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An Economically Rational Energy Policy for the United States

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Introduction

Hysteria makes for poor policy choices. For the past three decades, many politicians and the media have promoted inflated claims about the risks of climate change, many of which lack any scientific or empirical foundation.[1] To name just two dramatic claims, the entire disappearance of the Maldives because of rising oceans[2] and the end of snow in Great Britain[3] have failed to materialize. There is also a seemingly never-ending stream of long-term predictions about future catastrophes, including widespread famine from the collapse of agriculture, mass extinctions, and disease,[4] as well as earthquakes[5] and volcanic eruptions.[6] None appear to be based on empirical data, that is, on changes observed over the previous century as emissions increased greatly. Finally, there is a tendency to attribute individual weather events, such as the recent heavy rains in California, to climate change.[7]

The result has been a farrago of ill-conceived and unrealistic energy policies. In Europe, for example, many countries are experiencing energy price increases and shortages that are undermining the Continent's manufacturing and agricultural sectors, causing substantial financial and physical hardship for millions of citizens.[8]

In the U.S., rising energy prices and physical supply shortages have not reached European levels … yet. However, the Biden administration is intent on following the same failed energy policies—policies that will have little measurable impact on world climate but are already imposing long-term economic damage. Moreover, the U.S. share of world greenhouse gas (GHG) emissions is small enough and decreasing, so any reductions in GHG emissions that the current portfolio of laws and regulations may achieve will have little effect.[9] Even if one believes policies to address climate change are still crucial and that technological diffusion of low- or zero-emissions technologies will provide worldwide benefits, the current smorgasbord of green energy subsidies and mandates are likely the highest-cost means to achieve them.

Modern society requires ample supplies of reliable and affordable energy. Hence, a better approach is as follows:

- End all federal and state subsidies and mandates to generate electricity by wind and solar power. Assertions that these power sources can generate enough electricity to meet this country's demand are a fantasy for at least two reasons. First, the inherent intermittency of wind and solar generation cannot be overcome with existing battery storage technology, whether by large, utility-scale grid storage systems or by more recent proposals to use electric vehicles (EVs) to supply power to the grid when needed. Not only are the overall costs of providing battery storage prohibitive, but even under the most optimistic scenarios of declining battery storage costs, there are insufficient resources to manufacture batteries on the scale that would be required. Second, the inherent intermittency of windy and sunny days cannot be overcome with hydrogen-fueled generating plants. That technology, the infrastructure needed to store and transport hydrogen, and the ability to manufacture "green" hydrogen economically using surplus wind and solar generation don't exist.

- End all federal and state mandates and subsidies for EVs. The reductions in GHG emissions achieved by EVs will be minimal as long as the electricity required to charge them is generated from fossil fuels. Even if all EVs are charged solely with emissions-free electricity, the reduction in carbon emissions will have little measurable impact on world climate. If EVs truly are a superior and lower-cost technology than conventional internal combustion vehicles, as their proponents claim, then the EV market share will grow without subsidies or mandates. These vehicles will be adopted by consumers and, as adoption rates increase, the supporting charging infrastructure will be developed by the private sector. As for claims that forcing a rapid transition to EVs is needed to reduce local particulate emissions, some types of particulates come from tires and road wear, not tailpipes.[10]

- Eliminate the Renewable Fuel Standard (RFS), which has increased air and water pollution and raised food prices.[11] If midwestern politicians insist on subsidies for farmers who grow corn for ethanol and soya crops for biodiesel fuel, it would be far less costly and environmentally damaging to provide them with direct cash payments.

- Eliminate Corporate Average Fuel Economy (CAFE) standards, which are an inefficient approach to reducing gasoline consumption. The most recent increases in these standards—which will require automakers to increase miles-per-gallon (mpg) levels by almost 30% over 2022 levels by 2026—are unrealistic and serve only as an indirect mandate for EVs.

- Support nuclear power development by streamlining the regulations for siting new modular generation technologies. Increase research and development (R&D) funding for more advanced nuclear technologies, including fusion power. Address the issue of spent nuclear fuel by promoting fuel recycling, as is done in France.

- Stop demonizing fossil fuels, which have raised living standards worldwide to unprecedented levels. Given current technology, there are no economically viable substitutes for them. Developing nations whose primary objective is to improve economic growth and the welfare of their citizens will not abandon fossil fuels to assuage the fears in developed nations. Increasing natural gas production from this country's ample shale gas reserves, which were made economically extractable thanks to innovations in drilling technology, will, as it has already, reduce GHG emissions and improve air quality.

