposal in several ways.

First, for Americans to maintain their current type of usage of their vehicles—including professional and recreational activities such as landscaping, construction, hotshot trucking, equestrian sports, boating, camping, road trips, etc.—battery packs will need to become much larger. This renders the EPA's cost per vehicle analysis invalid.

Second, larger packs will mean more weight and potentially more aerodynamic drag and therefore less efficiency. Unlike an internal combustion engine vehicle, the weight is not reduced upon energy consumption. The F150 Lightning is a perfect example of a 300-mile EV that struggles to tow a lightweight camper 100 miles.[35]

As a rudimentary example of comparison, consider the scenario of a diesel truck pulling a trailer a short distance of 150 miles. The truck has a tank size of 36 gallons and achieves 12.5 MPG during the trip. This equates to 12 gallons of burned diesel, well within the no-stop capability of the truck. With modern diesel engines having an efficiency of just over 40%, and diesel having 37.95 kWh/gal of energy, the minimum energy required for a no-stop trip is 182.16 kWh.

With an optimistic motor efficiency of 94% the battery pack must have 193.79 kWh of usable energy. With high-performance batteries capable of 95% usable capacity this means that for the battery pack to make this short trip without stopping it must be no less than 203.99 kWh. With GM's Ultium battery cells having a capacity of 0.1157 kWh per pound, the battery cells alone for this scenario would weigh in excess of 1700 pounds. While the diesel can complete this task nearly three times before refueling, the EV must have a 200 kWh battery, twice the size of the EPAs chosen capacity, to complete the task even once.

The last detrimental aspect of this arbitrary benchmark is that part of the cost analysis done by EPA included refueling time. With larger batteries come longer recharge times, which again add to the cost. While EPA might argue that the high-speed chargers will make up for that, EPA does not want to address the fact that rapid charge or discharge of a battery accelerates its lifecycle. Every time a consumer inputs or draws large amounts of power from a battery, it damages it more than a slower input or draw, thereby decreasing the timeline for the battery's replacement and moving that expense up sooner in the timeline of EV ownership.

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[35]Tingwall, Eric. "Tow No! The Ford F-150 Lightning Struggled in Our Towing Test."*MotorTrend*, 12 July 2022, www.motortrend.com/reviews/ford-f150-lightning-electric-truck-towing-test/ (accessed 5 July 2022).

There is no mention of additional equipment, training, or hazards mentioned regarding the increased number of EVs on the road. The risk of toxic exposure in the event of an EV on a public roadway should be a profoundly serious consideration and yet is not mentioned.[36]

EPA's cost estimate does not include battery replacement.[37] With the proposed standards taking effect in 2027, and some of the cost and savings estimates being extrapolated out through 2055, even if Tesla can be the first EV manufacturer to achieve a battery that lasts 20 years, a replacement will be a requirement. Based on the EPA's chosen 100 kWh capacity and the Department of Energy's 2022 estimated cost of manufacturing of $153/kWh, a new battery without labor, disposal fees, and other associated expenses would cost the consumer $15,300.

Table 4-5, which outlines the studies used to justify the proposal, shows that all but one study either came from California or New York. The claimed national study only contained 862 vehicles and therefore poses insignificant statistical relevance. It also shows that the entirety of the country is not represented. While the Census Bureau splits the United States at 80% urban and 20% rural living, New York and California cannot be considered as viable representations of the county's entire population. Due to differences in infrastructure, state-imposed regulations and laws, population density, and other factors, it is likely that differences could be found even between major cities throughout the country.

On page 4-34, when referring to maintenance costs over the 225,000-mile life of a vehicle, EPA does not mention the need for battery replacement.

While EPA does not address this issue directly in any of its cost analysis, they do open the door to scrutiny and show their hypocrisy a bit by mentioning the battery durability standards in 1-4, 1-5, and 1-6. Based on the UN standards, a battery capable of supplying its platform with a range of 300 miles when new would be considered within the standard so long as it could provide 240 miles of range after 5 years or 62,000 miles. Additionally, it would remain within that standard if it could provide 210 miles of range to its associated platform after 8 years or approximately 100,000 miles. It only continues to degrade from there.

In the table below, the initial data is from the UN standard and the rest is calculated from there based on linear degradation of the battery throughout its lifecycle. The reality is that the degradation would be faster than this and fast charging used to compete with ICE vehicle refuel times will only exacerbate the degradation. I have also placed a couple helpful links below that support this claim.

A potential counter argument is that the CARB standard is more stringent. However, when looking at the tables it is clear that only 70% of the vehicles must achieve the CARB

[36]Larsson, Fredrik, et al. "Toxic Fluoride Gas Emissions from Lithium-Ion Battery Fires." *Scientific Reports,* 30 Aug. 2017, www.ncbi.nlm.nih.gov/pmc/articles/PMC5577247/ (accessed 5 July 2022).

[37] "Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles." EPA, Apr. 2023, www.epa.gov/system/files/documents/2022-12/420d22003.pdf (accessed 5 July 2023).

standard vs 90% of vehicles with the UN standards. So, while the%ages of retained usable power are higher, the allowable%age of vehicles failing to meet the standard is higher.

Assuming a simplistic linear degradation of the battery.									
Years	KM	Mileage	Usable Battery Energy	Associated Range (mi)					
0	0	0	100%	300		Mileage Delta	Percent Drop	Drop/Mile	
5	100000	62137	80%	240		62137	20	0.000322	0.000295 average % battery loss per mile
8	160000	99419	70%	210		37282	10	0.000268	
9	179962	111847	67%	201					
10	199957	124274	63%	190					
11	219953	136702	60%	179					
12	239949	149129	56%	168					
13	259944	161557	52%	157					
14	279940	173984	49%	146					
15	299936	186411	45%	135					
16	319932	198839	41%	124					
17	339927	211266	38%	113					
18	359923	223694	34%	102					

[38] [39]

Table 2-47 outlines electricity costs per kWh through 2060. This table, which undoubtably is used for subsequent calculations regarding cost of ownership or operation, shows the cost of energy steadily declining in the future. However, the Bureau of Labor Statistics shows that the average cost of electricity has steadily risen over the past twenty years. These costs will rise further if EPA's new power plant rule is made final as written.

Table 4-7 shows projected ownership savings and expenses. The battery-electric vehicle sedan/wagon "retail fuel" cell value is not correct. If calculating this value based on the national average price of electricity at 16.5 cents per kWh, and utilizing a Tesla model 3 which uses 34 kWh of energy per 100 miles of range, then the value in this cell based on the annual milage provided should be $881. Yet EPA calculates $520, which equates to $0.097 per kWh. This is laughably low for the consumer to charge an EV at home, let alone the 20% of the time EPA says consumers will use paid public charging of some type (Table 5-14). The costs of public charging can range from $0.36 to $0.48 per kWh based on information from Electrify America, a large EV charging service provider in the United States.

V. The Cost-Benefit Analysis of the Rule is Flawed

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[38]Edge, Jacqueline S., et al. "Lithium Ion Battery Degradation: What You Need to Know." *Physical Chemistry Chemical Physics*, 22 Mar. 2021, Lithium ion battery degradation: what you need to know - Physical Chemistry Chemical Physics (RSC Publishing) DOI:10.1039/D1CP00359C (accessed 5 July 2023).

[39]Kirkaldy, Niall, et al. "Lithium-Ion Battery Degradation: Measuring Rapid Loss of Active Silicon in Silicon–Graphite Composite Electrodes." *ACS Publications*, 3 Nov. 2022, https://pubs.acs.org/doi/10.1021/acsaem.2c02047 (accessed 5 July 2023).

