Climate Realism and a Positive Vision for American Energy

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Abstract

Everything that is grown, made, used, or moved needs energy. We want our energy to be affordable, available, secure, and sustainable. Twentieth century America is largely a story of achieving the first three qualities, and the last fifty years has been an attempt to achieve the fourth. To that end, climate idealists have presented data on the unsustainability of oil, gas, coal, and nuclear to justify climate and energy policies that categorically reject these disfavored forms of energy while subsidizing favored forms: wind, solar, and batteries. But climate idealists have failed to appreciate the full benefits of fossil fuels: how fossil fuels have been critical to powering industry, producing modern materials, and securing the United States' geopolitical position. At the same time, they exaggerate the unsustainability of fossil fuels, ignoring the strides we have already made in pollution reduction and conflating the reality of climate change with evidence of an imminent apocalypse. Such an approach is myopic and thus fails to see the costs of the energy transition, not just to the affordability of energy, but to its availability, security, and even sustainability.

This article argues that technological prescriptivism is not the most efficient way to accomplish our energy or climate goals. The United States' greatest climate successes have come from setting aggressive goals and allowing them to be reached through technology-neutral and market-based means. Our energy policy should focus on setting realistic goals for energy availability, security, and sustainability and allow American ingenuity to find the most affordable path forward. In this way, the United States can reduce global greenhouse gas emissions while providing for American workers and families. Four pillars support a positive and realistic energy policy. The first is setting availability, security, and sustainability objectives directly rather than with prescriptive command-and-control regulation or subsidization of specific technologies. The second is lowering other regulatory barriers to speed new development of next-generation energy technology. The third is modernizing other non-carbon emission regulations to account for the changing technological and increasingly international landscape. The fourth is investing directly in the protection and improvement of our domestic natural resources. This positive approach will give America and Americans the energy needed to build a better, more sustainable future.

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INTRODUCTION

Policymaking is an exercise in confronting reality. At the heart of this enterprise is the difficult work of weighing relative costs and benefits and deciding how to balance many competing goals. These evaluations, however, are only as good as the data on which they are based. Policy based on incomplete or faulty data rarely achieves its goals.

The dangers of this approach are evident in the current debates surrounding energy policy, as climate change towers over all other considerations. Consequently, despite (and in some ways because of) the effort and resources devoted to this matter by scientists and policymakers, discussions by politicians and the press about climate change and energy policy are often only tenuously connected to the available scientific evidence.[1] Indeed, misleading and downright false claims in reporting on climate change are endemic.

The American people have noticed, and, unsurprisingly, public opinion has never coalesced to the point where significant legislation addressing climate issues has been politically achievable. In light of this, climate idealists have sought to drive American climate policy through strategies that are often democratically unaccountable and legally dubious. These strategies may be in the political and financial interests of climate idealists, but, as shown below, they are not grounded in sound science.

There is a better way—one that recognizes the need to make policy changes considering climate change but that is also grounded in climate realism and balances sustainability with energy affordability, availability, and security. We have done this before. Previous environmental crises like acid rain, the depletion of the ozone layer, and lead poisoning have been handled through more democratically accountable and market-based methods. To confront climate change, we first must accept what the scientific evidence shows about the risks of climate change and the costs of decarbonization. This article gives an account of that data and

1. Scientific inquiry itself has become more politicized in recent decades. *See* Lief Rasmussen, *Increasing Politicization and Homogeneity in Scientific Funding: An Analysis of NSF Grants, 1990-2020*, CSPI REPORT NO. 4, (Nov. 16, 2021). This is a significant problem, but one that is outside the scope of this article.

sketches out an energy policy to support the flourishing of both the planet and its people. What we advocate for, in other words, is neither climate idealism nor climate denial, but climate realism.

The data in favor of an energy transition that eliminates fossil fuels have been presented at length. This article presents the countervailing evidence so that it too may factor into our calculations. To miscalculate is to abandon natural resources that have improved and prolonged billions of lives and ushered in an age of unprecedented prosperity. And while the use of fossil fuels has had environmental costs, the wide availability of affordable fossil fuels has also had many positive environmental effects, especially in limiting the negative impact of development.

This article proceeds in three parts. Part I outlines some of the major advantages of living in a high-energy age, noting the positive changes to daily life that oil and natural gas brought about throughout the twentieth century. This section then continues to discuss how the affordability, availability, and security of fossil fuels has been critical to powering industry, producing modern materials, and securing the United States' geopolitical position. Finally, this section disentangles the conflation of greenhouse gases (GHGs) with other environmental pollutants, recounts how, over the last 50 years, American water, air, and forests have become cleaner than at any time in modern history, and shows that projections of climate catastrophe are unsupported by the data.

Part II provides a clear look at the costs of transitioning to an energy system supported largely by wind, solar, and batteries. First, this section examines the negative impact wind and solar power are already having on electricity reliability and cost, and how batteries are unlikely to fix this. Next, it explores some of the negative industrial and geopolitical consequences of a reliance on energy sources that are less conducive to critical manufacturing and more dependent on foreign suppliers. Finally, this section looks at some of the unsustainable consequences of wind, solar, and battery production that are often ignored because of their low GHG emissions—specifically the quantum of materials required for construction, the intensity of emissions created by their construction, their massive land requirements, issues with waste, and human rights implications—which our existing regulatory framework fails to capture.

Finally, Part III proposes a positive vison for American energy policy, making several policy suggestions to strike the right balance between ignoring and exaggerating the advantages and disadvantages of fossil fuels. Technological prescriptivism is not the most efficient way to accomplish our energy or climate goals. Our energy policy should focus on setting realistic goals for energy availability, security, and sustainability and allow the market and American ingenuity to find the most affordable path forward. In this way, the United States can reduce GHG emissions while providing for American workers and families. In this section I outline four pillars to support a positive and realistic energy policy: directly setting objectives, lowering regulatory barriers to development, modernizing non-carbon emissions regulations, and investing directly in our natural resources. This positive approach will give America and Americans the energy needed to build a better, more sustainable future.

I. THE ADVANTAGES OF THE HIGH-ENERGY AGE

A. *Fossil Fuels Launched the High-Energy Age*

It is hard to overstate how extensively fossil fuels transformed the world during the twentieth century. Fossil fuels "began supplying more than half of the world's primary energy sometime during the 1890s."[2] By 1900, fossil fuels contributed about 6,000 terawatt-hours (TWh) per year—about half the world's energy—with world energy consumption at about 3,900 kilowatt-hour (kWh) per person per year—roughly the equivalent of 311 gallons of gasoline. A century later, fossil fuel energy had grown more than ten-fold to supply 89,000 TWh per year, dominating the energy consumption and raising per capita energy availability more than four-fold to 17,000 kWh per person per year—about the equivalent of 1,356 gallons of gasoline.[3] If anything, these raw numbers of energy availability understate the change. Efficiencies and the service that could be provided per energy unit increased even more dramatically.[4] Conservative calculations suggest that by the year 2000 the world had twenty-five times as much useful energy at its disposal than it did in 1900.[5]

Energy growth in the twentieth century was dominated by oil and natural gas.[6] Since the turn of the twenty-first century, global solar and wind energy consumption have also grown dramatically—from 1 and 31 TWh respectively in the year 2000 to 724 and 1,430 TWh in 2019. But even this rapid growth is less than ten percent of the 26,000 TWh growth in oil and natural gas consumption during the same period.[7]

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2. Vaclav Smil, *Energy in the Twentieth Century: Resources, Conversions, Costs, Uses, and Consequences*, 25 ANN. REV. ENERGY & ENV'T 21, 22 (2000).
3. *Global direct primary energy consumption*, OUR WORLD IN DATA, https://ourworldindata.org/grapher/global-primary-energy (last visited Oct. 17, 2022) [https://perma.cc/72FF-QZGS].
4. Smil, *supra* note 2.
5. *Id.*
6. *Global direct primary energy consumption*, *supra* note 3.
7. *Id.*

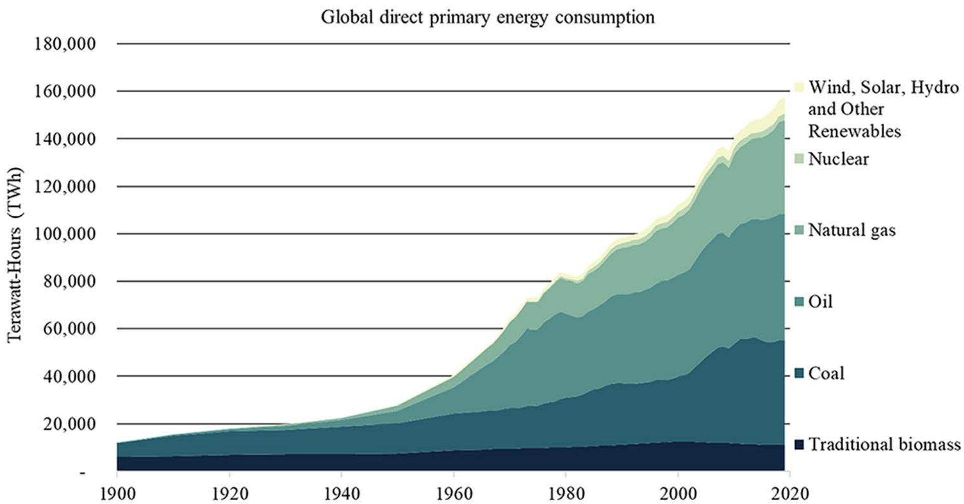

FIGURE 1: Global energy consumption from all sources.[8]

This power growth enabled unprecedented quality of life improvements. In 1900, the rare, electrified house had a few low-powered lightbulbs. By 2000, the average middle-class home had a refrigerator and freezer to keep food fresh, an electric or natural gas oven and stove top to prepare meals without smoke, air conditioning for the summer, reliable, push-button heat for the winter, and dozens of lightbulbs. The average American went from walking as his only reliable form of transportation to owning one, two, or three cars. The two-thousand-mile trip from Independence, Missouri to Oregon City, Oregon took a mid-nineteenth century traveler 160 days to complete. It can now be accomplished in a five-and-a-half-hour flight.

This energy growth also enabled and drove improvements in sanitation, public health, and medical treatments. Mortality from all causes in the United States declined firty-four percent from 1900 to 2010.[9] Deaths from accidents and infectious diseases have dropped to a fraction of their nineteenth-century levels. The two leading causes of death in 2010—heart disease and cancer—are largely deaths of senescence. In 1900, the average American newborn could expect to live 47.3 years. By 2010, they could expect to live to almost seventy-nine, more than thirty years of additional life.[10]

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8. *Id.*

9. Rebecca Tippet, *Mortality and Cause of Death, 1900 v. 2010*, CAROLINA DEMOGRAPHY (June 16, 2014).

10. *Id.*

B. Abundant Energy Availability Enabled Industry and Prosperity

In the United States, prosperity and population growth through the twentieth century were driven by an increase in industrialization and reliable manufacturing jobs. That industrialization, in turn, was driven by harnessing the supply and productive uses of oil and natural gas. From 1900 to the present, the United States has been a world leader in oil production.[11] As of 2013, the United States exceeds all countries—including Saudi Arabia—in petroleum production and has been the world's largest producer of natural gas since 2009.[12] This recent growth has largely resulted from the "Shale Revolution," which set off a tremendous boom in United States' production following 2008's great recession.[13] Today, the oil and natural gas industry accounts for about eight percent of the United States' GDP and nearly six percent of all United States employment.[14]

This inexpensive and reliable oil and natural gas did not merely increase jobs in the oil and natural gas industry but also in manufacturing more broadly. Research examining oil and natural gas booms in the United States has shown that they boost wages.[15] Despite these higher wages, overall manufacturing employment and output are also positively correlated with resource growth, as inexpensive energy facilitates higher productivity across all manufacturing and at lower costs.[16] The Industrial Production Index, a measure of real output of United States manufacturing and utilities, grew by a factor of eighteen from 1919 until 2000.[17] As a result, manufacturing jobs have tracked the growth of oil and natural gas production for most of the last century—until 2001.

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11. *Oil Production*, OUR WORLD IN DATA, https://ourworldindata.org/grapher/oil-production-by-country (last visited Oct. 17, 2022) [https://perma.cc/DJ3B-KGYT].

12. Samantha Gross, *Geopolitical Implications of United States Oil and Gas in the Global Market*, BROOKINGS INST. (May 22, 2018), https://www.brookings.edu/testimonies/geopolitical-implications-of-u-s-oil-and-gas-in-the-global-market/ [https://perma.cc/QU6P-4REJ].

13. Stephen P.A. Brown & Mine K. Yücel, *The Shale Gas and Tight Oil Boom: United States' Economic Gains and Vulnerabilities*, COUNCIL ON FOREIGN RELS. (October 2013).

14. Bob Iaccino, *How Much Does Oil and Gas Drive U.S. GDP?,* STREET (June 5, 2019, 9:11 AM EDT), https://www.thestreet.com/markets/how-much-does-oil-and-gas-drive-u-s-gdp-14981567 [https://perma.cc/3NRX-KC49].

15. Hunt Allcott & Daniel Keniston, *Dutch Diseases or Agglomeration? The Local Economic Effects of Natural Gas Resource Booms in Modern America* (Rev. Econ. Studies, Working Paper No. 20508, 2018).