- End the fixation on "preventing" climate change and avoid climate hysteria. Climate change is not an existential threat. Rather, those who promote this hysteria are rent seekers: environmental groups that fundraise based on unsupported claims about civilization's impending end, and renewable energy developers and EV manufacturers who benefit from

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the massive subsidies they receive. A far better approach is adaptation to and mitigation of potential future damages that may be caused by a changing climate, such as gradual sea-level rise and higher temperatures.

Current Federal and State Energy Policies

The Biden administration has enacted at least three policies to restrict the production of fossil fuels in the United States. First, it has restricted new oil and natural gas leases on federal lands and in the Gulf of Mexico.[12] Second, it has promulgated rules to reduce methane emissions on private lands, especially in the Permian Basin of southeastern New Mexico and western Texas,[13] where there are huge supplies of natural gas and oil. These rules will restrict the production of fossil fuels on private lands. More recently, the president announced that he intended to shut down all coal-fired power plants,[14] which still supplied 20% of U.S. electricity in 2022.[15]

Third, the administration has expanded the RFS that began under the Energy Policy Act of 2005. The RFS mandates the increasing use of biofuels, ostensibly to reduce U.S. dependence on foreign oil and to reduce GHG emissions.[16] Initially, the RFS included only corn-based ethanol, but a revision to the RFS known as RFS2—enacted as part of the Energy Independence and Security Act of 2007—added mandates for cellulosic ethanol, biomass-based diesel, and other "advanced" biofuels. In 2022, these mandates totaled 36 billion gallons, of which corn-based ethanol is 15 billion gallons.[17] (On December 1, 2022, the U.S. Environmental Protection Agency (EPA) announced even higher renewable fuel standards.)[18] The cellulosic ethanol mandate has proven to be impossible to meet because there has never been enough raw material—switchgrass, wood, and crop residue. In 2020, 500 million gallons of cellulosic ethanol were manufactured; that year's mandate called for 10.5 billion gallons.[19]

In May 2022, the U.S. Department of Transportation's National Highway Traffic Safety Administration (NHTSA) introduced new CAFE standards for automobiles, which the agency admits will force the sale of more EVs. Hence, the new standards are effectively an EV mandate. The new standards require new cars and light trucks to average 49 mpg in the model year 2026 (58.1 mpg for passenger cars and 41.5 mpg for light trucks), a 28% increase over three years.[20] Automakers can earn "credits" toward the standard by selling more EVs. However, the fuel savings and emissions reductions that are the stated basis for the standards are much less than claimed. This is due to the rebound effect—when the cost of driving decreases because of higher fuel efficiency, individuals tend to drive more[21]—and the fact that most EVs are charged with electricity generated by fossil fuels.

At the same time, the Biden administration has excoriated major oil companies for allegedly colluding to raise retail gasoline prices, although these companies own only 1% of all retail gasoline stations,[22] and for failing to produce and refine enough petroleum to combat rising prices. The administration also has discussed imposing a windfall profits tax on oil companies, based on false claims of price gouging. In February 2023, Senator Edward Markey (D-MA) reintroduced the Big Oil Windfall Profits Tax Act, which would impose a 50% tax on the difference in the price of crude oil and the average price between 2015 and 2019. A windfall profits tax was enacted in the late 1970s in response to higher crude oil prices caused by the OPEC oil embargoes, but it was soon abandoned.[23]

More recently, California Governor Gavin Newsom asked the state legislature to impose a windfall profits tax on oil companies, which he, too, claims—without evidence—are price gouging.[24] The administration also drained the Strategic Petroleum Reserve (SPR) in an effort to combat rising retail gasoline prices. In January 2021, the SPR contained about 640 million barrels of crude oil. By mid-January 2023, the SPR contained fewer than 372 million barrels, the lowest level since 1983.[25] And in February 2023, the administration announced its intent to withdraw an additional 26 million barrels by the end of this year.[26] Although gasoline prices fell by the end of 2022 from their highest levels that June, they remain about one dollar per gallon higher, on average, than in January 2021.