There are numerous problems with the cost-benefit analysis in the tailpipe rule. These include misinterpretation of vehicle ownership costs; miscalculated fuel savings; miscalculated losses from refueling time; calculation of transfers and tax credits; overestimation of light duty vehicle sales; overstatement of environmental benefits; overstatement of security benefits; and low discount rate.

Misinterpretation of vehicle ownership costs

"Vehicle Technology Costs"—the costs of purchasing and maintaining a vehicle excluding fuel costs—are assumed to be lower (a benefit) under the proposed rule than absent the rule. (See Table 160.) This result makes no sense, and the value should be negative, a cost to American households. Empirically, we observe that the vast majority of vehicles sold in America—even with substantial tax credit incentives—are not electric vehicles. American consumers are rational, not irrational. If purchasing an electric vehicle led to lower ownership costs of purchase, maintenance, and repair, then most purchases today would be for electric vehicles, particularly given the substantial tax benefits. Americans make a different choice with their hard-earned dollars. Consequently, the vehicle technology costs presented in Table 160 should all be negative, not positive.

Miscalculated fuel savings

The study finds substantial fuel savings costs from the rule. (See Tables 163 and 164.) Curiously, these values increase nearly 100-fold from 2027 to 2055. The retail fuel savings are approximately $1 billion in 2027, or approximately $7.50 for each of the 130 million households in the United States in 2022. There will doubtlessly be more households in 2027, and consequently the per-household benefit will be less.

By 2055, the total benefit is predicted to be closer to $100 billion, or approximately $750 per household, a consequential amount. The Net Present Value (NPV) in either the 3% case or the 7% from fuel savings account for over half of the total net benefits recorded in the summary in Table 156 ($1.1 trillion out of $1.4 trillion in the 3% discount rate case and $550 billion out of $610 billion in the 7% discount rate case.)

But the numbers on fuel savings are almost certainly wrong. They appear to presume a substantial increase in gasoline prices and a constant electricity price. These assumptions ignore two market realities. First, gasoline prices are set in a global petroleum market, not by federal policy. Global petroleum markets have had fairly predictable prices in a range of $40-$100 barrel for the past two decades or more. Federal policy can raise those prices artificially, but those policies are unlikely to remain steadily increasing over the next 30 years, as the study assumes. If their analysis is correct, then EVs will significantly crowd out ICE autos, which will result in a drastic reduction in demand, which should also result in lower gasoline prices.

Second, electricity prices are very much affected by domestic policies. Current Administration policy is to substantially reduce electricity generation capacity with new capacity limited to high-cost renewable sources. While future Administrations may reverse these policies, new generation capacity takes many years to bring online, and rational electric utilities will be reluctant to invest in efficient electricity generation that may be outlawed every few years. The net result is that electricity prices, unlike gasoline prices, will predictably increase over the next few decades under most plausible policy scenarios.

Consequently, the assumptions in the study that fuel costs under the proposed rule will decrease substantially are almost certainly incorrect in magnitude, and quite likely in direction as well.

Miscalculated costs of increased refueling times

The study correctly finds increased refueling times with electricity vehicles. (See Table 166.) But the magnitude of the costs of such increased refueling times are trivially small. In 2027, increased refueling times are estimated to cost -$0.1 billion, or $0.75 per household. Those refueling time costs are predicted to increase to $8.2 billion in 2055, or approximately $63 per household, assuming the number of households does not increase. If average wages are around $30/hour, this means that a median household is expected to lose approximately an additional 2 hours waiting to refuel in the entire year 2055 under the proposed rule relative to the non-rule case. If a vehicle is refueled even once every two weeks, this means that each refueling is predicted to take no more than additional five minutes or so. (120 minutes/26 refueling). This seems implausible.

Transfers and tax credits should be calculated as negative costs rather than positive benefits

Incorrectly, the study treats government subsidies and taxes as positive benefits rather than costs. (See Tables 167 – 169.) These transfers are costs that the federal government incurs for the purpose of altering consumer behavior. These transfer costs are *not benefits* to consumers but instead are *costs* that taxpayers incur. The study incorrectly treats them as benefit. All of the numbers in these tables, even if otherwise correctly calculated, should be negative, not positive.

Light duty sales are overestimated

The study assumes that the proposed rule will decrease light duty vehicle sales by no more than 0.35% in any year (2027), and in some years may actually increase sales (2029 and 2029). (See Table 171.) These results are inconsistent with standard economics:

- As noted above, the rule will *increase* ownership costs of vehicles, resulting in fewer car purchases;
- Current EV prices, even with tax credits, are substantially above comparable gasoline-powered vehicle or hybrid vehicle prices.
- By definition, regulations reduce consumer choices, leading to less consumer activity.

- If the proposed rule were not a binding constraint on consumer choices, consumers would be purchasing the same vehicles without the rule. The Administration wants the rule to *change* consumer behavior, not to *reinforce* it.

For these and other reasons, the number of vehicles purchased under the rule will be substantially less than without the rule.

Environmental benefits overstated

The study substantially overstates the environmental benefits of the rule. See Tables 172-187. All of the environmental benefits, even if accurately measured, are limited to benefits in local areas of the United States. There may well be reductions in CO2 and other emissions where a vehicle is driven. But the environmental harms elsewhere are substantial:

- Environmental harms from the poorly supervised extraction of rare-earth minerals in developing countries;
- Environmental harms transporting the rare earth minerals to battery factories in other countries, but principally in China;
- Environmental harms from the manufacture of batteries in other countries, but principally in China; and
- In addition, environmental harms from the generation and transmission of electricity, even with renewable generation, in the United States.

For these and other reasons, the environmental benefits are substantially overstated and may well be negative.

Security benefits are overstated

The study purports to find small energy security benefits by having less imported oil. See Table 200. The analysis ignores that United States can well be an *oil-exporting*, rather than an *oil-importing* country. For that reason alone, the stated energy security benefits are likely *costs* rather than *benefits*.

Moreover, the United States is certainly an importer of rare-earth minerals, and products such as car batteries that depend on rare-earth minerals. Consequently, while the proposed rule may have little effect from an oil security perspective, it is likely to have a substantial and negative effect on security for imports of rare earth minerals, particularly as the control of much rare earth mineral production is in China.

No analysis is provided for child labor, which almost certainly would increase with greater exploitation of rare earth minerals in developing countries and in China, and battery production in China.

Low discount rate

The study uses two discount rates, 3% and 7%. The 3% discount rate is below current federal standards, and below rates used by private businesses in making business decisions, and below rates used by private households in making household decisions. More realistic rates would be 7% and 10%.

Rule is Predicated on Flawed Modeling of the Social Cost of Carbon

The proposed rule claims purported climate benefits in terms of carbon dioxide emissions. Specifically, p. 29344 of the proposed rule states: "The present value of climate benefits attributable to the proposed standards are estimated at $83 billion to $1.0 trillion across a range of discount rates and values for the social cost of carbon (present values in 2027 for GHG reductions through 2055)" In engaging in this type of cost/benefit analysis one must assess the robustness of the social cost of carbon.