16. *Id.*

17. BD. OF GOVERNORS OF THE FED. RSRV. SYS., INDUSTRIAL PRODUCTION: TOTAL INDEX, FED. RSRV. ECON. DATA (last visited Oct. 27, 2022).

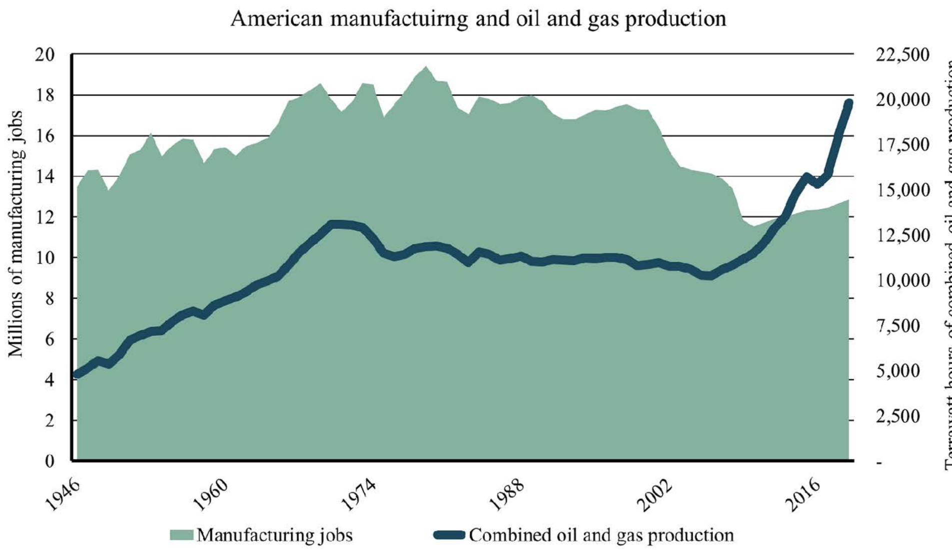

FIGURE 2: United States combined oil and natural gas production and manufacturing jobs.[18]

1. The Collapse of United States Manufacturing

In 2001, the addition of China to the World Trade Organization, combined with increasingly complicated labor and environmental standards, sent domestic manufacturing jobs off a cliff. The changing landscape incited massive regulatory arbitrage, and companies dutifully offshored manufacturing jobs to capitalize on low-wages and a lack of meaningful environmental regulations abroad. The result was reduced prices for consumer goods and the devastation of the American workforce.

While enhanced consumer purchasing power is undoubtedly beneficial, the lack of reliable and meaningful work has offset this gain. Work matters not just because it contributes to the GDP or because it provides a living wage but also because it provides meaning and purpose to those who do it. Meaningful work is key to building strong families and self-sufficient communities, which help instill

18. Manufacturing data from MANUFACTURING JOB NUMBERS FROM U.S. BUREAU OF LABOR STATISTICS, FEDERAL RESERVE ECONOMIC DATA; oil data from U.S. ENERGY INFO. ADMIN., U.S. FIELD PRODUCTION OF CRUDE OIL, (accessed Nov. 19, 2022), https://www.eia.gov/dnav/pet/hist/LeafHandler.ashx?n=PET&s=MCRFPUS2&f=A [https://perma.cc/63RV-APLP]; natural gas data from U.S. ENERGY INFO. ADMIN., NATURAL GAS GROSS WITHDRAWALS, (accessed Nov. 19, 2022) https://www.eia.gov/dnav/ng/hist/n9010us2a.htm [https://perma.cc/KMT2-9ESS]; and conversion to energy units from *Units and Calculators Explained*, U.S. ENERGY INFO. ADMIN. (accessed Nov. 19, 2022) https://www.eia.gov/energyexplained/units-and-calculators/ [https://perma.cc/8D3Y-NAQJ].

in children the values and abilities that enable them to build-up strong families and self-sufficient communities of their own.[19] This meaning is key both to self-proclaimed "knowledge workers" and to the more than half of American adults who do not have college degrees. Their contributions through diverse blue-collar jobs and trades underpin the economic and societal fabric of the country.

Tens of millions more Americans are unemployed or underemployed today than in the 1990s.[20] While some lost manufacturing jobs were replaced with other blue-collar work, it is not a one-to-one exchange. Manufacturing, construction, and resource extraction combine to account for forty percent of high paying blue-collar jobs. When workers leave these higher paying manufacturing sector jobs for healthcare and service sector jobs, their pay falls and the community stops generating wealth, eventually atrophying and dying. Thoughcombined oil and natural gas production has reached all-time highs, the United States has fewer manufacturing jobs than it did at the end of World War II, when the United States population was only forty percent of its current size.

As a result, small communities have collapsed and people, particularly the working class, are unsatisfied and pessimistic about the future. Deaths of despair have increased, suicides have increased, and the opioid epidemic has claimed more than 500,000 lives. The problem is only getting worse—the United States recorded more than 100,000 deaths from opioids in the last year.[21] Fentanyl is now the leading cause of death in Americans between ages eighteen and forty-five.[22]

C. Fossil Fuels Provide Energy Security and Foster Geopolitical Strength

The case for United States energy independence has been made before and need not be rehashed at length.[23] But it is important to recall just how important energy superiority has been for the United States and her allies over the last century and how oil and natural gas enabled it.

1. Energy Security is Key to Geopolitical Influence

In World War II, United States oil powered a two-ocean fleet and supplied our allies with fuel. Despite drastic superiority at the beginning of the struggle, Hitler's Germany ultimately lost when it overextended and failed in a push for Russian oil of the Caucuses, leaving the blitzing tanks of 1939 without enough

19. *See* OREN CASS, THE ONCE AND FUTURE WORKER: A VISION FOR THE RENEWAL OF WORK IN AMERICA 36 (2018).

20. *Id.* at 21–24.

21. Jon Kamp & Julie Wernau, *Drug Overdose Deaths, Fueled by Fentanyl, Hit Record High in U.S.*, WALL ST. J. (Nov. 17, 2021, 4:41 pm ET), https://www.wsj.com/articles/drug-overdose-deaths-fueled-by-fentanyl-hit-record-high-in-u-s-11637161200?mod=itp_wsj&ru=yahoo [https://perma.cc/5WTK-3NYS].

22. CTRS. FOR DISEASE CONTROL AND PREVENTION, DRUG OVERDOSE DEATHS IN THE U.S. TOP 100,000 NATIONALLY (November 17, 2021).

23. *See, e.g.*, C. Boyden Gray, *American Energy, Chinese Ambition, and Climate Realism*, 5 AM. AFFS. 80 (Winter 2021).

fuel to perform basic maneuvers.[24] Japan's fuel scarcity led it to gradually succumb to a depleted United States force, falling back further and further to their home islands, eventually without enough fuel to launch their fighter planes. When American troops surrounded General Hideki Tojo's home, he shot himself just above the heart, hoping to avoid prosecution. His life hung in the balance not because the wound was immediately fatal—it was not—but because it took over two hours to locate an ambulance with enough gasoline to drive him to the hospital.[25]

Energy and American fortunes have been consistently linked ever since. After the war, an abundance of oil and coal sustained the United States in a massive manufacturing and energy exporting boom, putting it in a position of unprecedented international power and influence.[26] In the 1970s, American oil production declined and substantially weakened our global standing. Saudi Arabia exploited our newfound dependence on foreign oil by imposing an embargo, leading to the first oil crisis and the 1973–75 recession.[27] American oil production continued to decline for the rest of the decade, leading to the USSR and Saudi Arabia outstripping the United States' oil production by 1975 and 1979, respectively.

When the Soviet Union's oil production began declining, in 1986 President Reagan's CIA director William Casey persuaded the Saudis to ramp up their oil production. The ensuing price reductions deprived the USSR of oil revenue, causing a recession from which the USSR never recovered, leading to its eventual breakup.[28] During the same period, the United States wisely reduced its reliance on foreign oil by expanding other domestic energy sources such as nuclear power, which increased fifteen-fold from 1970 to 1990. Still, as a net-importer of oil, foreign actors—many of whom were not our friends—had significant leverage over us.

Since the Shale Revolution, American oil and gas production has soared, launching the United States back to the top of the world's energy supply chain.[29] In 2014, the United States again surpassed Russia in combined oil and gas production. Then, in 2020, for the first time in more than fifty years, the United States became a net-oil exporter.[30]

This energy dominance has in turn yielded increased influence, increased security, and greater flexibility in foreign affairs.[31] This energy dominance pushed the American economy out of its post-2008 doldrums and allowed for the peaceful

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24. DANIEL YERGIN, THE PRIZE: THE EPIC QUEST FOR OIL, MONEY, AND POWER 337–38 (2003).
25. *Id.* at 366–67.
26. C. Boyden Gray & Michael Buschbacher, *Joe Biden's Low-Energy Blunder*, AM. CONSERVATIVE (Jan. 26, 2022), https://www.theamericanconservative.com/joe-bidens-low-energy-blunder/ [https://perma.cc/Q2RH-6YWU].
27. *Id.*
28. *Id.*
29. *See supra* Figure 2.
30. U.S. ENERGY INFO. ADMIN., NET IMPORTS OF TOTAL CRUDE OIL AND PRODUCTS INTO THE U.S. BY COUNTRY (2021).
31. DANIEL YERGIN, THE NEW MAP: ENERGY, CLIMATE, AND THE CLASH OF NATIONS, xv (2020).

exertion of influence abroad. Because the United States controls so much of the global oil and natural gas supply, it can take the lead in punishing bad foreign actors without military action byimposing tariffs, embargoes, asset freezes, and other sanctions, all without shocking oil prices. As a result, OPEC's predominance has waned, and major hydrocarbon producers like Iran and Venezuela have had their influence checked. In February 2014, in response to the Russian invasion of Ukraine, the United States could impose stiff sanctions, restricting Russian access to energy and arms without having to worry that Russian reprisals would weaken the global economy. Those sanctions led to the collapse of the Russian Ruble and to the Russian financial crisis. As a direct result, Russia was forced to limit its military ambitions in the region.[32] When Russia invaded Ukraine in 2022, having secured its own security by bolstering its oil and gas production and dependent customers through the Nord Stream and Power of Siberia pipelines, an energy crisis resulted in Europe. But the United States has been largely insulated from this crisis. American gasoline and natural gas prices did rise, but they have stayed far below those of our European counterparts.[33]

D. The United States' Environmental Progress

The primary argument against fossil fuels is that their combustion has directly resulted in tremendous damage to the environment. However, reality is more complicated. Early fossil fuel combustion indeed degraded air and water quality, but intelligent regulation has largely curtailed these problems. The United States is as clean as it has ever been. GHG emissions from fossil fuels do directly contribute to the rise in global surface temperatures we have observed over the last few decades, but modeling the future path of this temperature rise is difficult, and modeling second order weather effects is even more challenging. To date, no overall increase in extreme weather has been detected, and the lives lost in extreme weather events are decreasing.

1. The United States is as Clean as it has Ever Been

Environmental rhetoric often lumps all pollutants together. To the use of oil and natural gas is attributed not just global warming but fouled water ways, unbreathable air, and deforestation. But the United States has cleaner water, cleaner air, and more trees now than it has had at any point in the recent past.

Among all environmental issues, clean water is the top concern for Americans.[34] Largely, this concern is being met. Most types of water pollution

32. Gray & Buschbacher, *supra* note 26.

33. *See* Kate Marino, *Why natural gas costs so much more in Europe*, AXIOS (Jul. 11, 2021), https://www.axios.com/2022/07/11/europe-natural-gas-prices [https://perma.cc/3UPM-JKQB] (showing natural gas prices sometimes ten times higher in Europe than in the U.S.).

34. Megan Brenan, *Water Pollution Remains Top Environmental Concern in U.S.*, GALLUP (April 19, 2021), https://news.gallup.com/poll/347735/water-pollution-remains-top-environmental-concern.aspx [https://perma.cc/4WBD-YH4R].

have declined since 1962.[35] The share of fishable waters has increased twelve percent in the same period. While the 1972 Clean Water Act has not met its ambitious goals of making all United States waters fishable and swimmable by 1983 and having zero water pollution discharge by 1985, we have come a long way. Even Washington D.C.'s Anacostia River, at one time among the most polluted rivers in the nation, might be swimmable by 2025.[36]

Air quality has also improved dramatically over the last half century. Despite large growth in population, GDP, and even miles traveled, total emissions of the six main air pollutants have dropped seventy-three percent since 1980.[37] Lead pollution has been virtually eliminated and particulate matter is at all-time lows.[38] Deaths from air pollution have fallen by forty percent in the United States since 1990.[39] American cities are now among the cleanest in the world.

One of the most stunning successes in the American clean air program is the reduction of sulfur-dioxide emissions through the cap-and-trade program established under the 1990 Clean Air Act Amendments. Under the program, an aggregate national emissions cap—slowly lowered over successive years—was established for all large coal plants. As a result, sulfur dioxide emissions from electric power plants decreased thirty-six percent between 1990 and 2004 even while electricity generation from coal-fired plants increased twenty-five percent over the same period.[40] And this was achieved for a price far lower than expected. Initial EPA estimates projected a cost of $6.1 billion, but program cost estimates in 1998 were far lower, with a total cost estimated between $1.1 and 1.7 billion.[41]

Trees too, are coming back. As their populations grew, the United States and Europe each underwent rapid deforestation to create farmland and reliable energy through the harvest and combustion of wood and other biomass.[42] This deforestation stopped in the 1800s with the ability to extract and harness the energy content of coal and petroleum at scale. Forest cover has increased in the United States throughout the twentieth cenutry, and is now at the highest level since detailed

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35. David Keiser & Joseph Shapiro, *Consequences of the Clean Water Act and the Demand for Water* (Nat'l Bureau of Econ. Rsch. Working Paper No. 23070, 2017).