Meanwhile, on the state level, California and New York have banned hydraulic fracturing, the technology that enabled the shale gas revolution in this country. Yet shale gas nationally contributed to the rapid transition away from electricity produced from coal and enabled a 20% reduction of CO_2 emissions below 2005 levels. California banned all offshore oil and gas drilling, as well as (along with New York) the sale of new internal combustion vehicles beginning in 2035. Several states, including California, New Jersey, and New York, are also considering "electrification" mandates requiring consumers and businesses to replace gas and oil furnaces and to equip water heaters with electric heat pumps.[27]

Numerous cities, including Berkeley, Denver, Seattle, and New York, have banned natural gas hookups in new homes and commercial buildings. Last fall, a commissioner on the U.S. Consumer Product Safety Commission (CPSC) announced that the agency was considering a complete ban on the sale of gas stoves because of their impact on indoor air pollution.[28] Public outrage led the CPSC to deny such a ban was being contemplated, although California has already banned the sale of gas stoves beginning in 2030.[29]

While continuing to demonize fossil fuels, the Biden administration and select state governments persist in subsidizing and mandating renewable energy. Many states, for example, have enacted renewable portfolio (fuel) standards that require increasing percentages of total electric generation from renewable resources. More recently, some have imposed specific requirements, such as New Jersey Governor Phil Murphy's 2022 executive order that there be 11,000 megawatts (MW) of offshore wind by 2040[30] or New York's 2019 Climate Leadership and Community Protection Act, which requires 9,000 MW of offshore wind by 2035.[31]

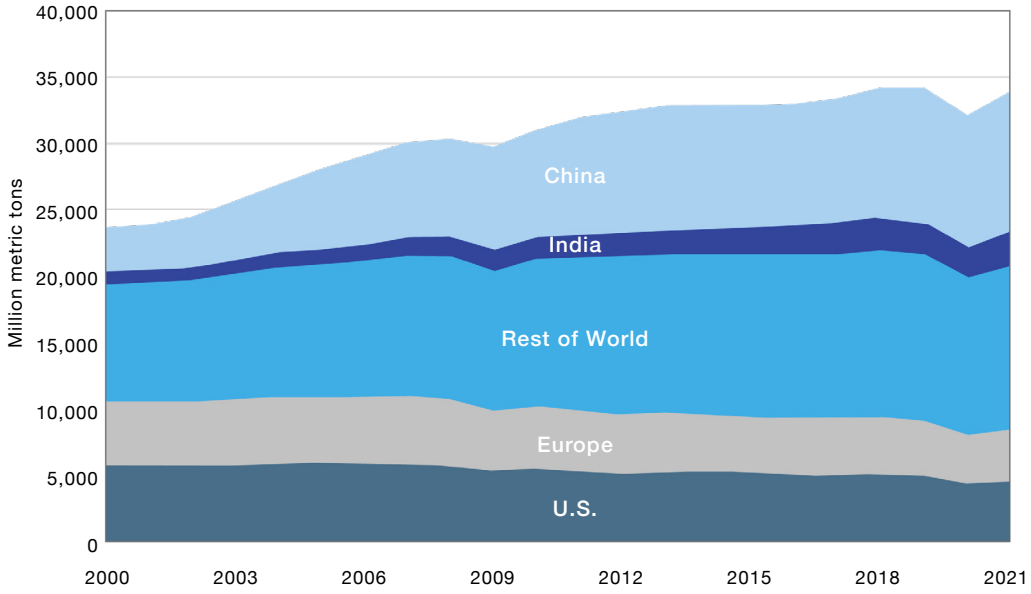
Coupled with mandates are additional subsidies for wind and solar generation. Offshore wind projects, for example, can reap the benefits of both the 30% federal investment tax credit and the wind production tax credit, which now stands at about $26 per megawatt-hour (MWh). States seeking to develop offshore wind projects have also offered other subsidies such as manufacturing credits and port facilities to stage construction. States including Massachusetts, New Jersey, New York, and Rhode Island have awarded long-term agreements to wind developers to purchase the electricity they generate at above-market prices, which will raise retail electric rates, harming citizens and businesses.[32]

Developers of wind and solar generation facilities are further subsidized because they do not pay for the costs of additional backup generation (reserve margin) that is required when the wind doesn't blow or the sun doesn't shine. Nor do they pay the costs of additional measures to ensure that power systems can compensate for variable production while maintaining voltage and frequency within acceptable ranges.[33] Meanwhile, the deceptively named Inflation Reduction Act of 2022 provides $369 billion in tax credits for a wide variety of climate-related programs, from carbon capture to hydrogen production,[34] as well as credits for battery storage facilities that are supposed to counter wind and solar intermittency.