The tremendous uncertainty associated with the SCC is relevant for this question.[40] The SCC is an estimate in dollars of the cumulative long-term damage caused by one CO_2 emitted in a specific year. That number also represents an estimate of the benefit of avoiding or reducing one ton of CO_2 emissions. The SCC is estimated by Integrated Assessment Models (IAMs), which have been used in the past by the federal government as a basis for regulatory policy. For example, the Obama administration's Interagency Working Group (IWG) had drawn upon three models – abbreviated as DICE, FUND, and PAGE—to estimate the SCC.[41,42] The Biden administration appears to be using other models as well.[43]

As any model is as good as the assumptions from which it is composed, we took these IAMs in house at The Heritage Foundation and tested their sensitivity to a variety of important and reasonable assumptions. We have found that under very reasonable assumptions they can offer a plethora of different estimates of the SCC, ranging from extreme damages to overall benefits. Therefore, the vast potential estimates of the SCC suggest that the economic impact of

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[40] Some of the remarks in this comment was also utilized in a separate regulatory comment. See Patrick Michaels, Kevin Dayaratna, Marlo Lewis. Federal Energy Regulatory Commission, Notice Inviting Technical Conference Comments, 86 FR 66293." https://cei.org/wp-content/uploads/2022/04/CEI-Comments-Michaels-Dayaratna-Lewis-Docket-No-PL21-3-000-January-7-2022.pdf

[41] IWG, Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, August 2016, p. 4, https://www.epa.gov/sites/default/files/2016-12/documents/sc_co2_tsd_august_2016.pdf (hereafter IWG, TSD 2016).

[42] For the DICE (Dynamic Integrated Climate and Economy) model, see William D. Nordhaus, "DICE/RICE Models," https://williamnordhaus.com/dicerice-models. For the FUND (Framework for Uncertainty, Negotiation, and Distribution) model, see "FUND Model, http://fund-model.org (accessed September 15, 2021). For the PAGE (Policy Analysis for the Greenhouse Effect) model, see Climate CoLab, "PAGE," https://www.climatecolab.org/wiki/PAGE

[43]Interagency Working Group, "Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates under Executive Order 13990" https://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf (hereafter IWG, TSD 2021) and United States Environmental Protection Agency, "EPA External Review Draft of "Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances," November 11, 2022, https://www.epa.gov/environmental-economics/scghg

climate change is highly questionable, and therefore understanding of climate-related risks is quite uncertain.

Among others, SCC estimates are highly sensitive to:

- Discount rates chosen to calculate the present value of future emissions and reductions.
- Estimated climate sensitivities chosen to estimate the warming impact of projected increases in atmospheric GHG concentration.
- Timespan chosen to estimate cumulative damages from rising GHG concentration.
- Assumptions regarding agricultural benefits

We find the economic impact of climate change (even if it exists) is quite uncertain depending on assumptions made and that the EPA should take note accordingly.

How Discount Rates Affect the SCC[44]

Models used to estimate the SCC rely on the specification of a discount rate. Discounting is essential in benefit-cost analysis because compliance costs are best viewed as investments intended to yield benefits in the future. Applying discount rates enables agencies to compare the projected rate of return from CO_2-reduction expenditures to the rates of return from other potential investments in the economy.

Office of Management and Budget (OMB) guidance in Circular A-4 specifically stipulates that agencies discount the future costs and benefits of regulations using both 3.0% and 7.0% discount rates.[45] The Obama and Biden administrations have suggested that a 7% discount rate is an affront to intergenerational equity, apparently on the theory that discount rates higher than 1% to 2% imply that people living today are more valuable than people living decades or centuries from now.[46]

We respectfully disagree. The point of discounting is not to rank the worth of different generations but to have a consistent basis for comparing alternate investments. Only then can policymakers determine which investments are most likely to transmit the most valuable capital stock to future generations. In other words, discounting clarifies the *opportunity cost* of investing in climate mitigation, for example, rather than medical research, national defense, or trade liberalization.

Not only is it reasonable to include a 7% discount rate in SCC estimation, it is arguably the best option because 7% is the rate of return of the New York Stock Exchange over the last hundred and twenty-five years and thus particularly pertinent to the financial institutions

[44] Sections 3-6 draw upon Kevin Dayaratna's testimony on "Climate Change, Part IV: Moving Toward a Sustainable Future," before the House Oversight and Reform Subcommittee on the Environment, September 24, 2020, https://oversight.house.gov/sites/democrats.oversight.house.gov/files/Dayaratna%20Testimony%2C%20updated%20for%20Sept%2024%20hearing.pdf.

[45] Office of Management and Budget, "Circular A-4," Obama White House, February 22, 2017, https://obamawhitehouse.archives.gov/omb/circulars_a004_a-4/ (accessed September 27, 2021).

[46] IWG, TSD 2021, pp. 17-19.

impacted by this rule.[47] Only by using a 7% discount rate can policymakers assess the wealth foregone when government spends funds on GHG reduction rather than other policy objectives or simply allows companies and households to invest more of their dollars as they see fit.

Institute for Energy Research economist David Kreutzer illustrates the point as follows. Suppose an emission-reduction investment produces $100 in benefits by 2171 (150 years from now). That is equivalent to investing $5.13 today with a 2% annual return on investment. But if the same $5.13 is invested in stock that appreciates at 7% annually, the investment yields $131,081 in 2171. Clearly, that is a much larger bequest to future generations. How does that negatively affect "intergenerational equity"? It would confer much greater wealth on posterity, endowing them with far more productive capital stock.

Kreutzer also notes that all baseline scenarios assume future generations are richer than current generations. He comments:

> It is a terrible policy to make investments that return $100 instead of $131,081, but it is virtually brain-dead to argue the bad return is justified on equity grounds. Those alive centuries from now are almost certain to be much wealthier, healthier, and possessed of technology to better overcome any adversity—including climate change.[48]

It is hard to shake the suspicion that the IWG declines to use a 7% discount rate, even as a sensitivity case analysis, because doing so would spotlight the comparatively low rates of return of GHG-reduction policies.

At the Heritage Foundation, Dayaratna and colleagues ran DICE and FUND using a 7% discount rate to quantify how much the IWG's lower discount rates increases SCC estimates. Below is the 2016 Technical Support Documents' SCC estimates[49] followed by the Heritage analysts' results published in the peer-reviewed journal *Climate Change Economics*:[50]

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[47] D. W. Kreutzer, "Discounting Climate Costs," Heritage Foundation *Issue Brief* No. 4575, June 16, 2016, https://www.heritage.org/environment/report/discounting-climate-costs; Kevin Dayaratna, Rachel Greszler and Patrick Tyrrell, "Is Social Security Worth Its Cost?" Heritage Foundation Backgrounder No. 3324, July 10, 2018, https://www.heritage.org/budget-and-spending/report/social-security-worth-its-cost.

[48] David Kreutzer, IER Comments on Social Cost of Greenhouse Gas Estimates, Docket No. OMB-2021-0006, June 24, 2021, HTTPS://WWW.INSTITUTEFORENERGYRESEARCH.ORG/CLIMATE-CHANGE/IER-COMMENTS-ON-SOCIAL-COST-OF-CARBON-ESTIMATES/.

[49] IWG, Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, August 2016, p. 4, https://www.epa.gov/sites/default/files/2016-12/documents/sc_co2_tsd_august_2016.pdf (hereafter IWG, TSD 2016).

[50] K. Dayaratna, R. McKitrick, and D. Kreutzer, "Empirically Constrained Climate Sensitivity and the Social Cost of Carbon," *Climate Change Economics*, Vol. 8, No. 2 (2017), p. 1750006-1-1750006-12, https://www.worldscientific.com/doi/abs/10.1142/S2010007817500063 (hereafter Dayaratna et al. (2017)).