36. Anacostia Watershed Society, *Swimmable and Fishable by 2025*, https://www.anacostiaws.org/what-we-do/swimmable-fishable-by-2025.html (last accessed Dec. 24, 2022) [https://perma.cc/4SPM-XQRE].

37. U.S. ENV'T PROT. AGENCY, AIR QUALITY NATIONAL SUMMARY (last updated June 1, 2022).

38. *Id.*

39. Hannah Ritchie & Max Roser, *Outdoor Air Pollution*, OUR WORLD IN DATA (last updated Jan. 2022), https://ourworldindata.org/outdoor-air-pollution [https://perma.cc/3NL5-GA5G].

40. Richard Schmalensee & Robert N. Stavins, *Lessons Learned From Three Decades of Experience With Cap-and-Trade*, 11 REV. ENV'T ECON. & POL'Y 59, 62 (2017).

41. Justin Gerdes, *Cap and Trade Curbed Acid Rain: 7 Reasons Why it Can Do The Same For Climate Change*, FORBES (Feb. 13, 2012), https://www.forbes.com/sites/justingerdes/2012/02/13/cap-and-trade-curbed-acid-rain-7-reasons-why-it-can-do-the-same-for-climate-change/?sh=195b8b61943a [https://perma.cc/UMJ7-BNLA].

42. Dina Spector, *American Forests Look Nothing Like They Did 400 Years Ago*, INSIDER (Sep. 4, 2013), https://www.businessinsider.com/northeastern-us-forest-transformation-2013-9 [https://perma.cc/QU75-MAUA].

record keeping began.[43] Jim Sterba suggests that this may be the greatest reforestation in history: "By the 1950s, depending on the region, nearly half to more than two-thirds of the landscape was reforested, and in the last half century, states in the Northeast and Midwest have added more than 11 million acres of forest."[44]

Reforestation remains a project with popular bipartisan support. But the return of American forests did not happen despite fossil fuels—it happened because of them. Thanks to the rise of fossil fuels, wood is a less important source of fuel. When wood is still consumed in the United States, it is mainly in the form of wood or paper products, with only fifteen percent of American wood consumption used for fuel.[45]

2. The Challenge of Climate Modeling

Concern with air and water pollution has taken a back seat to concerns about the emission of GHGs as the primary driver of global climate change. On this topic, three things can be asserted confidently. First, increases of atmospheric carbon dioxide and other GHGs have the first-order effect of increasing atmospheric temperature. Second, global surface temperature measurements show a rise around 1 °C from 1850 until present day.[46] Third, long term modeling of the Earth's climate has proved shockingly difficult. Scientific confidence in the first two points has led us to elide the uncertainty in our models.

The current rhetoric of climate change critics rests on lumping skepticism of these three points together, as if they are all the same. Those who claim atmospheric GHG concentrations do not change Earth's surface temperatures are misinformed, but those who claim that climate modeling is difficult are correct. The projection of future climate is "one of the most complex problems undertaken by the scientific community. . . . With the rapid increase of complexity in Earth system models, reducing uncertainties in climate projections becomes extremely challenging."[47]

Accurate models require complexity because the Earth's climate is an incredibly complex system. Projecting global temperature changes requires modeling the mechanisms of countless physical processes which are often chaotic or stochastic and which span different length scales. Lower-level mechanisms, like the absorption of carbon dioxide into seawater, are tightly coupled to higher level mechanisms, like large-scale ocean circulation. The mechanisms interact in complicated reinforcing and balancing feedback loops, and our modeling of theses mechanisms often relies on scarce data or extrapolations beyond observed

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43. Hannah Ritchie & Max Roser, *Deforestation and Forest Loss*, OUR WORLD IN DATA (2021), https://ourworldindata.org/deforestation [https://perma.cc/W55L-NGKR].

44. JIM STERBA, NATURE WARS 3 (2012).

45. U.S. DEP'T OF AGRIC., U.S. FOREST RESOURCE FACTS AND HISTORICAL TRENDS 39 (Aug. 2014).

46. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS 5 (Valérie Masson-Delmotte et al. eds., 2021).

47. Yun Qian et al., *Uncertainty Quantification in Climate Modeling and Projection*, 97 BULL. AM. METEOROLOGICAL SOC'Y 821 (2016).

conditions. This uncertainty can lead to bifurcated scenarios, where small changes in the model lead to large shifts in projected temperatures. For example, increases in atmospheric carbon dioxide could increase atmospheric temperature causing global icesheets to melt, reducing albedo, increasing the absorption of solar radiation, and raising global temperatures.[48] Or the same temperature increase could cause greater water vaporization, increasing cloud coverage, thus increasing albedo, and in turn reducing solar radiation and lower global temperatures.[49] Natural variability associated with large-scale ocean circulation could contribute to cooling in the coming decades, while releases of GHGs from the same circulation oceans could lead to warming.[50]

Some of the largest variability comes from unpredictable factors. Temperature "forcing" because of solar and volcanic variability are some of the largest drivers of climate models.[51] Major volcanic eruptions could have a cooling effect, as could the decrease in solar radiation after the Grand Modern Maximum, a peak in observed solar activity and radiation that occurred in the late twentieth century. This underlying, multivariate complexity is understood by scientists but not properly conveyed by climate advocates.

The models themselves are imperfect and climate scientists have seen modeling failures in the past. Initial warming trends seemed debunked during the "global warming hiatus," when, from 1998 to 2012, global surface temperatures hardly changed—only to come surging back in the last decade.[52] Even predictions of GHG production can be difficult. A recent analysis found that despite increased global fossil fuel consumption, carbon dioxide emissions have remained unchanged over the last decade, mainly owing to changes in land use.[53]

3. Current Evidence Does Not Point to Catastrophe

There is deep uncertainty about how the climate will change through the twenty-first century, but some things are clear. A 5 ˚C global surface temperature rise, as projected by the Intergovernmental Panel on Climate Change's (IPCC)

48. Kristina Pistone et al., *Radiative Heating of an Ice-Free Arctic Ocean,* 46 GEOPHYSICAL RES. LETTERS 74–80 (2019).

49. Brian J. Soder et al., *Global Cooling After the Eruption of Mount Pinatubo: A Test of Climate Feedback by Water Vapor*, 296 SCIENCE 727–29 (Apr. 26, 2002), https://www.science.org/doi/10.1126/science.296.5568.727 [https://perma.cc/AB4W-QBE4].

50. D.S. Trossman et al., *Large-Scale Ocean Circulation-Cloud Interactions Reduce the Pace Of Transient Climate Change*, 43 GEOPHYSICAL RES. LETTERS 3935–43 (Apr. 11, 2016); *Living With the Oceans. A Report on the State of the World's Oceans*, WORLD OCEAN REV. (2010).

51. John C. Fyfe et al., *Significant Impact of Forcing Uncertainty in a Large Ensemble Of Climate Model Simulations*, 118 PROC. NAT'L ACAD. SCI. (2021).

52. Xiao-Hai Yan et al., *The Global Warming Hiatus: Slowdown or Redistribution?*, 4 EARTH'S FUTURE 472–82 (Nov. 22, 2016), https://agupubs.onlinelibrary.wiley.com/doi/pdf/10.1002/2016EF000417 [https://perma.cc/D98E-CTFP].

53. Zeke Hausfather, *Global CO2 Emissions Have Been Flat for a Decade, New Data Reveals*, CARBON BRIEF (Nov. 4, 2021), https://www.carbonbrief.org/global-co2-emissions-have-been-flat-for-a-decade-new-data-reveals [https://perma.cc/JKH6-Q8YZ].

worst case scenario, RCP8.5, is incredibly unlikely.[54] The emissions pathway to get to the worst case requires virtually no emissions reductions and an unprecedented fivefold increase in coal use by 2100.[55] While worst-case scenarios can be a useful thought exercise, they should not be the main driver of policy. A 2 to 3 ˚C temperature rise is far more likely than a 5 ˚C rise.[56]

These smaller temperature rises will likely be far more manageable. The IPCC's sixth assessment report states that with warming of 2 to 3 ˚C we are likely to see the most catastrophic effects of climate change, like the melting of the Greenland or West Antarctic Ice Sheets, only "over multiple millennia."[57] This is far slower than the extreme and catastrophic risks generally associated with an impending 5 ˚C warming.

And the consequences of a warming climate, thus far, have been small. Climate idealists often point to rising climate-related deaths from temperatures or natural disasters. However, the data does not support these assertions.[58] It is true that, since the 1970s, unusually hot summer days have become more common in the United States, but at the same time, unusually cold winter temperatures, particularly very cold nights, have become less common.[59] While both extreme heat and extreme cold can be fatal, extreme cold is far more deadly. A 2015 meta-study in *Lancet* found that seventeen times more deaths are attributable to low temperatures than high temperatures.[60] Recent news articles trumpeted that climate change is already causing five million deaths a year—but the research those articles cite does not support this assertion.[61] The referenced 2021 study did indeed find that five million deaths a year were linked to "non-optimal temperatures," of which ninety

54. Zeke Hausfather & Glen P. Peters, *Emissions– The 'Business As Usual' Story Is Misleading*, 577 NATURE 618–20 (Jan. 29, 2020), https://www.nature.com/articles/d41586-020-00177-3 [https://perma.cc/ZAQ3-YKQ8].

55. *Id.*

56. *Id.*

57. IPPC 2021, CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS, WORKING GROUP I CONTRIBUTION TO THE SIXTH ASSESSMENT REPORT OF THE INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, BOX TS9.

58. *See, e.g.*, Indur M. Gloklany, *Climate Change is not the Biggest Global Health Threat*, 374 LANCET 973 (Sept. 19, 2009) (rebutting a Lancet study claiming "climate change is the biggest global health threat of the twenty-first century" while presenting findings that suggest climate change is the twenty-first biggest health threat of the twenty-first century.)

59. U.S. ENV'T PROT. AGENCY, CLIMATE CHANGE INDICATORS: WEATHER AND CLIMATE (Last updated Aug. 1, 2022).

60. *See* Antonio Gasparrini et al., *Mortality Risk Attributable to High and Low Ambient Temperature: A Multicountry Observational Study*, 386 LANCET 369, 372–73 (2015).

61. *See* Robert Preidt, *Climate Change Already Causes 5 Million Extra Deaths per Year*, HEALTHDAY (July 8, 2021), https://consumer.healthday.com/b-7-8-global-warming-s-high-temps-already-behind-5-million-extra-deaths-per-year-2653690431.html [https://perma.cc/78GG-D7VM]; Laura Millan Lombrana, *Climate Change Linked to 5 Million Deaths a Year, Study Shows*, BLOOMBERG NEWS (July 7, 2021), https://www.bloomberg.com/news/articles/2021-07-07/climate-change-linked-to-5-million-deaths-a-year-new-study-shows [https://perma.cc/86M7-XFWE].

percent were cold-related and ten percent heat-related.[62] But these are deaths associated with climate—not climate change. The authors performed a time series analysis, examining the change in temperature related deaths over sixteen years, and found a net *decrease* in mortality over that period.[63] While heat-related deaths increased somewhat, this was more than offset by reductions in cold-related deaths, and the authors suggest that climate related mortality has decreased by about 166,000 deaths per year.[64]

Other extreme weather—hurricanes, floods, tornadoes—have not detectably increased because of climate change.[65] The frequency of hurricanes making landfall in the United States has declined slightly since 1900.[66] Those that do make landfall have not increased in intensity.[67] There has been a small increase in strong hurricanes in recent decades, but this is not a rise from a pre-industrial baseline. Instead, it is "a recovery from a deep minimum in the 1960s–1980s."[68] Flooding has similarly decreased. As a share of GDP, flood damages have declined nearly ten-fold since 1900 and the fatalities per capita have fallen nearly three-fold.[69] Strong tornadoes, those of an Enhanced Fujita level three or higher, have not increased since the 1950s.[70]

The natural disasters that do occur cause far fewer deaths than they did a century ago because the worst killers—droughts and floods—have been mitigated by technological improvements.[71] Most deaths from natural disasters in the twenty-first century have resulted from earthquakes, which are not associated with climate change.

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62. Qi Zhao et al., *Global, Regional, and National Burden of Mortality Associated with Non-Optimal Ambient Temperatures from 2000 to 2019: A Three-Stage Modelling Study*, 5 LANCET PLANETARY HEALTH e415, e420–22 (2021).

63. *Id.*

64. *See id.*

65. *See* CLIMATE CHANGE 2021, *supra* note 46 at 1513–1765.

66. Phillip Klotzbach et al., *Continental U.S. Hurricane Landfall Frequency and Associated Damage: Observations and Future Risks*, 99 BULL. AM. METEOROLOGICAL SOC'Y 1359 (2018).

67. Bjorn Lomborg, *Hurricane Ida isn't the Whole Story on Climate; The Number of Landfall Hurricanes isn't Rising and the World is Getting Better at Mitigating Their Destruction*, WALL ST. J., (Sept. 15, 2021), https://www.wsj.com/articles/hurricane-ida-henri-climate-change-united-nations-un-galsgow-conference-natural-disaster-infrastructure-carbon-emissions-11630704844 [https://perma.cc/NSQ6-NLAN].