Collectively, these policies are supposed to mitigate climate change. But the declining U.S. share of global GHG emissions—less than 14% in 2021 (**Figure 1**)—means that even if this country's GHG emissions fell to zero overnight, the effect on world climate would be minimal, as John Kerry, President Biden's climate "czar," himself stated.[35,36]

Figure 1

World CO2 Emissions, 2000–21



Source: *BP Statistical Review of World Energy 2022*, **p. 12**

Unlike the U.S. and Europe, carbon emissions from non-OECD nations (i.e., the developing world), especially China and India, are increasing rapidly as their economies grow. Instead, these nations are adopting "promises" to begin reducing emissions decades from now. China, for example, has promised to reduce emissions beginning in 2060, India in 2070. It is unrealistic to believe that developing nations will reduce GHG emissions that will limit their economic growth and condemn their citizens to immiseration. Some argue that it is also unfair.[37] What this means is that world GHG emissions are likely to increase for decades, regardless of actions taken by developed nations.

What Should U.S. Energy Policies Achieve?

Politicians often embrace a "just do something" approach to problems, real or perceived, regardless of whether their "solutions" will be effective or even counterproductive. In some cases, the policy objectives are never clearly spelled out.

Since the first OPEC oil embargo 50 years ago and long before climate change occupied international attention,[38] U.S. energy policies have been distinguished primarily by an utter failure to achieve their publicly stated objectives.[39]

Moreover, when it comes to the objectives of energy policy, candor and consistency are often at odds. In 2008—before the shale gas revolution that unlocked huge new supplies of natural gas and crude oil—Steven Chu, who would become President Barack Obama's secretary of Energy, said, "Somehow we have to figure out how to boost the price of gasoline to the levels in Europe" to "decrease our dependency on oil, to build and strengthen our economy."[40] In 2012, Chu retracted his remarks, saying he wanted to lower gasoline prices. Many politicians, including President Biden, have stated that high prices for fossil fuels are necessary to hasten the transition from fossil fuels—though when gasoline prices skyrocketed as a result of his inflationary economic policy, he excoriated oil companies for high gasoline prices.[41]

It is an economic truism that as the price of a product rises, its consumption will decline and the demand for substitutes will increase. One could adopt green energy policies that increased fossil fuel prices artificially to reduce consumption, such as through a carbon tax. Similarly, one could adopt mandates that prohibited fossil fuel consumption, either directly or by mandating increased reliance on non-fossil fuel alternatives.

From a purely economic standpoint, taxes are more efficient than mandates and subsidies, in that taxes allow consumers to adjust their consumption based on relative prices and their own preferences. Yet relatively few U.S. politicians have embraced either higher fuel taxes or a carbon tax, and efforts to impose the latter in the U.S. have failed.[42] Instead, the policies of choice have been mandates together with subsidies needed to achieve those mandates.[43]

However, a key problem discussed in this report is that large-scale deployment of wind and solar generation is not economically viable. Both have higher costs than fossil fuels (despite proponents' claims to the contrary) and provide power only intermittently. The cost of backup resources—whether by generation or storage—to address that inevitable problem is rarely acknowledged by wind and solar proponents.

In any event, wind and solar power aren't as environmentally friendly as their proponents claim. Wind turbines are responsible for killing millions of raptors and bats each year, for example.[44] There is growing resistance to siting wind turbines along the Eastern Seaboard because of the adverse impacts on the endangered North Atlantic right whale[45] and commercial fisheries.[46] Large-scale solar photovoltaic panels can affect ground-dwelling species and prevent the use of productive agricultural land.[47] Solar panels, wind turbines, and batteries require huge quantities of raw materials that must be mined and processed, which today are sourced from countries whose environmental laws are more lax than those in the United States.[48] Disposing no-longer-usable wind turbine blades and solar panels, the latter of which contain various heavy metals that can leach into groundwater supplies, remains a problem.[49]

Economic well-being in any modern society requires affordable and reliable energy. The recent experience in nations such as Great Britain shows that high prices and scarce supplies create economic hardship: industries, such as fertilizer manufacturers, have been devastated by soaring energy prices, while millions of individuals face the prospect of literally freezing in the dark.[50]

Hence, the first question is whether the most important policy objective for the U.S. is to improve the economic well-being of its residents. That may seem a trivial question whose obvious answer is yes. It is not. The World Economic Forum, for example, has discussed the merits of "degrowth," which means "shrinking, rather than growing economies, to use less of the world's dwindling resources."[51]

A discussion of the reasonableness of the degrowth movement is far outside the scope of this report. What seems clear, however, is that most nations, especially developing ones, will not knowingly accept immiseration of their citizens to "save" the planet.[52] Nor does it seem likely that the U.S. public will embrace economic stagnation, much less the deliberate reduction of their living standards.[53] Yet experience shows that economic growth and environmental improvement are not opposites, as some suggest,[54] but are instead complementary: wealthier nations can afford stricter environmental standards and, as individual wealth increases, so does the demand for environmental quality.