Table ES-1: Social Cost of CO_2, 2010 – 2050 (in 2007 dollars per metric ton of CO_2)

Year	5% Average	**3% Average**	2.5% Average	High Impact (95^{th} Pct at 3%)
2010	10	**31**	50	86
2015	11	**36**	56	105
2020	12	**42**	62	123
2025	14	**46**	68	138
2030	16	**50**	73	152
2035	18	**55**	78	168
2040	21	**60**	84	183
2045	23	**64**	89	197
2050	26	**69**	95	212

	DICE Model Average SCC – Baseline, End Year 2300			
Year	**Discount Rate - 2.5%**	**Discount Rate – 3.0%**	**Discount Rate – 5.0%**	**Discount Rate – 7.0%**
2020	$56.92	$37.79	$12.10	$5.87
2030	$66.53	$45.15	$15.33	$7.70
2040	$76.96	$53.26	$19.02	$9.85
2050	$87.70	$61.72	$23.06	$12.25

	FUND Model Average SCC – Baseline, End Year 2300			
Year	**Discount Rate - 2.5%**	**Discount Rate – 3.0%**	**Discount Rate – 5.0%**	**Discount Rate – 7.0%**
2020	$32.90	$19.33	$2.54	–$0.37
2030	$36.16	$21.78	$3.31	–$0.13
2040	$39.53	$24.36	$4.21	$0.19
2050	$42.98	$27.06	$5.25	$0.63

If any government agency is going to use SCC analysis, it should include SCC discounted at 7% as part of its benefit-cost analysis, because only on that basis can the public compare climate policy "investments" to other capital expenditures. And only through such comparisons can policymakers reasonably assess which investments will best position future generations to inherit the most productive capital stock. Furthermore, as the above analysis illustrates, under a 7% discount rate, the SCC is essentially zero and might even be negative at times, suggesting overall net benefits to climate change.

How the Time Horizon Affects the SCC

Human beings use technology to adapt to environmental conditions. Consequently, the loss functions in IAMs depend on assumptions about how adaptive technologies will be developed and deployed as the world warms. It is essentially impossible to forecast technological change decades, let alone centuries, into the future.

Consider U.S. natural gas as an example. Around the turn of this century, it was accepted wisdom that our supplies were running so low that large net imports would be required. A mere ten years later, thanks to the widespread use of hydraulic fracturing of shale, it was apparent there are literally hundreds of years of supply within rock layers under vast areas of the lower-48 states (as well as in Europe and China, as later discovered).

Substitution of gas-fired combustion for coal firing reduces net greenhouse gas emissions by nearly 60%. Supercritical natural-gas fired turbine technology can actually reduce net emissions to *zero* in an experimental plant,[51] though a much-anticipated commercial-grade upscaling has yet to be achieved. These developments only serve to emphasize how foolhardy it is to use, as the IWG does, a 300-year period (2000-2300). Dayaratna and his former Heritage Foundation colleague David Kreutzer ran the DICE model with a significantly shorter, albeit still unrealistic, time horizon of 150 years into the future.[52]

Here are the DICE-estimated SCC values with a baseline ending in 2300:

TABLE 1

Average SCC Baseline, End Year 2300

Year	Discount Rate: 2.5%	Discount Rate: 3%	Discount Rate: 5%	Discount Rate: 7%
2010	$46.57	$30.04	$8.81	$4.02
2015	$52.35	$34.32	$10.61	$5.03
2020	$56.92	$37.79	$12.10	$5.87
2025	$61.48	$41.26	$13.60	$6.70
2030	$66.52	$45.14	$15.33	$7.70
2035	$71.57	$49.03	$17.06	$8.70
2040	$76.95	$53.25	$19.02	$9.85
2045	$82.34	$57.48	$20.97	$11.00
2050	$87.69	$61.72	$23.06	$12.25

Source: Calculations based on Heritage Foundation Monte Carlo simulation results using the DICE model. B 2860 heritage.org

Here are the results with a baseline ending in 2150:

[51] See for example Sonia Patel, "Breakthrough: NET Power's Allam Cycle Test Facility Delivers First Power to ERCOT Grid," Power, November 18, 2021, https://www.powermag.com/breakthrough-net-powers-allam-cycle-test-facility-delivers-first-power-to-ercot-grid/

[52] Dayaratna and Kreutzer, *Loaded DICE: An EPA Model Not Ready for the Big Game*, Backgrounder No. 2860, The Heritage Foundation, November 21, 2013, https://www.heritage.org/environment/report/loaded-dice-epa-model-not-ready-the-big-game.

TABLE 3

Average SCC, End Year 2150

Year	Discount Rate: 2.5%	Discount Rate: 3%	Discount Rate: 5%	Discount Rate: 7%
2010	$36.78	$26.01	$8.66	$4.01
2015	$41.24	$29.65	$10.42	$5.02
2020	$44.41	$32.38	$11.85	$5.85
2025	$47.57	$35.11	$13.28	$6.68
2030	$50.82	$38.00	$14.92	$7.67
2035	$54.07	$40.89	$16.56	$8.66
2040	$57.17	$43.79	$18.36	$9.79
2045	$60.27	$46.68	$20.16	$10.92
2050	$62.81	$49.20	$22.00	$12.13

Source: Calculations based on Heritage Foundation Monte Carlo simulation results using the DICE model. B 2860 heritage.org

The SCC estimates drop substantially—in some cases by more than 25%—as a result of ending the SCC estimation period in 2150.

How the Equilibrium Climate Sensitivity (ECS) Distribution Affects the SCC

The key climate specification used in estimating the SCC is the equilibrium climate sensitivity (ECS) distribution. Such distributions probabilistically quantify the earth's temperature response to a doubling of CO_2 concentrations.

ECS distributions are derived from general circulation models (GCMs) or more comprehensive earth system models (ESMs), which attempt to represent physical processes in the atmosphere, ocean, cryosphere and land surface. The IWG used the ECS distribution from a study by Gerard Roe and Marcia Baker published 15 years ago in the journal *Science*.[53] This non-empirical distribution, calibrated by the IWG based on assumptions it selected in conjunction with past Intergovernmental Panel on Climate Changes (IPCC) recommendations,[54] is no longer scientifically defensible.[55] In particular, since 2011, a variety of newer and empirically-constrained distributions have been published in the peer-reviewed literature. Many of those distributions suggest lower probabilities of extreme global warming in response to CO_2 concentrations. Figure 1 are three such distributions:[56]

[53] Gerard H. Roe and Marcia B. Baker. 2007. Why Is Climate Sensitivity So Unpredictable? *Science*, Vol. 318, No. 5850, pp. 629–632, https://science.sciencemag.org/content/318/5850/629.
[54] IWG, Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866, February 2010, pp. 13-14, https://www.epa.gov/sites/default/files/2016-12/documents/scc_tsd_2010.pdf (hereafter IWG, TSD 2010).
[55] Patrick J. Michaels, "An Analysis of the Obama Administration's Social Cost of Carbon," testimony before the Committee on Natural Resources, U.S. House of Representatives, July 22, 2015, https://www.cato.org/publications/testimony/analysis-obama-administrations-social-cost-carbon.
[56] Nicholas Lewis, "An Objective Bayesian Improved Approach for Applying Optimal Fingerprint Techniques to Estimate Climate Sensitivity," *Journal of Climate*, Vol. 26, No. 19 (October 2013), pp. 7414–7429, https://journals.ametsoc.org/view/journals/clim/26/19/jcli-d-12-00473.1.xml; Alexander Otto et al., "Energy Budget