68. Gabriel A. Vecchi et al., *Changes in Atlantic Major Hurricane Frequency Since the Late-19th Century*, 12 NATURE COMMC'NS 1, 1 (July 13, 2021).

69. Bjorn Lomborg, *The World is Getting Safer from Floods*, WALL ST. J., (Sept. 9, 2021), https://www.wsj.com/articles/flood-climate-change-ipcc-united-nations-infrastructure-deaths-cost-severe-weather-11631134276 [https://perma.cc/EQN5-C2VU].

70. NAT'L CTRS. FOR ENV'T INFO., U.S. DEP'T COM., HISTORICAL RECORDS AND TRENDS, https://www.ncdc.noaa.gov/climate-information/extreme-events/us-tornado-climatology/trends [https://perma.cc/9N9B-ELJH] (2017).

71. *See* Hannah Ritchie & Max Roser, *Natural Disasters*, OUR WORLD IN DATA (Nov. 2021), https://ourworldindata.org/natural-disasters [https://perma.cc/2QAC-A69R].

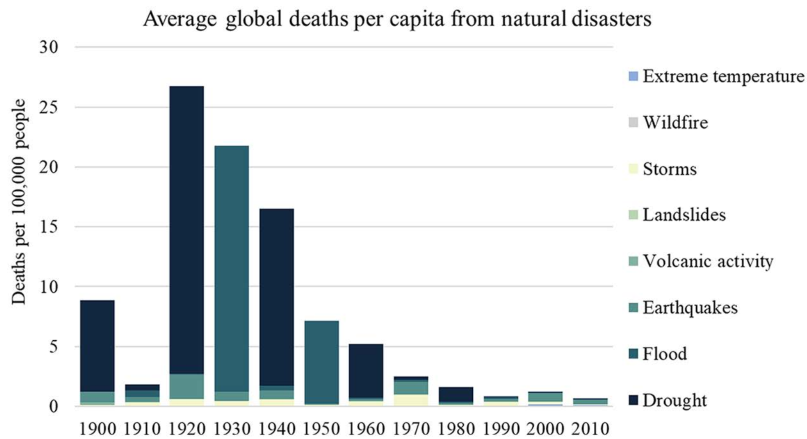

FIGURE 3: Average global deaths per capita from natural disasters.[72]

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None of this is to argue that efforts should not be made to reduce GHG emissions or otherwise mitigate climate change, and advocates are right to call for lessening our global climate impact. Rapid changes in temperature could lead to losses in biodiversity and the displacement of people across the world, but the best models agree that it will not be the apocalypse or the "world on fire"[73] it has been said to be.

The benefits of reducing emissions to avoid the consequences of climate change must be weighed against its costs. Net-zero is not the only way to deal with the consequences of climate change. Research by Nobel Prize-winning economist William Nordhaus demonstrates that our current net-zero strategies, intended to maintain global temperature rise below 1.5 °C, will be far more expensive than any future damages.[74] Instead, the ideal policy involves balancing current costs and future damages so that resources may be used to deal with other important problems.[75] As explained in the next section, the present plans for decarbonization will lead to dramatic reductions in the quality of life for people around the world: higher energy costs and less reliable power in developed countries and lower energy access and continued poverty in developing countries. These burdens are unlikely to be borne quietly.

72. *Id.*
73. Sarah Bahr, *Tracking Climate Change in 193 Countries*, N.Y. TIMES (Jan. 5, 2022), https://www.nytimes.com/2022/01/02/insider/tracking-climate-change-in-193-countries.html [https://perma.cc/QJ5R-LVX2].
74. *William Nordhaus Prize Lecture*, THE NOBEL PRIZE (Dec. 8, 2018), https://www.nobelprize.org/prizes/economic-sciences/2018/nordhaus/lecture/ [https://perma.cc/JBF9-7C2A].
75. *Id.*

II. THE COST OF A TRANSITION TO WIND, SOLAR, AND BATTERIES

A. Wind and Solar Will Make Electricity More Expensive and the Grid Less Reliable

The energy transition has begun. In 2020, for the first time, renewable energy—consisting of solar, wind, hydro, and biomass power—surpassed coal in United States electrical generation.[76] United States coal-fired electricity generation peaked in 2007 and has plummeted since. This gap was made up in part by wind and solar; wind energy, quickly growing, now makes up about eight percent of electricity generation, and solar about two percent.[77] Most of the remaining coal generation was replaced by natural gas, which has grown to provide forty percent of American electricity.[78] This shift to natural gas for power generation is the largest single factor in American reduction of GHG emissions. While coal emits the equivalent of 1,000 grams of carbon dioxide per kWh, natural gas emits only450 grams per kWh.[79] The United States' peak GHG production is in the past.

This transition was not achieved without a cost. Coal and nuclear power represent stable and reliable baseload power. But the wind, solar, and natural gas energy that have replaced them are far less stable. Natural gas relies on just-in-time deliveries of fuel, susceptible to problems with pipelines and natural gas storage facilities. Wind and solar are naturally intermittent and are not always available. Achieving an electrical grid fully supported by wind, solar, and batteriest, will come with a high price tag and at great detriment to energy availability.

1. The Intermittency of Wind and Solar

Electrical grids maintain a delicate balance in which real-time power consumption is matched precisely to real-time power generation. This total power demand varies throughout the day, with a minimum baseload power generated from sources that run constantly and additional peak load capacity from nimbler generators that can be called into service as demand rises.

For most of the post-war years, the United States' baseload power came from coal and nuclear generators. These two sources combined to comprise around seventy-five percent of American energy generation from 1980 to 2000.[80] But

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76. U.S. ENERGY INFO. ADMIN., RENEWABLES BECAME THE SECOND-MOST PREVALENT U.S. ELECTRICITY SOURCE IN 2020 (July 28, 2021), https://www.eia.gov/todayinenergy/detail.php?id=48896 [https://perma.cc/ZL5R-8DRP].

77. *Id.*

78. *Id.*

79. Christopher Helman, *How Green is Wind Power, Really? A New Report Tallies Up the Carbon Cost of Renewables,* FORBES (Apr. 28, 2021), https://www.forbes.com/sites/christopherhelman/2021/04/28/how-green-is-wind-power-really-a-new-report-tallies-up-the-carbon-cost-of-renewables/?sh=55555ba373cd [https://perma.cc/CV3E-CMVH].

80. *See infra* Figure 4.

today they account for only forty percent. This change resulted from a complex web of local, state, and national subsidies for wind and solar filtered through the complex regulatory system supervised by Regional Transmission Organizations and Independent System Operators. Because of heavy subsidization, wind and solar can underbid more traditional power plants in the power markets.[81] When coal and nuclear plants are underbid often enough, they become unprofitable. As a result, they have slowly but surely been retired.

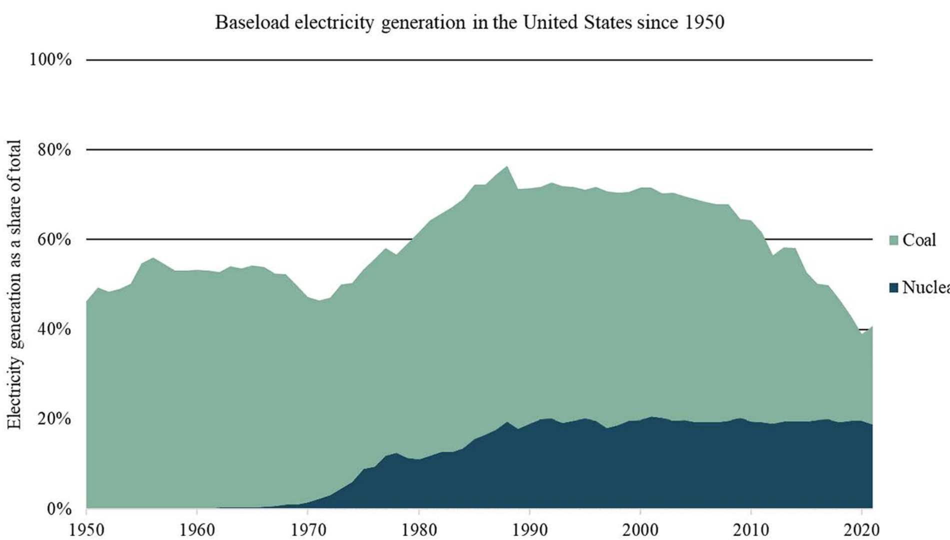

FIGURE 4: Baseload electricity generation in the United States since 1950.[82]

As noted above, there are many emissions benefits to the increased use of solar and wind, but these come at the cost of intermittency. On average, wind energy generates about thirty-five percent of its total capacity and solar only twenty-five percent—a small fraction of that attained by comparable baseload sources.[83] More importantly, these sources cannot be depended on to provide energy on demand. While geographic diversity and limited storage can overcome some diurnal variability of sunlight and wind, the true challenge is seasonal variabilities and the possibility of occasional multiday weather events that stop electricity production at solar and wind generation facilities.[84]

81. Michael Buschbacher & Taylor Myers, *FERC Gaslights America*, AM. CONSERVATIVE (Sept. 6, 2022), https://www.theamericanconservative.com/ferc-gaslights-america/ [https://perma.cc/Z6UX-BNYW].

82. U.S. ENERGY INFO. ADMIN., AUG. 2022 MONTHLY ENERGY REVIEW 4 (2022). Graphic adapted from Buschbacher & Myers, *supra* note 81.

83. CAPACITY FACTORS FOR UTILITY SCALE GENERATORS PRIMARILY USING NON-FOSSIL FUELS, U.S. ENERGY INFO. ADMIN., https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_6_07_b [https://perma.cc/3JXL-6V2D] (last visited Oct. 23, 2022).

84. For example, solar photovoltaic power operated at a capacity factor of 32.1 percent in June 2020, but only 14.9 percent in December. *Id.*; *see* Mark P. Mills, *Transition to Nowhere*, CITY J. (Oct. 20,

The decline of baseload power and an increasing reliance on intermittent sources has led to a crisis of grid reliability. The North American Electric Reliability Corporation (NERC) estimated that two-thirds of the United States faces heightened risks of power outages.[85] These power outages are most likely to occur during times of unusual heat and cold when electricity demand rises. When a demand spike coincides with low supply levels, grid operators are forced to ask customers to reduce power consumption and, if the problem persists, eventually to order shutdowns to prevent total grid collapse.[86] The 2021 Texas power crisis is a sobering example. When Winter Storm Uri caused wind turbines to fail, a chain reaction of other power sources went offline, shutting down the Texas grid for days, killing at least 210 people, and costing somewhere between $200 and $300 billion.[87]

To overcome this intermittency, tremendous power storage would be required. Even a bit of storage can be expensive. Consider California's $400 million Moss Landing, grid-scale battery.[88] The new battery has a capacity of 400 megawatts (MW) and 1600 megawatt-hour (MWh)—more than ten times larger than Tesla's South Australian battery. But, operating at capacity, the battery can provide four hours of backup for only part of California's overall electricity demand. California's peak summer demand hovers around 45,000 MW.[89] This demand means there would need to be about 112 Moss Landings to provide just four hours of back up for the whole state. To sustain the grid through a 12-hour sun and wind lull would require 5.4 TWh of storage, or more than 3,000 Moss Landings.[90]

To achieve this much energy storage, battery energy density needs to improve significantly. The best commercially available battery technology, lithium-sulfur, has energy capacity two to three times more than the common lithium-ion batteries, but it is still twenty-eight times less than natural gas. Overcoming these barriers does not require a mere engineering improvement but a scientific revolution. Engineering improvements are routine, and gains—even if diminishing gains—can be expected. This sort of engineering growth is most famously embodied by Moore's law, which observed that the number of transistors that

2021), https://www.city-journal.org/california-switch-to-primarily-solar-and-wind-powered-grid-is-dead-end [https://perma.cc/XW5S-J97W].

85. Ethan Howland, *FERC Commissioners Respond to Elevated Power Outage Risks Across Two-Thirds of U.S.*, UTIL. DIVE (May 20, 2022), https://www.utilitydive.com/news/ferc-nerc-power-outage-risks-summer-drought/624111/ [https://perma.cc/PQ3A-HKFA].

86. Buschbacher & Myers, *supra* note 81.

87. *Id.*

88. Buschbacher & Myers, *supra* note 81.

89. *2021 Summer Loads and Resource Assessment*, CAL. INDEP. SYS. OPERATOR, http://www.caiso.com/Documents/2021-Summer-Loads-and-Resources-Assessment.pdf [https://perma.cc/S8NP-Q986], at 18 (last visited Feb. 16, 2023).