Given this reality, this report assumes that the most reasonable energy policy objective for the U.S. is to provide plentiful and reliable supplies of energy, at the lowest possible cost, with as low an environmental footprint as possible. The next section considers how this country can achieve that objective and why current energy policies will fail to achieve it.

Rational and Irrational Energy Policies

Under the current presidential administration, as well as in numerous states, the sine qua non of energy policy is to achieve net-zero GHG emissions by replacing fossil fuels with renewable energy resources, primarily wind and solar power, as well as biofuels.[55]

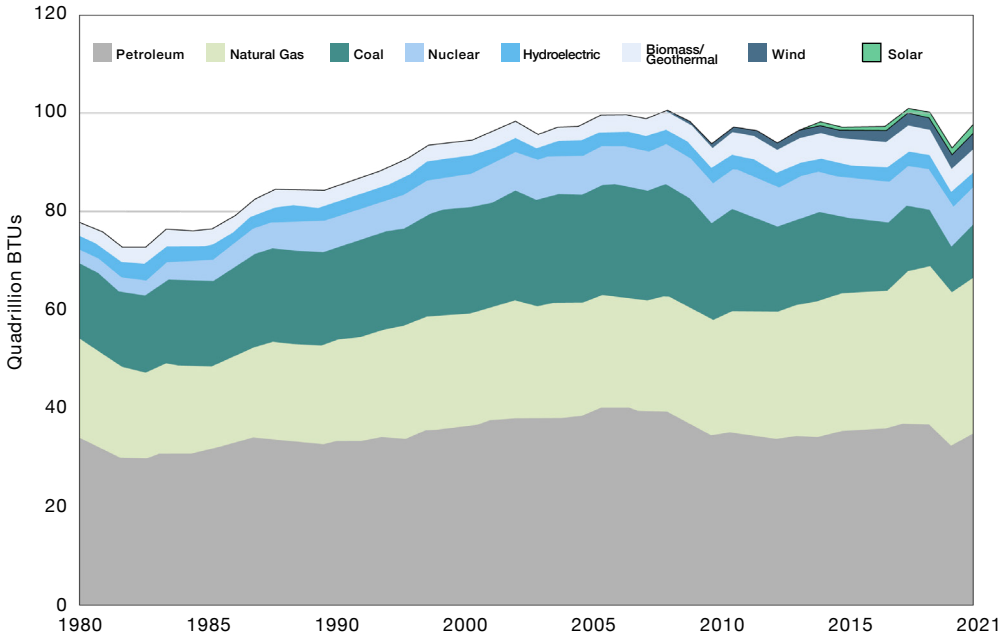
The primary means that supposedly will achieve this result are subsidies and mandates for wind and solar energy, as well as for battery storage facilities; mandatory adoption of EVs, together with subsidies that encourage their purchase and support the development of a nationwide charging infrastructure; and mandatory fuel switching in residential homes, multifamily dwellings, and businesses to eliminate the use of fossil fuels for space and water heating as well as cooking. The Inflation Reduction Act provides subsidies for manufacturing hydrogen and the infrastructure needed to transport it.[56]

Federal renewable energy subsidies were first adopted under the Public Utilities Regulatory Policy Act of 1978 (PURPA) and have since been expanded with the provision of investment and production tax credits. Since the enactment of PURPA, 29 states and the District of Columbia have adopted renewable portfolio standards that call for supplying increasing percentages of renewable energy. Nevertheless, the goal of replacing fossil fuels with renewables remains far off. As discussed in this report, given existing technology, this goal is unachievable, assuming the objective remains plentiful, reliable energy supplies.

In 2021, total energy consumption was about 98 quadrillion BTUs (Quads) (**Figure 2**). Of that total, non-hydroelectric renewable energy provided just under 10% of total U.S. energy consumption; fossil fuels provided about 80%. (Nuclear power, hydroelectric power, and other renewables provided the remainder.) Because there is little additional hydroelectric capacity that can be developed and limited potential for geothermal and biomass expansion, wind and solar energy electricity generation would need to increase by a factor of 10 to replace fossil fuel consumption, even before addressing reliability issues caused by solar/wind intermittency that will require significant overbuilding of capacity and massive amounts of electricity storage.