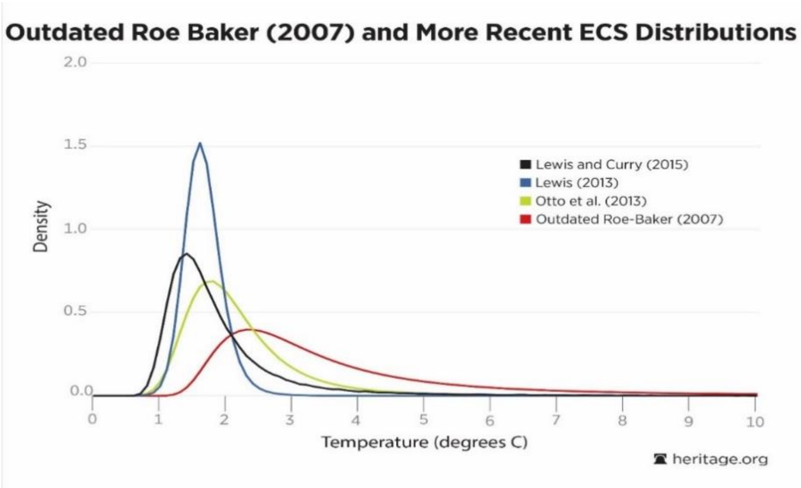


Figure 1: A variety of equilibrium climate sensitivity (ECS) distributions

The areas under the curves between two temperature points represent the probability that the earth's temperature will increase between those amounts in response to a doubling of CO_2 concentration. For example, the area under the curve from 4°C onwards (known as right-hand "tail probability") represents the probability that the earth's temperature will warm by more than 4°C in response to a doubling of CO_2 concentrations. Note that the more up-to-date ECS distributions (Otto et al., 2013; Lewis, 2013; Lewis and Curry, 2015) have significantly lower tail probabilities than the outdated Roe-Baker (2007) distribution used by the IWG.

Here, again, is the IWG's 2016 SCC estimates for 2020-2050:

Table ES-1: Social Cost of CO_2, 2010 – 2050 (in 2007 dollars per metric ton of CO_2)

Year	5% Average	**3% Average**	2.5% Average	High Impact (95th Pct at 3%)
2010	10	**31**	50	86
2015	11	**36**	56	105
2020	12	**42**	62	123
2025	14	**46**	68	138
2030	16	**50**	73	152
2035	18	**55**	78	168
2040	21	**60**	84	183
2045	23	**64**	89	197
2050	26	**69**	95	212

Constraints on Climate Response," *Nature Geoscience*, Vol. 6, No. 6 (June 2013), pp. 415–416, https://www.nature.com/articles/ngeo1836; Nicholas Lewis and Judith A. Curry, "The Implications for Climate Sensitivity of AR5 Forcing and Heat Uptake Estimates," *Climate Dynamics*, Vol. 45, No. 3, pp. 1009–1923, http://link.springer.com/article/10.1007/s00382-014-2342-y.

In *Climate Change Economics*, Dayaratna and colleagues re-estimated the DICE and FUND models' SCC values using the more up-to-date ECS distributions and obtained the following results:[57]

	DICE Model Average SCC – ECS Distribution Updated in Accordance with Lewis and Curry (2015), End Year 2300			
Year	**Discount Rate - 2.5%**	**Discount Rate – 3.0%**	**Discount Rate – 5.0%**	**Discount Rate – 7.0%**
2020	$28.92	$19.66	$6.86	$3.57
2030	$33.95	$23.56	$8.67	$4.65
2040	$39.47	$27.88	$10.74	$5.91
2050	$45.34	$32.51	$13.03	$7.32

	FUND Model Average SCC – ECS Distribution Updated in Accordance with Lewis and Curry (2015), End Year 2300			
Year	**Discount Rate - 2.5%**	**Discount Rate – 3.0%**	**Discount Rate – 5.0%**	**Discount Rate – 7.0%**
2020	$5.86	$3.33	–$0.47	–$1.10
2030	$6.45	$3.90	–$0.19	–$1.01
2040	$7.02	$4.49	–$0.18	–$0.82
2050	$7.53	$5.09	$0.64	–$0.53

Using the more up-to-date ECS distributions dramatically lowers SCC estimates. The IWG's outdated assumptions overstate the probabilities of extreme global warming, which artificially inflates their SCC estimates. In its Fifth Assessment Report (AR5), the IPCC used the Coupled Model Intercomparison Project Phase 5 (CMIP5) models to project future warming and the associated climate impacts.[58] Figure 2 compares predicted and observed average tropospheric temperature over the tropics.[59] The observations come from satellites, weather balloons, and reanalyses.[60] A careful look analysis reveals that only one of the 102 model runs correctly

[57]Dayaratna, McKitrick, and Kreutzer, "Empirically Constrained Climate Sensitivity and the Social Cost of Carbon."
[58] Program for Climate Model Diagnosis and Intercomparison, CMIP5 – Coupled Model Intercomparison Project Phase 5 – Overview, https://pcmdi.llnl.gov/mips/cmip5/.
[59] The CMIP5 predictions are available at https://climexp.knmi.nl/start.cgi.
[60] Climate reanalyses produces synthetic histories of recent climate and weather using all available observations, a consistent data assimilation system, and mathematical modeling to fill in data gaps. See National Center for Atmospheric Research, Atmospheric Reanalysis: Overview & Comparison, https://climatedataguide.ucar.edu/climate-data/atmospheric-reanalysis-overview-comparison-tables and ECMWF, Climate Reanalysis, https://www.ecmwf.int/en/research/climate-reanalysis

simulates what has been observed. This is the Russian climate model INM-CM4, which also has the least prospective warming of all of them, with an ECS of 2.05°C, compared to the CMIP5 average of 3.2°C.

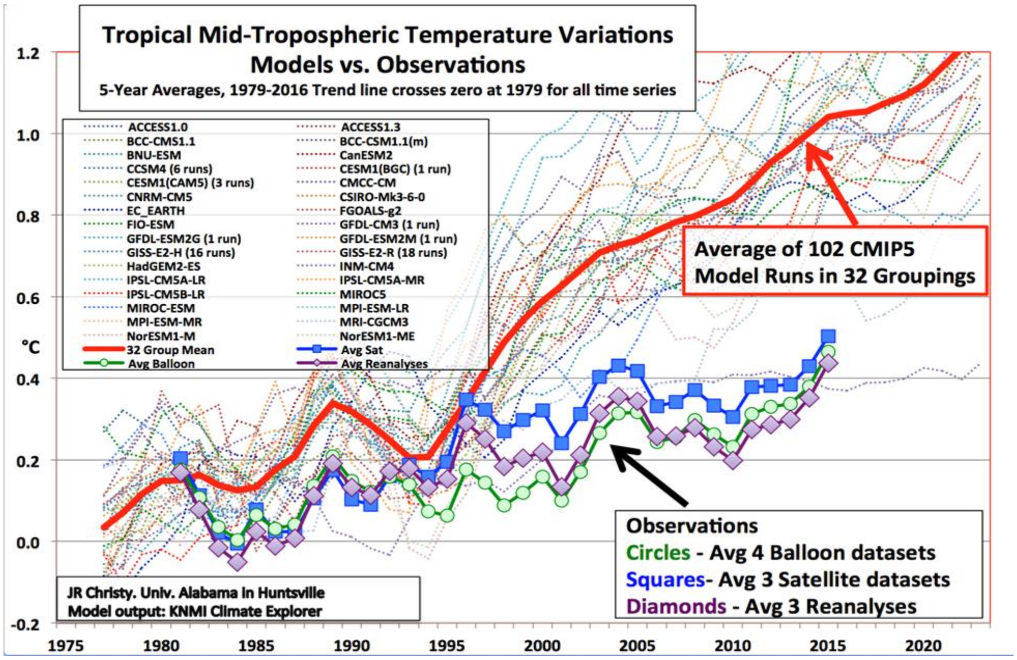


Figure 2. Solid red line—average of all the CMIP-5 climate models; Thin colored lines—individual CMIP-5 models; solid figures—weather balloon, satellite, and reanalysis data for the tropical troposphere. [61]