90. Matthew Shaner et al., *Geophysical Constraints on the Reliability of Solar and Wind Power in the United States*, 11 ENERGY & ENV'T SCI. 914, 915 (2018).

could be squeezed into an integrated circuit doubles every two years.[91] Similar, but more modest gains, have been seen in photovoltaic efficiency. Commercially available cells had efficiencies of only around ten percent in the 1960s but have grown to be more than twenty-five percent efficient today.[92] While a scientific revolution in battery technology may occur, it is imprudent to count on it. The sheer scale of battery storage required and its current limitations have led John Moura, Director of Reliability Assessment and Performance Analysis at NERC, to a straightforward conclusion: "Batteries aren't going to do it."[93]

2. The Cost of Wind and Solar

It is not only reliability that will be damaged by a transition to wind, solar, and batteries. Proponents of a fossil-fuel free grid rely on the promise of technological developments rendering solar, wind, and batteries far cheaper than they are today, often citing the rapidly falling prices of these technologies.[94] But past performance may not predict future results. Technology development will come, but so will surging prices and supply chain issues.[95]

Further, because of their low-capacity factors, far more wind and solar generators must be built to provide reserve capacity to ensure sufficient power to both meet current demand and charge batteries. ISO New England has estimated that its reserve-generation capacity would need to increase from the current 15% to 300% as more solar and wind are added.[96] To be truly price competitive, renewable sources would need to be between 1/3 and 1/2 the per-kWh costs of fossil fuels. They are not. In 2020, the low-end lifetime costs of power were $31 per MWh for utility solar, $26 for wind, and $28 for natural gas.[97] These costs do not

91. Gordon E. Moore, *Cramming More Components onto Integrated Circuits,* 38 ELEC. 1, 2 (Apr. 19, 1965), https://newsroom.intel.com/wp-content/uploads/sites/11/2018/05/moores-law-electronics.pdf [https://perma.cc/E3G7-HZMQ].

92. Mark P. Mills, *The "New Energy Economy": An Exercise in Magical Thinking* 15, MANHATTAN INST. (Mar. 2019), https://media4.manhattan-institute.org/sites/default/files/R-0319-MM.pdf [https://perma.cc/39EH-69BY].

93. Robert Walton, *'Batteries aren't going to do it': NERC's Moura Calls for Gas Investment to Maintain Reliability*, UTIL. DIVE (July 21, 2022), https://www.utilitydive.com/news/nerc-2022-reliability-report-gas-solar/627784/ [https://perma.cc/P4BE-B7ZZ].

94. *See, e.g.*, Johnny Wood, *Renewable energy is cheaper than previously thought, says a new report-and could be a gamechanger in the climate change battle*,, WORLD ECON. F. (Oct., 18, 2021), https://www.weforum.org/agenda/2021/10/how-cheap-can-renewable-energy-get/ [https://perma.cc/7659-JWTA].

95. *See, e.g.*, Subramani Ra Mancombu, *After Surging by over 400%, Lithium Prices May Rise Further on Short Supply*, HINDU BUS. LINE (Nov. 15, 2021), https://www.thehindubusinessline.com/markets/commodities/up-400-y-o-y-lithium-prices-may-rise-further-on-supply-shortage/arti cle37499493.ece [https://perma.cc/D5JN-AWP4].

96. *2021 Economic Study: Future Grid Reliability Study Phase 1*, at 2, ISO NEW ENG. (July 29, 2022), https://www.iso-ne.com/static-assets/documents/2022/07/2021_economic_study_future_grid_reliability_study_phase_1_report.pdf [https://perma.cc/P2UX-KG9K].

97. *Lazard's Levelized Cost of Energy Analysis—Version 13.0* (Oct. 2020), https://www.lazard.com/media/451419/lazards-levelized-cost-of-energy-version-140.pdf [https://perma.cc/2SFB-QKFZ].

account for the cost of the added transmission needed to connect so many more sources of a kind that are often sited far distances from the population centers they will support. For now, these transmission costs are distributed across the grid, but as reliance on wind and solar power increases, they will eventually come to be felt more acutely in power prices.

The long-term costs of this transition may be unbearable. A recent *Nature Climate Change* study examining the Biden Administration's net-zero by 2050 plan looked at the cost of different levels of decarbonization. While some small GHG reductions were inexpensive, reaching even ninety-five percent decarbonization would cost more than $11,279 per person per year in today's dollars.[98] For a family of four that adds up $45,000 per year, or two-thirds of the median household income in the United States.[99]

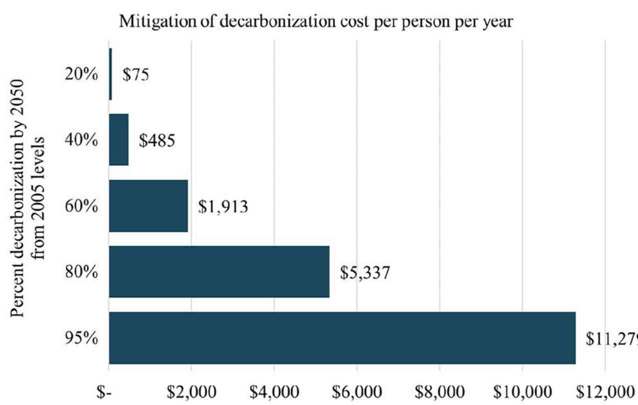

FIGURE 5: Cost of decarbonization per person per year.[100]

B. A Transition to Wind, Solar, and Batteries Will Damage American Industry

Advocates calling for a complete transition to wind, solar, and battery power have not adequately accounted for the outsized role of fossil fuels in materials production and heavy industry.[101] Oil and natural gas are key to the synthesis of

98. Wei Pang et al., *Supplementary Information for "The Surprisingly Inexpensive Cost of State-Driven Emissions Control Strategies,"* NATURE PORTFOLIO 21, https://static-content.springer.com/esm/art%3A10.1038%2Fs41558-021-01128-0/MediaObjects/41558_2021_1128_MOESM1_ESM.pdf [https://perma.cc/K6ZA-3A9M] (Aug. 23, 2021).

99. EMILY A. SHRIDER ET AL., U.S. CENSUS BUREAU, INCOME AND POVERTY IN THE UNITED STATES: 2020, at 1 (Sept. 14, 2021).

100. Wei Pang et al., *The Surprisingly Inexpensive Cost of State-Driven Emissions Control Strategies,* 11 NATURE 738 (Sept, 2021), https://www.nature.com/articles/s41558-021-01128-0 [https://perma.cc/E8ZE-6X4Z].

101. Samantha Gross, *The Challenge of Decarbonizing Heavy Industry*, BROOKINGS INST. (June 2021), https://www.brookings.edu/research/the-challenge-of-decarbonizing-heavy-industry/ [https://perma.cc/4PCU-979V].

fertilizers, plastics, and steel, and there are not yet feasible non-fossil fuel alternatives.

Synthetic nitrogen fertilizers are necessary for modern food production. The most common synthetic fertilizer is ammonia synthesized in the energy-intensive Haber-Bosch process, which fixes atmospheric nitrogen to the hydrogen atoms of natural gas. Without the fertilizer derived from the Haber-Bosch process, the best estimates are that current farmland could sustain only about half of the global population.[102] Fertilizer, together with growing sophistication in farm machinery and irrigation systems, have tripled the per-acre yield of the world's cropland, improved yields in the United States nearly ten-fold, and helped eliminate the widespread malnutrition of the nineteenth century.[103]

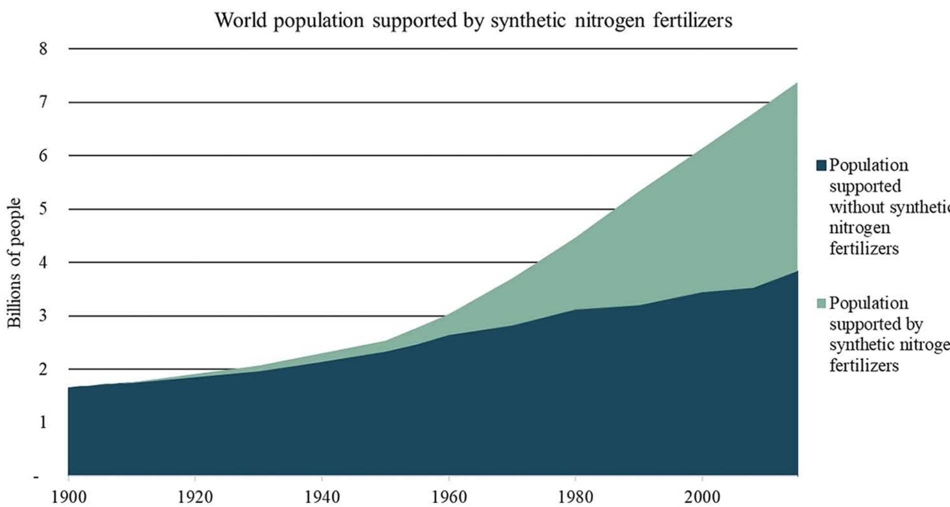

FIGURE 6: World population supported by synthetic fertilizer created with natural gas.[104]

Additionally, modern life is unimaginable without plastics. We wake up on pillows stuffed with synthetic filling, brush our teeth with plastic toothbrushes, make our coffee in plastic coffee machines, grab our breakfast from plastic-lined refrigerators, put on our plastic North Face jackets, turn off the plastic light switches, open the plastic door handles to our cars, and drive to an office where we work on plastic computers and answer plastic phones. But where plastics are truly indispensable is the medical field. Disposable syringes, surgical gloves, IV

102. Hannah Ritchie, *How Many People Does Synthetic Fertilizer Feed?*, OUR WORLD IN DATA (Nov. 17, 2021), https://ourworldindata.org/how-many-people-does-synthetic-fertilizer-feed/ [https://perma.cc/SF3S-4FZF].

103. Smil, *supra* note 2, at 35–36.

104. Ritchie, *supra* note 102.

bags and tubes, durable packaging for pills, protective coatings on instruments, medical waste disposal bags, stents, prosthetics, diagnostic tools, and virtually every item that might be found in a hospital, clinic, or doctor's office is made with plastics. While metal and glass alternatives exist, plastics are far less expensive and eliminate the need for costly and complicated sterilization.[105]

The primary materials used for these medical devices have been, since the advent of plastics in the 1930s and 1940s, polyethylene (PE), polypropylene (PP), and polyvinyl chloride (PVC), the first, second, and third most widely used plastics, respectively.[106] PE and PVC are both polymers synthesized from ethylene. In the United States this ethylene is made through the steam cracking of ethane, isolated from natural gas. It can also be made through the steam cracking of naphtha, a petroleum product, though the process is more complicated, with lower yield and higher costs.[107] PP is similarly made through the refining and polymerization of propane, isolated mostly from shale gas in the United States and naphtha in the rest of the world.

While some plastic use can be reduced through intelligent regulations,[108] the properties of plastics are nearly irreplaceable—no one wants to return to glass medical syringes. While some have suggested a transition to bioplastics, which are similar polymers derived from non-fossil fuel sources like sugarcane, nearly all plastics still come from fossil fuels. As of 2014, bioplastics represented only 0.2 percent of the global polymer market, and there is some debate over their carbon savings.[109]

Steel also owes its rise to fossil fuels. In 1900, American steel production was 11.4 million tons, more than British and German production combined.[110] By 2000, American production had grown to 101 million metric tons, only a fraction of the 848 million metric tons produced worldwide.[111] This steel is used to build cars, planes, ships, containers, and buildings, and provides the structural backbone of most of the world's commercial and industrial activity. Steel is also used to make household goods, from chef's knives to wood stoves, and it is essential to

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105. Emily J. North & Rolf U. Halden, *Plastics and Environmental Health: The Road Ahead*, 28 REV. ENVTL. HEALTH 1, 3 (2013).

106. Len Czuba, *Applications of Plastics in Medical Devices and Equipment*, *in* HANDBOOK OF POLYMER APPLICATIONS IN MEDICINE AND MEDICAL DEVICES 9 (Kayvon Modjarrad & Sina Ebnesajjad eds., 2014).

107. Hepeng Jia, *Uncertainty clouds China's dream of making ethylene from ethane*, CHEM. & ENG'G NEWS (Feb. 16, 2020), https://cen.acs.org/business/petrochemicals/Uncertainty-clouds-Chinas-dream-making/98/i7 [https://perma.cc/3SJQ-P6LU].

108. *See, e.g.*, ROGER SCRUTON, HOW TO THINK SERIOUSLY ABOUT THE PLANET 169 (2012).

109. Andreas Künkel, *Polymers, Biodegradable*, *in* ULLMANN'S ENCYCLOPEDIA OF INDUSTRIAL CHEMISTRY (2016).

110. *See* Jonathan Schifman, *The Entire History of Steel*, POPULAR MECHS. (July 9, 2018), https://www.popularmechanics.com/technology/infrastructure/a20722505/history-of-steel/ [https://perma.cc/DXC8-G3V9].

111. INTERNATIONAL IRON AND STEEL INSTITUTE, WORLD STEEL IN FIGURES 3 (2002), https://worldsteel.org/wp-content/uploads/World-Steel-in-Figures-2002.pdf [https://perma.cc/3DFE-AN46].

solar panels, wind turbines, and electric vehicles. The main inputs in steel production are iron ore and energy.[112] Carbon monoxide and hydrogen are the reducing agents that help separate the oxygen from the iron ore. Almost all the carbon monoxide and hydrogen used in this reduction are generated from fossil fuels—largely coal but increasingly natural gas.[113] Sweden has recently boasted of the first "fossil fuel-free steel," but it will not be commercially available until 2026 and is unlikely to be cost effective until 2040.[114] In the meantime, steel production is currently responsible for eight percent of the world's energy demand and is expected to increase by more than a third by 2050.[115]

There are no reasonable plans for transitioning the world away from any of these materials. As a result, regulations that seek to systematically ban the use of fossil fuels only drive up the price of these materials and drive manufacturing out of the United States and into other countries willing to use fossil fuels.