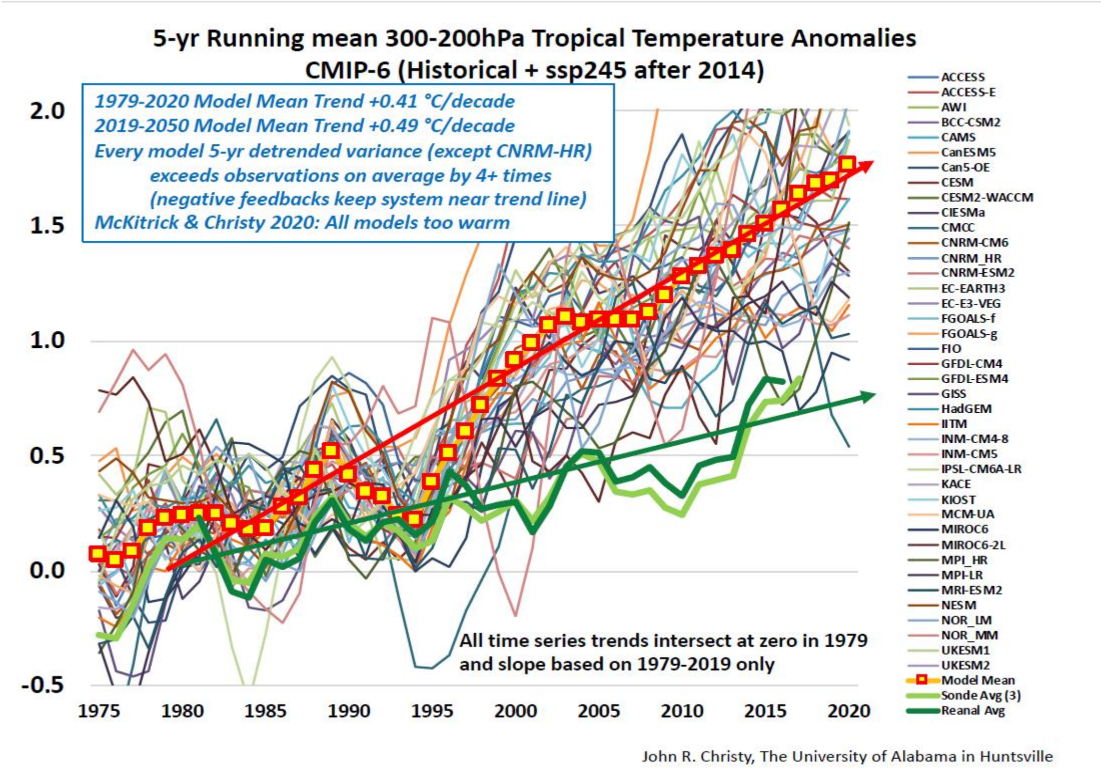
Best scientific practice uses models that work and does not seriously consider those that do not. This is standard when formulating the daily weather forecast, and should be the standard with regard to climate forecasts.

The IPCC's recently released Sixth Assessment Report (AR6) uses a new suite of models, designated CMIP6. As shown by McKitrick and Christy (2020) however, the CMIP6 models are even worse.[62] Of the two models that work, the Russian INM-CM4.8, has even less warming than its predecessor, with an ECS of 1.8°C, compared to the CMIP6 community value of around four degrees.[63] The other one is also a very low ECS model from the same, group, INM-CM5. The model mean warming rate exceeds observation by more than two times at altitude in the tropics.

[61]Christy, J.R.: 2017, [in "State of the Climate in 2016"], *Bull. Amer. Meteor. Soc*. 98, (8), S16-S17, https://journals.ametsoc.org/view/journals/bams/98/8/2017bamsstateoftheclimate.1.xml.

[62]R. McKitrick and J. Christy. 2020. Pervasive Warming Bias in CMIP6 Tropospheric Layers. *Earth and Space Science* Volume 7, Issue 9, https://agupubs.onlinelibrary.wiley.com/doi/10.1029/2020EA001281.

[63]Most (not all) of the CMIP-6 models were available for McKitrick and Christy (2020); this figure is the mean ECS of what was released through late 2020.



Quoting from McKitrick and Christy's conclusion:

> The literature drawing attention to an upward bias in climate model warming responses in the tropical troposphere extends back at least 15 years now … Rather than being resolved, the problem has become worse, since now every member of the CMIP6 generation of climate models exhibits an upward bias in the entire global troposphere as well as in the tropics.

Zeke Hausfather, hardly a climate skeptic, has noted that while the CMIP6 models are warmer than the previous generation, the warmer they are, the more they over-forecast warming in recent decades, confirming what McKitrick and Christy found.[64]

Zhu, Poulsen, and Otto-Bliesner (2020) used a CMIP6 model called CESM2 to project warming from an emission scenario that reaches 855 parts per million by 2100—roughly three times the pre-industrial concentration. Despite being tuned to match the behavior of 20th century climate, CESM2 produced a global mean temperature "5.5°C greater than the upper end of proxy temperature estimates for the Early Eocene Climate Optimum." That was a period when CO_2 concentrations of about 1,000 ppm persisted for millions of years.[65] Moreover, the modeled tropical land temperature exceeded 55°C, "which is much higher than the temperature tolerance

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[64] Zeke Hausfather, "Cold Water on Hot Models," The Breakthrough Institute, February 11, 2020, https://thebreakthrough.org/issues/energy/cold-water-hot-models.

[65] NOAA National Centers for Environmental Information, Early Eocene Period, 54 to 48 Million Years Ago, https://www.ncdc.noaa.gov/global-warming/early-eocene-period.

of plant photosynthesis and is inconsistent with fossil evidence of an Eocene Neotropical rainforest."[66]

Altogether, faulty assumptions regarding climate sensitivity have been manifested in the SCC and associated regulatory policy, and more realistic assumptions inject significant uncertainty into the potential long-term impact of climate change.

-Negative SCC Values

Policymakers and the media often assume carbon dioxide emissions have only harmful impacts on society. However, CO_2 emissions have enormous direct agricultural[67] and ecological benefits,[68] global warming lengthens growing seasons,[69] and warming potentially also alleviates cold-related mortality, which may exceed heat-related mortality by 20 to 1.[70]

Of the three IAMs used by the IWG, only the FUND model estimates CO_2 fertilization benefits. Dayaratna and colleagues investigated whether a model with CO_2 fertilization benefits could produce negative SCC estimates. A negative SCC means that each incremental ton of CO_2 emissions produces a net benefit.