There are better alternatives. With its capacity for natural gas and oil production, the United States could be the leading producer of fertilizer, plastic, and steel. Reshoring this raw material production and downstream manufacturing would create millions of jobs—including jobs producing wind and solar energy components. What's more, American plastic and steel production are inherently less polluting than their Chinese counterparts and could be subject to stronger environmental protections than they currently are. American plastics are largely made from natural gas instead of the far more wasteful and polluting naphtha processes. The GHG emissions from hot-dip galvanized steel in China are nearly fifty percent higher than the same product produced in North America.[116] American mining is subject to far stricter environmental regulations than its Asian and African counterparts, but increasing domestic manufacturing and heavy industry is impossible without fossil fuels.

C. A Transition to Wind, Solar, and Batteries Will Limit American Geopolitical Influence

Advocates of slashing fossil fuel production acknowledge that it will lead to a geopolitical realignment—but it will be one that hinders the United States, aids our chief rival China, and it ignores human rights implications.[117]

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112. INT'L ENERGY AGENCY, IRON AND STEEL TECHNOLOGY ROADMAP 25 (Oct. 2020), https://iea.blob.core.windows.net/assets/eb0c8ec1-3665-4959-97d0-187ceca189a8/Iron_and_Steel_Technology_Roadmap.pdf [https://perma.cc/DLN4-G9RD].

113. *Id.* at 26.

114. Scott Carpenter, *Swedish Steelmaker Uses Hydrogen Instead of Coal to Make Fossil-Free Steel*, FORBES (Aug. 31, 2020), https://www.forbes.com/sites/scottcarpenter/2020/08/31/swedish-steelmaker-uses-hydrogen-instead-of-coal-to-make-fossil-free-steel/?sh=539b46ac2c8b [https://perma.cc/B38X-9ZVG].

115. IRON AND STEEL ROADMAP, *supra* note 112, at 60.

116. Steel Recycling Inst., *Chinese and North American Produced Hot-dip Galvanized Steel Research Summary*, AM. IRON & STEEL INST. (Oct. 2018), https://www.steel.org/wp-content/uploads/2020/11/Research-Summary-China-vs-NA-HDG.pdf [https://perma.cc/FGG2-ULBG].

117. Sergey Paltsev, *The complicated geopolitics of renewable energy*, 72 BULL. ATOM. SCIENTISTS 390, 393 (2016).

As detailed above, in section I.C, the United States is the world's largest producer of oil and natural gas. The United States is responsible for nearly a fifth of the world's oil production and roughly a quarter of its natural gas production.[118] Domestic production is more than enough to meet domestic needs, and the United States is a net-exporter of both. China, on the other hand, is the world's largest importer of both oil and natural gas.[119] Most Chinese electricity—66%—is generated from coal.[120]

The story is reversed for wind, solar and batteries. Wind, solar, and batteries depend on the mining of minerals far more than their fossil fuel counterparts. China dominates most of the mineral supply chains critical to this production, controlling nearly two-thirds of all lithium, four-fifths of the refined cobalt market, and nearly all processed natural graphite.[121] Rare-earth elements, critical in the manufacturing of batteries, are located almost exclusively in China.[122] China produced 140,000 tons of rare-earth elements in 2020 and has reserves of 44,000,000 tons.[123] The second-largest reserves, some 22,000,000 tons, are located immediately south of China in Vietnam.[124] The United States in contrast has just 1,500,000 tons—a reserve that would be rapidly exhausted if mined at rates required to support the energy transition.

China's raw material advantage makes it dominant in the renewable energy space. A little less than half of the world's polysilicon, the ultra-conductive material that makes solar panels work, is produced in the Uyghur Region of China.[125] Every electric vehicle motor requires two pounds of these critical minerals and offshore wind turbines require as much as 500 pounds of rare earth metals per megawatt capacity.[126] These are not one-time transactions. Photovoltaic panels

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118. C. Boyden Gray, *American Energy, Chinese Ambition, and Climate Realism*, 5 AM. AFFS. J. 80 (2021).

119. *Id.*

120. *Electricity mix in China, January-November 2020*, INT'L ENERGY AGENCY (Oct. 26, 2020), https://www.iea.org/data-and-statistics/charts/electricity-mix-in-china-january-november-2020 [https://perma.cc/V9T7-55UA].

121. MASSIF CAP., RISKS AND OPPORTUNITIES IN THE BATTERY SUPPLY CHAIN 7-10 (May 2019), https://cdn2.hubspot.net/hubfs/4518141/Risks%20and%20Opportunities%20in%20the%20Battery%20Supply%20Chain.pdf [https://perma.cc/2FLA-CKCU]; Nicholas LePan, *The New Energy Era: The Lithium-Ion Supply Chain*, VISUAL CAPITALIST (Dec. 11, 2019), https://www.visualcapitalist.com/the-new-energy-era-the-lithium-ion-supply-chain/ [https://perma.cc/ZB3X-2K6R]; *About Spherical Graphite*, N. GRAPHITE, http://www.northerngraphite.com/_resources/media/SPG-Summary-2.pdf [https://perma.cc/UTM2-YAFH].

122. Nicholas LePan, *Rare Earth Elements: Where in the World Are They?*, ELEMENTS (Nov. 22, 2021), https://elements.visualcapitalist.com/rare-earth-elements-where-in-the-world-are-they/ [https://perma.cc/W4R5-3CZ8].

123. *Id.*

124. *Id.*

125. Colum Murphy, *Solar Energy Boom Could Worsen Forced Labor in China, Group Says*, BLOOMBERG NEWS (Mar. 28, 2022), https://www.bloomberg.com/news/articles/2022-03-28/solar-energy-boom-could-worsen-forced-labor-in-china-group-says [https://perma.cc/Q2JR-2XVG].

126. Robert Bryce, *The Electric-Vehicle Push Empowers China*, WALL ST. J. (Dec. 24, 2021), https://www.wsj.com/articles/the-electric-vehicle-push-empowers-china-rare-earths-mining-motors-rivals-11640290395 [https://perma.cc/G4TP-ZMSH].

must be replaced every fifteen years, and one estimate suggests that just to power the European Union, "essentially the entire annual global silicon production and [three times] the annual global silver production would be required for replacement only."[127] A transition to wind, solar, and batteries, will require the United States to import the raw materials—if not the finished products—from its chief global rival and entangle itself in their human rights atrocities.[128]

Of course, exerting influence to condemn China's continually deteriorating human rights record is more complicated than simply stopping the import of critical minerals. The United States and China have integrated economies and are significantly interdependent. Major American media corporations, like AT&T, Comcast, and Disney, have strong ties to China. BlackRock, headquartered in the United States and the world's largest asset manager, has pushed its clients to buy Chinese investments while vocally admonishing domestic CEOs and boards of directors for the carbon emissions of their companies. This tangling of interests allows China to apply pressure and advance their own aggressive and repressive interests. The annual report from Congress's United States-China Economic and Security Review Commission called for restricting American investment in China and limiting investors' ability to buy U.S.-listed Chinese stocks.[129] Even George Soros called BlackRock's recent investments a "tragic mistake" and one that "is likely to lose money for BlackRock's clients and, more important, will damage the national security interests of the United States and other democracies." But continuing to cede influence to China through the aggressive importation of wind, solar, and batteries only exacerbates the problem.

D. In Many Ways, Wind, Solar, and Batteries are Less Sustainable

Despite what their proponents contend, wind, solar, and batteries are not environmental panaceas. Most critically, while there are fewer lifecycle GHG emissions from wind, solar, and batteries, they do more damage on other fronts. But because this damage is not done at the point of use, these impacts receive far less attention than those of fossil fuels. Land use concerns also plague the deployment of solar and wind, and local municipalities have repeatedly rejected the siting of projects.

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127. Lars Schernikau & William Smith, *How many km^2 of solar panels in Spain and how much battery backup would it take to power Germany*, 1 (2021), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3730155 [https://perma.cc/W5QY-L6KA].

128. *See* Laura T. Murphy & Nyrola Elima, *In Broad Daylight: Uyghur Forced Labour and Global Solar Supply Chains* 28, SHEFFIELD HALLAM LAURA T. MURPHY & NYROLA ELIMA, SHEFFIELD HALLAM U., IN BROAD DAYLIGHT: UYGHUR FORCED LABOUR AND GLOBAL SOLAR SUPPLY CHAIN 28 (May 2021), https://www.shu.ac.uk/helena-kennedy-centre-international-justice/research-and-projects/all-projects/in-broad-daylight [https://perma.cc/ZTW4-227C] ("By 2020, four of the six highest-capacity polysilicon producers were companies with significant manufacturing bases in the XUAR–Daqo New Energy Corp, GCL-Poly, TBEA/Xinte, and East Hope. All four of them utilise state-sponsored labour transfers, the end products of which are sold into the international solar module market.").

129. U.S.–CHINA ECON. & SEC. REV. COMM'N, 2021 REPORT TO CONGRESS: EXECUTIVE SUMMARY AND RECOMMENDATIONS (2021).

1. Supply Chain Issues With Wind, Solar, and Batteries

A common misconception surrounding wind, solar, and batteries is that they produce little to no GHG emissions. While the energy generation itself produces very little carbon, building the generators requires tons of materials. All of this has a carbon footprint. Recent analysis suggests that wind energy generates an average of eleven grams of carbon dioxide per kWh electricity, and solar an average of forty-four grams per kWh.[130] This capacity is a great improvement on the 450 grams per kWh of natural gas or 1,000 grams per kWh for coal, but still does not rise to the level of nuclear power, which averages only nine grams per kWh. Battery electric vehicles are also generally considered "zero emissions vehicles" because they emit no carbon dioxide through their tailpipes. But some "wells-to-wheel" analyses—looking at the energy consumed from mining, energy generation, transportation, and then car power delivery—indicate total GHG emissions in some circumstances are not reduced at all.[131]

There are other externalities to these technologies as well. Electric vehicles do not emit particulate matter through their tailpipes (having none). But due to their higher weight—24 percent more than comparable internal combustion engine vehicles—their tires generate more particulate matter from rubbing against the roadway.[132] Consequently, electric vehicles ultimately produce about the same amount of particulate matter as an internal combustion engine vehicle.[133] This heavier weight also leads directly to more deaths. A *Nature* editorial explains: "The likelihood of passengers being killed in a collision with another vehicle increases by twelve percent for every 500-kg difference between vehicles." Most electric vehicles weigh between 500 and 700 kgs more than their non-electric counterparts.[134]

As detailed above in section II.C, wind, solar, and batteries require a tremendous amount of critical minerals and rare-earth elements. Extracting and processing just one ton of rare-earth elements produces about 2,000 tons of toxic waste.[135] Rare-earth extraction in and around China's Baotou produces 10 million

130. Christopher Helman, *How Green is Wind Power Really? A New Report Tallies Up The Carbon Cost Of Renewables*, FORBES (Apr. 28, 2021), https://www.forbes.com/sites/christopherhelman/2021/04/28/how-green-is-wind-power-really-a-new-report-tallies-up-the-carbon-cost-of-renewables/?sh=1ad9fc8073cd [https://perma.cc/4AHP-4GX5].

131. Rohan Challa et al., *Wells-to-wheel Greenhouse Gas Emissions of Electric Versus Combustion Vehicles From 2018 to 2030 in the US*, 308 J. ENV'T. MGMT. 1, 9 tbl. 4 (2022) (concluding that the percent decrease in well-to-wheel GHG emissions found in the study varied between -31 percent to 58 percent).

132. Victor R.J.H. Timmers & Peter A.J. Achten, *Non-exhaust PM emissions from electric vehicles*, 134 ATMOSPHERIC ENV'T 10, 12 (2016).

133. *Id.*

134. Blake Shaffer et al., *Make electric vehicles lighter to maximize climate and safety benefits*, 598 NATURE 254, 254–55 (2021).

135. Jonathan Kaiman, *Rare earth mining in China: the bleak social and environmental costs*, GUARDIAN (Mar. 20, 2014, 10:30 AM), https://www.theguardian.com/sustainable-business/rare-earth-mining-china-social-environmental-costs [https://perma.cc/9CM6-ACVG].

tons of wastewater per year that is subsequently pumped into nearby dams and leaches into the surrounding water supply.[136]

End of life waste also poses a problem. The speed of wind and solar growth has far outpaced our ability to handle its waste. The International Renewable Energy Agency predicted 78 million metric tons of used photovoltaic panels by 2050.[137] Other researchers suspect this estimate is far too low, and that economic incentives for early replacement could quadruple that number.[138] Very few photovoltaic panels are recycled, and most end up in landfills where lead, cadmium, and other heavy metals contaminate surrounding soil. The problem is not unique to solar. More than 720,000 tons worth of wind turbine blades will enter landfills over the next twenty years and turbine towers will require replacement every twenty-five years at a cost of $500,000 per tower.[139] Only five percent of electric vehicle batteries are currently recycled, and more are made each year.[140]

More appalling than the environmental damage is the use of child and slave labor to manufacture these components. Cobalt, a key component in lithium-ion batteries, is mainly found in the south-eastern provinces of the Democratic Republic of the Congo. Of the 255,000 miners in the Congo, as many as 35,000 are children, some as young as six years old.[141] The children work in horrific and hazardous conditions, digging tunnels and hauling cobalt to the surface for less than a dollar a day.