The researchers calculated the probability of a negative SCC under a variety of assumptions. Below are some of the results published both at the Heritage Foundation as well as in the peer-reviewed journal *Climate Change Economics*:[71]

	FUND Model Probability of Negative SCC – ECS Distribution Based on Outdated Roe–Baker (2007) Distribution, End Year 2300			
Year	**Discount Rate - 2.5%**	**Discount Rate – 3.0%**	**Discount Rate – 5.0%**	**Discount Rate – 7.0%**

[66]Jiang Zhu, Christopher J. Poulsen & Bette L. Otto-Bliesner. 2020. High climate sensitivity in CMIP6 model not supported by paleoclimate. *Nature Climate Change* volume 10, pages 378–379, https://www.nature.com/articles/s41558-020-0764-6.

[67] Literally hundreds of peer-reviewed studies document significant%age increases in food crop photosynthesis, dry-weight biomass, and water-use efficiency due to elevated CO_2 concentrations. See the Center for the Study of Carbon Dioxide and Global Change's Plant-Growth Database: http://co2science.org/data/plant_growth/plantgrowth.php

[68]See, for example, Randall J. Donahue et al. 2013. Impact of CO2 fertilization on maximum foliage cover across the globe's warm, arid environments. *Geophysical Research Letters* Vol. 40, 1–5, https://friendsofscience.org/assets/documents/CO2_Fertilization_grl_Donohue.pdf; Zaichun Zhu et al. The Greening of the Earth and Its Drivers. 2016. *Nature Climate Change* 6, 791-795, https://www.nature.com/articles/nclimate3004; and J.E. Campbell et al. 2017. Large historical growth in global gross primary production. *Nature* 544, 84-87, https://www.nature.com/articles/nature22030.

[69]EPA, Climate Change Indicators: Length of Growing Season, https://www.epa.gov/climate-indicators/climate-change-indicators-length-growing-season.

[70]Antonio Gasparrini et al. 2015. Mortality risk attributable to high and low ambient temperature: a multicountry observational study, *The Lancet*, Volume 386, Issue 9991, https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(14)62114-0/fulltext.

[71]Dayaratna and Kreutzer, "Unfounded FUND: Yet Another EPA Model Not Ready for the Big Game," Backgrounder No. 2897, April 29, 2014, http://thf_media.s3.amazonaws.com/2014/pdf/BG2897.pdf; and Dayaratna et al. (2017).

2020	0.084	0.115	0.344	0.601
2030	0.080	0.108	0.312	0.555
2040	0.075	0.101	0.282	0.507
2050	0.071	0.093	0.251	0.455

	FUND Model Probability of Negative SCC – ECS Distribution Updated in Accordance with Otto et al. (2013), End Year 2300			
Year	**Discount Rate - 2.5%**	**Discount Rate – 3.0%**	**Discount Rate – 5.0%**	**Discount Rate – 7.0%**
2020	0.268	0.306	0.496	0.661
2030	0.255	0.291	0.461	0.619
2040	0.244	0.274	0.425	0.571
2050	0.228	0.256	0.386	0.517

	FUND Model Probability of Negative SCC – ECS Distribution Updated in Accordance with Lewis (2013), End Year 2300			
Year	**Discount Rate - 2.5%**	**Discount Rate – 3.0%**	**Discount Rate – 5.0%**	**Discount Rate – 7.0%**
2020	0.375	0.411	0.565	0.685
2030	0.361	0.392	0.530	0.645
2040	0.344	0.371	0.491	0.598
2050	0.326	0.349	0.449	0.545

	FUND Model Probability of Negative SCC – ECS Distribution Updated in Accordance with Lewis and Curry (2015), End Year 2300			
Year	**Discount Rate - 2.5%**	**Discount Rate – 3.0%**	**Discount Rate – 5.0%**	**Discount Rate – 7.0%**
2020	0.402	0.432	0.570	0.690
2030	0.388	0.414	0.536	0.646
2040	0.371	0.394	0.496	0.597
2050	0.354	0.372	0.456	0.542

As the above statistics illustrate, under a variety of reasonable assumptions, the SCC has a substantial probability of being negative. In fact, in some cases, the SCC is more likely to be negative than positive, which implies—if one adopts the perspective of a central planner—that the EPA should, in fact, subsidize (not limit) CO_2 emissions. We, of course, oppose such interventionism. Our purpose here is to illustrate the extreme sensitivity of these models to reasonable changes in assumptions as well as to point out that the probabilities of negative SCC value are non-trivial and potentially quite substantial.

-Updated Agricultural Benefits and Benefit-Cost Analysis

It is a well-established fact that increases in CO_2 concentration enhance plant growth by increasing their internal water use efficiency as well as raising the rate of net photosynthesis.[72] As discussed in the previous section, the FUND model attempts to incorporate those benefits; however, this aspect of the model is grounded on research that is one-to-two decades old. Even so, as discussed in the preceding section, Dayaratna et al. (2017) found substantial probabilities of negative SCC using the outdated assumptions in FUND. Dayaratna et al. (2020) summarized more recent CO_2 fertilization research in a peer-reviewed study published in *Environmental Economics and Policy Studies* and re-estimated the FUND model's SCC values upon updating those assumptions.[73] To facilitate the EPA's review of that research, we excerpt several paragraphs from Dayaratna et al. (2020):

> Three forms of evidence gained since then indicates that the CO_2 fertilization effects in FUND may be too low. First, rice yields have been shown to exhibit strong positive responses to enhanced ambient CO_2 levels. Kimball (2016) surveyed results from Free-Air CO_2 Enrichment (FACE) experiments, and drew particular attention to the large yield responses (about 34%) of hybrid rice in CO_2 doubling experiments, describing these as "the most exciting and important advances" in the field. FACE experiments in both Japan and China showed that available cultivars respond very favorably to elevated ambient CO_2. Furthermore, Challinor et al. (2014), Zhu et al. (2015) and Wu et al. (2018) all report evidence that hybrid rice varietals exist that are more heat-tolerant and therefore able to take advantage of CO_2 enrichment even under warming conditions. Collectively, this research thus indicates that the rice parameterization in FUND is overly pessimistic.
>
> Second, satellite-based studies have yielded compelling evidence of stronger general growth effects than were anticipated in the 1990s. Zhu et al. (2016) published a comprehensive study on greening and human activity from 1982 to 2009. The ratio of land areas that became greener, as opposed to browner, was approximately 9 to 1. The increase in atmospheric CO_2 was just under 15% over the interval but was found to be responsible for approximately 70% of the

[72]K.E. Idso and S.B. Idso. 1994. Plant responses to atmospheric CO2 enrichment in the face of environmental constraints: A review of the past 10 years' research. *Agricultural and Forest Meteorology*, 69, 153-203, https://www.sciencedirect.com/science/article/abs/pii/0168192394900256; Jennifer Cuniff et al. 2008. Response of wild C4 crop progenitors to subambient CO_2 highlights a possible role in the origin of agriculture. G*lobal Change Biology* 14: 576-587, https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2486.2007.01515.x.

[73]Kevin Dayaratna, Ross McKitrick, and Patrick Michaels. 2020. Climate sensitivity, agricultural productivity and the social cost of carbon in FUND. *Environmental Economics and Policy Studies* 22: 433-448, https://link.springer.com/article/10.1007/s10018-020-00263-w.

observed greening, followed by the deposition of airborne nitrogen compounds (9%) from the combustion of coal and deflation of nitrate-containing agricultural fertilizers, lengthening growing seasons (8%) and land cover changes (4%), mainly reforestation of regions such as southeastern North America.

Munier et al. (2018) likewise found a remarkable increase in the yield of grasslands. In a 17-year (1999-2015) analysis of satellite-sensed LAI, during which time the atmospheric CO_2 level rose by about 10%, there was an average LAI increase of 85%. A full 31% of earth's continental land outside of Antarctica is covered by grassland, the largest of the three agricultural land types they classified. Also, for summer crops, such as maize (corn) and soybeans, greening increased an average of 52%, while for winter crops, whose area is relatively small compared to those for summer, the increase was 31%. If 70% of the yield gain is attributable to increased CO_2, the results from Zhu et al (2016) imply gains of 60%, 36%, and 22% over the 17-year period for, respectively, grasslands, summer crops and winter crops, associated with only a 10% increase in CO_2, compared to parameterized yield gains in the range of 20% to 30% for CO_2 doubling in FUND.

Third, there has been an extensive amount of research since Tsingas et al. (1997) on adaptive agricultural practices under simultaneous warming and CO_2 enrichment. Challinor et al. (2014) surveyed a large number of studies that examined responses to combinations of increased temperature, CO_2 and precipitation, with and without adaptation. In their metanalysis, average yield gains increased 0.06% per ppm increase in CO_2 and 0.5% per percentage point increase in precipitation, and adaptation added a further 7.2% yield gain, but warming decreased it by 4.9% per degree C. In FUND, 3°C warming negates the yield gains due to CO_2 enrichment. However, based on Challinor et al.'s (2014) regression analysis, doubling CO_2 from 400 to 800 pm, while allowing temperatures to rise by 3°C and precipitation to increase by 2%, would imply an average% yield increase ranging from 2.1 to 12.1% increase, indicating the productivity increase in FUND is likely too small.

Based on that literature, Dayaratna et al. (2020) updated the FUND model's coefficients to increase its agricultural benefits by 15% and 30%. In addition, the authors used an updated ECS distribution—that of Lewis and Curry (2018).[74] In the charts below, the last three columns show the mean SCC as well as the associated probability of negative SCC values under different discount rates.

	FUND Model Average SCC, agricultural component updated - Discount Rate – 2.5%

[74]Lewis and Curry. 2018. The impact of recent forcing and ocean heat uptake data on estimates of climate sensitivity. *Journal of Climate* Vol. 31: 6051-6071, https://journals.ametsoc.org/view/journals/clim/31/15/jcli-d-17-0667.1.xml.

	Roe Baker (2007)	Lewis and Curry (2018)	Lewis and Curry (2018) + 15%	Lewis and Curry (2018) + 30%
2020	$32.90	$3.78 / 0.46	$0.62 / 0.53	-$1.53 / 0.59
2030	$36.16	$4.69 / 0.44	$1.25 / 0.51	-$1.02 / 0.57
2040	$39.53	$5.76 / 0.42	$2.03 / 0.48	-$0.33 / 0.54
2050	$42.98	$6.98 / 0.39	$2.96 / 0.46	-$0.55 / 0.51

	FUND Model Average SCC, agricultural component updated - Discount Rate – 3%			
	Roe Baker (2007)	**Lewis and Curry (2018)**	**Lewis and Curry (2018) + 15%**	**Lewis and Curry (2018) + 30%**
2020	$19.33	$1.61 / 0.49	-$0.82 / 0.57	-$2.74 / 0.63
2030	$21.78	$2.32 / 0.47	-$0.35 / 0.54	-$2.39 / 0.61
2040	$24.36	$3.18 / 0.44	$0.28 / 0.51	-$1.85 / 0.57
2050	$27.06	$4.21 / 0.42	$1.08 / 0.48	-$1.12 / 0.54

	FUND Model Average SCC, agricultural component updated - Discount Rate – 5%			
	Roe Baker (2007)	**Lewis and Curry (2018)**	**Lewis and Curry (2018) + 15%**	**Lewis and Curry (2018) + 30%**
2020	$2.54	-$1.02 / 0.62	-$2.25 / 0.71	-$3.41 / 0.78
2030	$3.31	-$0.77 / 0.58	-$2.14 / 0.67	-$3.41 / 0.74
2040	$4.21	-$0.39 / 0.54	-$1.89 / 0.63	-$3.24 / 0.70
2050	$5.25	$0.15 / 0.49	-$1.47 / 0.58	-$2.87 / 0.65

	FUND Model Average SCC, agricultural component updated - Discount Rate – 7%			
	Roe Baker (2007)	**Lewis and Curry (2018)**	**Lewis and Curry (2018) + 15%**	**Lewis and Curry (2018) + 30%**
2020	-$0.37	-$1.25 / 0.71	-$2.06 / 0.80	-$2.84 / 0.85
2030	-$0.13	-$1.18 / 0.67	-$2.08 / 0.76	-$2.94 / 0.82

2040	$0.19	-$0.98 / 0.62	-$1.98 / 0.71	-$2.91 / 0.77
2050	$0.63	-$0.66 / 0.56	-$1.74 / 0.65	-$2.71 / 0.72

As the results illustrate, under more realistic assumptions regarding agricultural productivity and climate sensitivity, the mean SCC essentially drops to zero and in many cases has a substantial probability of being negative. At a minimum, Dayaratna et al. (2020) further demonstrates that the SCC is highly sensitive to very reasonable changes in assumptions. The models can therefore suggest a variety of outcomes of climate change - ranging from catastrophic disaster or continued prosperity to climate change – all under very reasonable assumptions.

As a result of the uncertainty summarized in the above published analysis, the proposed rule is arbitrary and capricious and therefore should not be implemented.

Miniscule Temperature Impact Not Discussed In the Proposed Rule

The proposed rule begins by saying:

> Motor vehicle emissions contribute to ozone, particulate matter (PM), and air toxics, which are linked with premature death and other serious health impacts, including respiratory illness, cardiovascular problems, and cancer. This air pollution affects people nationwide, as well as those who live or work near transportation corridors. In addition, there is consensus that the effects of climate change represent a rapidly growing threat to human health and the environment, and are caused by GHG emissions from human activity, including motor vehicle transportation. Recent trends and developments in emissions control technology, including vehicle electrification and other advanced vehicle technologies, indicate that more stringent emissions standards are feasible at reasonable cost and would achieve significant improvements in public health and welfare. Addressing these public health and welfare needs will require substantial additional reductions in criteria pollutants and GHG emissions from the transportation sector. (p.29186)

Subsequently, the rule states: "The transportation sector is the largest U.S. source of GHG emissions, representing 27.2% of total GHG emissions." (p. 29186). Since the policy is intended to avert climate change it is necessary to quantify the climate impact of the proposed rule. At The Heritage Foundation, we used the Model for the Assessment of Greenhouse Gas Induced Climate Change version 6, developed by researchers at the EPA to quantify the climate impact. We found that assuming a climate sensitivity of 5.0 degrees C (the upper bound of estimated climate sensitivities indicated by the Intergovernmental Panel on Climate Change), there would be less than 0.0305 degrees C temperature mitigation by 2050 and less than 0.0644 by 2100.

If the objective of the proposed rule is to avert climate change, then it is insufficient for the rule to be based solely on GHG emission reductions; the EPA should go a step further to take these missions and calculate temperature impacts as done above. As a result, the proposed rule is arbitrary and capricious and should not be implemented.

For all of the reasons detailed above, we urge the U.S. Environmental Protection Agency not to go forward with the proposed rule.

Respectfully submitted,

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