Forty-five percent of the world's solar-grade polysilicon is manufactured in the Uyghur Region of China.[142] Polysilicon manufacturers in that region participate in so called "labor transfer" programs. Millions of Uyghurs are sent to concentration camps, sterilized, subjected to "reeducation," and then used as cheap slave labor.[143] The December 2021, Uyghur Forced Labor Prevention Act requires proof that goods manufactured in the Uyghur Region were not produced with forced labor. U.S. Customs and Border Control has detained huge quantities of solar panels because of polysilicon-manufacturing's entanglement with slave labor, and some Chinese manufacturers have stopped exporting to the United

136. *Id.*

137. Atalay Atasu et al., *The Dark Side of Solar Power*, HARV. BUS. REV. (Jun. 18, 2021), https://hbr.org/2021/06/the-dark-side-of-solar-power [https://perma.cc/8R5W-S9ZC].

138. *Id.*

139. Christina Stella, *Unfurling the Waste Problem Caused by Wind Energy*, NPR (Sept. 10, 2019, 4:37 PM), https://www.npr.org/2019/09/10/759376113/unfurling-the-waste-problem-caused-by-wind-energy [https://perma.cc/VPF6-HYL4]; Wallace Manheimer, *On the Inability of Wind and Solar Electric Generation to Power Modern Civilization*, 8 J. ENERGY RSCH. & REV. 51, 59 (2021).

140. Hector Rallo et al., *Battery 2nd Life Used as an ESS: Economic and Environmental Analysis Comparing Lead-Acid and Lithium-Ion on Different Real Scenario* (July 23, 2019), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3423188 [https://perma.cc/D72E-YT3M].

141. U.S. DEPT. OF LAB., CHILD LABOR AND FORCED LABOR REPORTS: DEM. REP. CONGO (2020).

142. Murphy & Elima, *supra* note 128.

143. *Id.*

States entirely.[144] These trends are part of the reason that less than half of the solar projects planned for the first six months of 2022 were installed.[145] Other sources for these minerals exist, but none can support anything like the volume demanded by American net-zero plans.

2. Land Use Concerns Plague Development

It is no secret that wind and solar require large plots of land. Wind requires three times as much land as solar and a hundred times more land than natural gas or nuclear generation.[146] Princeton University's Net Zero America report estimated that, to achieve 100 percent solar and wind electricity generation, the United States would require 228,000 square miles of land—a little less than the size of Texas.[147] Many would prefer to keep that land for something else.

Part of the concern is aesthetic. Because solar panels need unobstructed sun and turbines need unobstructed wind to produce power efficiently, they must be built in open land or atop ridges, meaning they are visible for miles. Plans for America's largest solar farm in Nevada were scrapped because the locals did not want it defacing the top of a local mesa.[148] The town of Swanton, Vermont voted 731 to 160 to reject a seven-turbine wind project that would have disrupted the skyline view of Rocky Ridge.[149] Since 2015, at least 317 wind projects have been rejected across the United States—some in dramatic fashion.[150] New solar and wind farms also require new high voltage transmission lines. These can be even harder to locate, as local residents risk losing forests and agricultural land for projects that only help to transmit the energy to a faraway city. Just one recent example is the rejection of the $1 billion New England Clean Energy Connect

144. *See* John Liu & Luz Ding, *Solar Panels Piling Up at US Border on Xinjiang Forced Labor Law*, BLOOMBERG NEWS (Aug. 15, 2022, 12:05 AM), https://www.bloomberg.com/news/articles/2022-08-15/solar-panels-piling-up-at-us-border-on-xinjiang-forced-labor-law [https://perma.cc/XT2Z-VXGH].

145. Katherine Antonio & Tyler Hodge, *Utility Scale Solar Projects Report Delays*, CLEANTECHNICA (Aug. 11, 2022), https://cleantechnica.com/2022/08/13/u-s-utility-scale-solar-projects-report-delays/ [https://perma.cc/J724-N24K].

146. *See* John van Zalk & Paul Behrensa, *The spatial extent of renewable and non-renewable power generation: A review and meta-analysis of power densities and their application in the U.S.*, 123 ENERGY POL'Y 83, 86–87 (2018).

147. *See* Eric Larson et al., *Net-Zero America: Potential Pathways, Infrastructure, and Impacts: Final Report* 243, PRINCETON U. (Oct. 29, 2021).

148. *See* Gabriella Angeleti, *Plans scrapped for solar project that would disrupt Michael Heizer's Double Negative*, ART NEWSPAPER (Jul. 26, 2021), https://www.theartnewspaper.com/2021/07/26/plans-scrapped-for-solar-project-that-would-disrupt-michael-heizers-double-negative [https://perma.cc/F6GL-KKCJ].

149. Robert Bryce, *The Windmills of Bernie's Mind*, WALL ST. J. (Feb. 7, 2016, 4:30 PM), https://www.wsj.com/articles/the-windmills-of-bernies-mind-1454880639 [https://perma.cc/NW7W-K2WK].

150. Robert Bryce, *Here's The List Of 317 Wind Energy Rejections The Sierra Club Doesn't Want You To See*, FORBES (Sept. 26, 2021, 4:04 PM), https://www.forbes.com/sites/robertbryce/2021/09/26/heres-the-list-of-317-wind-energy-rejections-the-sierra-club-doesnt-want-you-to-see/?sh=313ed3e95bad [https://perma.cc/5WRZ-E6KF].

by an overwhelming fifty-nine percent of voters in Maine, hamstringing Massachusetts's net-zero plans.[151]

Other concerns stretch beyond the visual. Solar and wind installations present other serious risks to the local environment. One report explains that "[t]he potential effects of the construction and the eventual decommissioning of solar energy facilities include the direct mortality of wildlife; environmental impacts of fugitive dust and dust suppressants; destruction and modification of habitat, including the impacts of roads; and off-site impacts related to construction material acquisition, processing, and transportation."[152] Constructing photovoltaic arrays often requires removal of vegetation and causes soil degradation, resulting in significant increases in onsite runoff and soil erosion.[153] Additionally, the installation of solar panel arrays and the change in albedo can create local heat islands, raising air temperatures over solar installations relative to the surrounding areas.[154] The Department of Energy acknowledges that wind turbines could reduce, fragment, or otherwise degrade wildlife habitats.[155] Spinning turbine blades can also pose imminent threats to flying wildlife, like bats and birds. For example, in early 2022, one wind-energy company pled guilty to the unintentional killing of at least 150 bald and golden eagles.[156]

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Just as the account in Section I was not meant to deny the climate risks of fossil fuels, the account in this section is not meant to deny the climate benefits of wind, solar, and batteries. Wind emits nearly 100 times fewer grams of carbon dioxide per kWh generated than coal. But policymakers and advocates must weigh the other impacts of these technologies. It is not merely climate that is important in setting energy policy. A positive energy policy should ensure, as well as it is able, that our energy is affordable, available, secure, and sustainable.

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151. Samantha Gross, *Renewables, Land Use, And Local Opposition In The United States*, BROOKINGS INST. (Jan. 2021), https://www.brookings.edu/wp-content/uploads/2020/01/FP_20200113_renewables_land_use_local_opposition_gross.pdf [https://perma.cc/SA78-SWWF]; David Iaconangelo, *$1B Transmission Smack Down May Upend Northeast Renewables*, ENERGYWIRE (Nov. 12, 2021, 7:19 AM), https://subscriber.politicopro.com/article/eenews/2021/11/12/1b-transmission-smack-down-may-upend-northeast-renewables-282991 [https://perma.cc/XQG2-3BDC].

152. Jeffrey E. Lovich & Joshua R. Ennen, *Wildlife Conservation and Solar Energy Development in the Desert Southwest, United States*, 61 BIOSCI. 982, 982 (2011).

153. *See* Greg A. Barron-Gafford et al., *Agrivoltaics Provide Mutual Benefits Across the Food-Energy-Water Nexus in Drylands*, 2 NATURE SUSTAINABILITY 848, 848–49 (2019).

154. *See id.* at 849.

155. *See* WIND ENERGY TECHNS. OFFICE, U.S. DEP'T OF ENERGY, ENVIRONMENTAL IMPACTS AND SITING OF WIND PROJECTS (last accessed Mar. 29, 2023).

156. Margaret Osborne, *Wind Energy Company Pleads Guilty to Killing Eagles*, SMITHSONIAN MAG. (Apr. 11, 2022), https://www.smithsonianmag.com/smart-news/wind-energy-company-pleads-guilty-to-killing-eagles-180979898/ [https://perma.cc/4NCS-J9SV].

III. A POSITIVE VISION FOR AMERICAN ENERGY POLICY

It is important to be realistic about how we use our natural resources. Climate idealism leads to irrational policy choices that will not save the environment but, instead, cause much unnecessary suffering. Ceasing oil and natural gas extraction would have immediate and devastating consequences for people across the country and the world, especially the most vulnerable. How we care for our shared home is vital. But realism is critical, and there are ways to protect the environment that do not require Malthusianism.

The United States should expand its current power and energy production, and leverage its energy resources to empower American workers, enhance national security, and reduce global pollution. To do this, we must stop picking winners and losers and instead set reasonable objectives and allow market-based and technological solutions to find the most affordable way to obtain these outcomes.

There are four pillars to a positive American energy policy. The first is setting availability, security, and sustainability objectives directly rather than with prescriptive command-and-control regulation or by subsidizing specific technologies. The second is lowering other regulatory barriers to speed new development of next generation energy technology. The third is modernizing other non-carbon emission regulations to account for the changing technological and increasingly international landscape. The fourth is investing directly in the protection and improvement of our domestic natural resources. This positive approach will give America and Americans the energy needed to build a better—and more sustainable—future.

A. Set Availability, Security, and Sustainability Objectives Directly Rather Than Through Technology Specific Subsidies or Prescriptive Command-and-Control Regulation

Prescriptive regulation or pick-a-winner subsidies are almost never the most efficient means of generating policy outcomes. This command-and-control regulation is currently firmly entrenched in our regulatory landscape, through technology-based standards and lopsided incentive systems. Such standards dictate the method—and at times the specific equipment—required to comply with each regulation, eliminating any incentives to find lower cost ways of meeting goals. Subsidies encourage only the favored son and draw investors looking to exploit the government kitty for as long as the money is offered.

The consequences of such policies are evident in our current deployment of wind, solar, and battery technologies. Because of heavy subsidization, wind and solar have been able to drive baseload power generation—like coal and nuclear—off the grid at the expense of energy availability. These same subsidies have encouraged the sourcing of components from China to the detriment of American industry and geopolitical strength. Crucially, this outsourcing has shielded the truly unsustainable practices that haunt the production of these technologies. While dramatic GHG reductions have been achieved in recent years, almost all of this is attributable to a transition to natural gas and not to wind and solar.

Market-based solutions will work far better. Rather than mandate specific technologies, a market-based solution would instead set objectives to allow for creativity and competition in the means chosen to achieve those ends. Encouraging energy availability may mean penalizing generators who fail to deliver during peak power and offering rewards for generators who supply their own backups. Encouraging energy security likely means setting goals for domestic sourcing—though such goals cannot be affordably achieved with current domestic permitting and environmental requirements.[157] Encouraging energy sustainability means establishing some cap or price on GHG emissions.

The problem of GHG emissions is particularly well suited to a market-based solution because its source and effects only operate on a global scale rather than a localized one: inevitably, some sources will emit more carbon dioxide than their counterparts, but these bumps are all smoothed out in the upper atmosphere. Using a market-based policy to regulate GHG emissions would encourage companies to adopt the cheapest and best pollution-control technologies because it always pays to clean up a bit more if a sufficiently inexpensive method can be chosen.

The two primary market-based options are carbon taxes and cap-and-trade. Of the two, cap-and-trade is preferable because it shifts the focus from means (the price of carbon) to ends (the total volume of carbon we are willing to emit). Cap-and-trade allows realistic goals to be met for the lowest price and has long proven to be environmentally and economically effective.[158] Goals for carbon reduction encourage investment in new and innovative ways of reducing carbon that no prescriptive policy could predict.

However, to make a carbon target effective, it must come alongside two parallel policies: an end to technology subsidies and mandates and some form of international carbon adjustment. Fair prices, and thus the best solution, cannot be achieved with the thumb of subsidization on the scale. The complex knot of local, state, and national wind, solar, and battery subsidies will not be easy to disentangle. This would mean eliminating electric vehicle incentives, gas mileage regulations, tax breaks for solar panels, and much more. But the closer our system can get to an even playing field, the more likely we are to achieve our carbon goals for the lowest price.

Adjustment for international carbon emissions is also essential. Such an adjustment might take the form of a border carbon adjustment or a Nordhaus-style climate club.[159] But setting a carbon cap in the United States while failing to consider international emissions would only encourage American companies to outsource both our labor and our carbon dioxide production, which would be to the detriment of American workers and for no net benefit to global GHG

157. *See* Section III.B

158. Schmalensee & Stavins, *supra* note 40.

159. *See* William Nordhaus, *Climate Clubs: Overcoming Free-riding in International Climate Policy*, 105 AM. ECON. REV. 1339, 1339 (2015).

emissions. This phenomenon is known as leakage. It is impossible to draw a circle around a city, a state, a country, or even a continent, cap emissions, and claim that you have achieved anything. Because these caps inevitably drive-up prices, investment shifts to other areas that do not have such mechanisms.

Much of the United States' emissions contribution stems from our reliance on international energy sources that allow us to ignore their true impact. For example, China is contributing thirty percent of the world's GHG emissions. China produced nearly thirteen billion tons of carbon dioxide in 2019, as much as the United States, India, Russia, and Japan combined.[160] Two-thirds of China's electricity, and the vast majority of China's GHG emissions come from coal.[161] As a result, producing a solar panel in China creates around twice as many GHGs as making one in the western world—and it uses slave labor.[162] International carbon adjustment could remedy this. For example, an accurate valuing of the lower carbon emissions from American steel and plastic production would encourage reshoring while also cutting global emissions and mitigating their environmental and human costs. An exporter refund would also lower the international price of American liquified natural gas, encouraging its export. If the United States exported enough natural gas to China to replace Chinese coal the world could reduce total carbon dioxide by nearly five billion tons, significantly more than the 4.6 billion tons the United States emitted in 2020.[163]

B. Lower Other Regulatory Barriers to Speed New Development of Next Generation Energy Technology

The only way to lower greenhouse gas emissions without sacrificing the benefits of energy is through further technological development. A mindset of Malthusian scarcity is wrong and politically untenable, and many do not realize just how much the current regulatory regime hamstrings development. Rather than encouraging development, these regulations destroy domestic supply chains, driving our energy sources overseas. This is bad for American security and Americans overall.[164] There are a few straightforward changes to our energy and environmental regulations that would significantly streamline development.

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160. *The Chinese Companies Polluting the World More Than Entire Nations*, BLOOMBERG NEWS (Oct. 24, 2021), https://www.bloomberg.com/graphics/2021-china-climate-change-biggest-carbon-polluters/ [https://perma.cc/GU7U-7ZYG].

161. Muyu Xu & Gavin Maguire, *China Coal Surge Puts Supply Record, Power Jump Within Reach*, REUTERS (Oct. 22, 2021), https://www.reuters.com/business/energy/china-coal-surge-puts-supply-record-power-jump-within-reach-2021-10-22/ [https://perma.cc/7NYM-EJQD].

162. Matthew Dalton, *Behind the Rise of U.S. Solar Power, a Mountain of Chinese Coal*, WALL ST. J. (Jul. 31, 2021, 8:32 AM), https://www.wsj.com/articles/behind-the-rise-of-u-s-solar-power-a-mountain-of-chinese-coal-11627734770 [https://perma.cc/J9HZ-WDSN].

163. *In 2020, the United States Produced the Least CO2 Emissions from Energy in Nearly 40 Years*, ENERGY INFO. ADMIN. (July 26, 2021), https://www.eia.gov/todayinenergy/detail.php?id=48856# [https://perma.cc/A4SQ-86ZE].

164. *See* Gray & Buschbacher, *supra* note 26.

First, significant reform to the National Environmental Policy Act (NEPA) is needed. When it was enacted in 1970, NEPA checked an industry that ran ragged over our air, water, and forests. Today, these problems have been largely resolved, but rather than decreasing in complexity, NEPAs requirements have ballooned. As Oren Kass explains, "In the 1970s, the average "Environmental Impact Statement" (EIS) mandated by NEPA for a federal highway project was 22 pages long and the process took two years to complete; by 2011 the typical highway EIS could run more than 1,000 pages and the process required more than 8 years."[165] When new energy projects are proposed—whether they be natural gas pipelines or wind farms—they must sit through nearly a decade of review and spend millions of dollars. Worse still, NEPA has been weaponized by environmental activists, who bring litigation to kill fossil fuel projects.

As I have said previously, a few permitting reforms would make a big difference.[166] First, Congress or the courts should re-establish who can bring a NEPA action in court. The law itself does not authorize judicial review, but since the 1970s, a game of judicial telephone has allowed anyone claiming even the barest injury to sue. Instead, the right to sue should be exclusive to those who have suffered a "legal wrong." This would preserve judicial review for those suffering real harms—say, a landowner whose property would periodically flood because of a federally funded dam project—and not activists claiming aesthetic or similarly amorphous "injury." Second, there should be a "proximate cause" standard for what kinds of environmental effects are relevant to an agency's NEPA analysis, limiting agency assessment to only those environmental impacts with a "reasonably close causal relationship" to the agency's actions. Such a standard would eliminate the requirement that agencies consider the cumulative effects of all similar actions, including speculation about actions by third parties entirely beyond the control of the permittee. Finally, aggressive time limits on permitting and statutes of limitations on review would allow developers to quickly deploy new projects without the looming threat of future challenge.

Another reform that is desperately needed is a pause on any further tightening of the EPA's National Ambient Air Quality Standards, or NAAQS. Among the chief reasons that American companies have chosen to establish supply chains abroad are the incredibly complicated permitting processes for infrastructure. Overly strict air emissions standards, set by the EPA under the Clean Air Act, have severely discouraged the construction of new industry. For example, the Obama administration tightened ozone standards to a level that "some national parks could not meet, let alone cities like Atlanta, Baltimore, Cincinnati,

165. Oren Cass, *On Regulatory Reform*, AM. COMPASS (Jun. 10, 2020), https://americancompass.org/essays/on-regulatory-reform/ [https://perma.cc/6NJW-RJJH].

166. *See* C. Boyden Gray & Michael Buschbacher, *Joe Manchin's Legacy Now Depends on Permitting Reform*, WALL ST. J. (Aug. 7, 2022, 5:58 PM), https://www.wsj.com/articles/its-not-too-late-for-permitting-reform-yet-nepa-environment-energy-activist-permitting-climate-11659906591 [https://perma.cc/K3B8-K655].

Columbus, and Cleveland."[167] Some estimates put costs of compliance with air-quality regulations by 2018 at nearly twenty percent of profits.[168] As described in section I.D, the United States already has some of the cleanest air. More aggressive NAAQS would make the perfect the enemy of the good.

Other improvements should be made to some technology specific permitting. First, the processes by which we regulate natural gas extraction and infrastructure need reform. Proposed Federal Energy Regulatory Commission (FERC) interim policy statements add upstream and downstream GHG emissions to the list of criteria by which the Commission can reject a certificate, which only adds uncertainty and makes "it *more* difficult to expand the deployment of low or no-carbon resources."[169] Meanwhile, the Pipeline and Hazardous Materials Safety Administration (PHMSA) is making it increasingly difficult to move liquid natural gas at all, chilling investment in the facilities necessary to effectively deploy these resources.[170] Natural gas pipelines by themselves generate very few emissions and most of these regulations serve the purpose of—by proxy—eliminating downstream natural gas use. But, as detailed above, increased natural gas use has led to a *decrease* in GHG emissions. Permitting reforms that allow pipeline development to accommodate carbon conscious demand will help our climate goals.

Lastly, nuclear permitting desperately needs reform. Nuclear energy emits fewer lifetime GHG emissions than wind and solar, leaving a footprint a fraction of the size, with a nearly spotless safety record. Because Chernobyl, Fukushima, and Three Mile Island are household names, it is easy to forget that there has been exactly one nuclear power related death in the United States in the last thirty years. That death resulted from a temporary crane failure, which dropped a component that was being relocated, but is a danger common to all heavy industry and not unique to nuclear power.[171] Yet the United States has built only one nuclear plant since 1996, owing largely to soaring regulatory costs and decades long permitting reviews.[172]

More should be done to accelerate construction. First, where they exist, state moratoria on nuclear development should be repealed. Some states, like West

167. Cass, *supra* note 165.

168. *Id.*

169. Mark C. Christie, *Items C-1 and C-2: Commissioner Christie's Dissent from the Certificate Policy and Interim Greenhouse Gas Policy Statements*, FED. ENERGY REG. COMM'N (Feb. 17, 2022), https://www.ferc.gov/news-events/news/items-c-1-and-c-2-commissioner-christies-dissent-certificate-policy-and-interim [https://perma.cc/8ZND-E89U].

170. *See, e.g.*, Letter from Jeff Landry to Tristan Brown (Feb. 28, 2022), *available at* http://www.ag.state.la.us/Files/Article/13010/Documents/PHMSAComment-FINAL.pdf [https://perma.cc/Y6WC-9S8R].

171. *See* Dave Lochbaum, *Fatal Accident at Arkansas Nuclear One*, ALL THINGS NUCLEAR (Sept. 13, 2018, 6:00 AM), https://allthingsnuclear.org/dlochbaum/fatal-accident-at-arkansas-one/ [https://perma.cc/ZX5F-WD5Y].

172. *See* Philip Eash-Gates et al., *Sources of Cost Overrun in Nuclear Power Plant Construction Call for a New Approach to Engineering Design*, 4 JOULE 2348 (2020).

Virginia, have already taken these steps. Second, safety reform in the Nuclear Regulatory Commission is needed. The current "as low as reasonably achievable" or ALARA standard is so broad that it is almost impossible to achieve. We do not demand this safety from any other source, and it is unreasonable to burden nuclear energy with it. Additionally, the approval process should be streamlined. The current process can drag on for decades, and the paperwork burden means that without adjustment, small reactors will be priced out.

Interest in nuclear development is already reviving. Abilene Christian University applied for a construction license on an experimental molten-salt reactor.[173] NuScale's small modular-reactor design was approved for further testing at a national lab.[174] After decades of work, Southern Company's Vogtle's Unit 3 was authorized to begin operation.[175] A revival of nuclear development will take far more than this, but these are good signs after decades of stagnation.

C. Modernize Other Non-Carbon Emissions Regulations to Account for the Changing Technical Landscape

A theme that cuts across our energy regulations is the inability of our current schemes to adequately capture the externalities of evolving technologies. Most of our regulatory framework, established through statutes like the Clean Air Act and the Clean Water Act, were drafted in an era where emissions were mainly generated at the site of energy generation. Through this lens, solar, wind, and electric vehicles perform well. But local emissions are not the only emissions that count, and the true source of pollution for many new technologies has nothing to do with what comes out of their stacks or tailpipes. Until we regulate these harms, there will remain incentives to use energy sources that are worse for people and the environment but just better at hiding it.

As detailed in section II.D, pollution from the mining of critical minerals and the construction of wind, solar, and batteries almost always happens elsewhere. Ignoring this pollution provides a de facto subsidy for these technologies, favoring their construction over that of domestic energy sources and encouraging the transfer of mining overseas. To offset this, we should either assess an "environmental tariff" to the importation of or ban products that were produced in violation of American air and water regulations to balance the equation. This would require improved lifecycle analysis for foreign manufactured products to ensure that foreign importers are not exploiting an uneven playing field.

173. *Application Submitted for US Molten Salt Research Reactor*, WORLD NUCLEAR NEWS (Aug. 19, 2022), https://www.world-nuclear-news.org/Articles/Application-submitted-for-US-molten-salt-research [https://perma.cc/6Z92-C4FG].

174. *See* Larry Pearl, *NRC to Certify NuScale Small Modular Reactor Design for Use in the US*, UTIL. DIVE (Aug. 1, 2022), https://www.utilitydive.com/news/nrc-certifies-nuscale-small-modular-reactor-design-SMR-nuclear-us/ [https://perma.cc/4VRE-STQB].

175. *See* Larry Pearl, *NRC Authorizes Southern Nuclear to Begin Operation of Vogtle Unit 3*, UTIL. DIVE (Aug. 4, 2022), https://www.utilitydive.com/news/nrc-authorizes-southern-nuclear-vogtle-unit-3-begin-operation/628843/ [https://perma.cc/XHK8-NT4Z].

Additionally, we must eliminate the importation of materials that were mined or built with child or slave labor. While such imports are already illegal, it can be difficult to prove the role of this labor. The Uyghur Forced Labor Prevention Act, which established a presumption that materials made by some known users of slave labor are in violation of these laws, is a good first step. But if the United States is serious about human rights, more than this is needed.

D. Invest in Our Natural Resources—and New Technology to Preserve Them—Directly

Finally, and most briefly, we should invest in our natural resources directly. First, we should fund the development of environmental remediation projects. This might take the form of additional funding for Superfund sites. There are about 40,000 Superfund sites spread across the United States, consisting of former dumping grounds for hazardous waste, and manufacturing facilities, processing plants, landfills, and other sites from an era of less strict pollution controls. These sites have suffered from chronic backlogs and delays and would be well served by additional funding.

Another place that funding should go to is our national parks. As the great naturalist Theodore Roosevelt explained, "There can be nothing in the world more beautiful than the Yosemite, the groves of the giant sequoias and redwoods, the Canyon of the Colorado, the Canyon of the Yellowstone, the Three Tetons; and our people should see to it that they are preserved for their children and their children's children forever, with their majestic beauty all unmarred."[176] But our natural parks are chronically underfunded. The U.S. National Park system has a $12 billion maintenance backlog but an annual budget of only $2.5 billion.[177]

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Policies that look only through the myopic lens of reducing American GHG emissions accomplish nothing but virtue signaling and cause a great deal of harm. Climate realism in our energy policy is needed. The United States has the will and the power to address our problems. Will we use it?

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176. *Theodore Roosevelt Quotes*, NAT'L PARK SERV. (Apr. 10, 2015), https://www.nps.gov/thro/learn/historyculture/theodore-roosevelt-quotes.htm [https://perma.cc/PLV5-T9PM].

177. Alvin Powell, *National Parks' Economic Benefits Put at Over $100B*, HARV. GAZETTE (Sept. 23, 2019), https://news.harvard.edu/gazette/story/2019/09/report-looks-into-u-s-national-parks-budgeting-woes/ [https://perma.cc/XYP2-WHUJ].