Figure 2

U.S. Energy Consumption by Source, 1980–2021



Source: Compiled by the author from U.S. Energy Information Administration, *Monthly Energy Review,* Table 1.3, January 2023

Current State and Federal Energy Policies Are Inefficient and Inequitable and Will Not Achieve Their Goals

Measured against the policy objectives of ample and reliable energy supplies at the lowest possible cost and with the lowest environmental footprint, state and federal green energy mandates that seek net-zero carbon emissions cannot be achieved with existing technology. Even if, hypothetically, these policies could achieve net zero and eliminate the consumption of fossil fuels, they are likely the costliest way of doing so.

Green Energy Subsidies and Mandates

Subsidies and mandates distort markets and act primarily as mechanisms to transfer wealth from consumers to the favored few who benefit.[57] Because both measures insulate suppliers from market forces, they reduce the economic incentive to innovate and to lower costs. Forcing consumers to purchase an otherwise unwanted product does not provide suppliers with an incentive to innovate.[58] Rewarding consumers for purchasing a product they would purchase anyway is a waste of money. Electric utilities have been required to purchase wind and solar power generation developed by independent suppliers since 1978, whether under the guise of

PURPA or more recent state renewable portfolio standards. Moreover, subsidies for wind and solar power are undermining competitive wholesale electricity markets.[59] Prices become more volatile—extremely low when there is surplus solar and wind generation and extremely high when there is none—which makes it more difficult for unsubsidized fossil fuel generation to survive economically.

Subsidies and mandates for EVs also act as wealth-transfer mechanisms. Just as colleges and universities responded to more lavish government loan subsidies for students by hiking tuition, EV subsidies can provide a convenient umbrella for manufacturers to raise their prices and capture a portion of the subsidies that supposedly benefit consumers.[60] Additionally, EVs continue to be far more costly than their internal combustion counterparts. Consequently, EVs are primarily purchased by the most affluent consumers. According to Kelley Blue Book, the average price of an electric car was more than $65,000 last fall—$17,000 more than an average gas-powered vehicle.[61] In a 2021 survey, the average income of EV purchasers was $150,000, more than double the median household income.[62]

EV prices are also rising because of higher materials and manufacturing costs. To take one example, when Ford first announced its all-electric Lightning pickup in May 2022, the price was $45,000 for the lowest-cost model. The current price for that same model, available this year: $58,000.[63] The least expensive "extended range" version—320 miles under ideal conditions but less than 100 miles when towing a large trailer[64]—has a sticker price of $81,000. The lowest-cost 2023 Tesla Model 3 has a sticker price of $44,000,[65] while the 2023 Model X has a starting price of just under $112,000.[66] EV manufacturers are de-emphasizing low-cost models to focus on selling higher-cost, more profitable ones.

Because EVs avoid paying federal and state gasoline taxes used to maintain roads and highways, the costs of doing so are transferred to consumers who cannot afford EVs and their related charging infrastructure. The Congressional Research Service estimated that cumulative federal tax credits for EVs through fiscal-year 2022 would total about $10 billion.[67]

The Argonne National Laboratory estimates that the *cumulative* reduction in CO_2 emissions from EVs through calendar-year 2021 was 19.1 million metric tons.[68] Hence, the cost of those reduced CO_2 emissions—excluding all state subsidies for EVs, plus indirect subsidies for EV charging infrastructure—exceeds $500 per metric ton, more than double the most recent estimates of the so-called social cost of carbon (SCC), which purports to measure the damage caused by each additional ton of carbon emitted into the atmosphere.[69] The most *current* average estimate of the SCC, prepared by Resources for the Future, is $185 per ton (more than three times higher than the current value of $51 per ton that has been used previously by the EPA)[70] and equivalent to $1.79 per gallon of gasoline.[71]

Green energy subsidies and mandates also impose additional network costs that their proponents either discount or ignore entirely. The inherent intermittency of wind and solar energy requires substantial quantities of backup generation, called installed reserve margin (IRM),[72] or storage to compensate for their unavailability on cloudy, windless days and at night. The New York State Reliability Council, for example, estimates that IRM will need to increase from the current 20% of available supply to over 100% by 2040 to achieve that state's net-zero mandate.[73]

Today, natural gas-fired generators typically provide reserve capacity because they can be cycled on and off quickly (the power is called dispatchable), unlike baseload generators such as coal and nuclear plants, which are designed to run continuously. Hence, net zero will require either huge quantities of dispatchable emissions-free resources (DEFRs) or battery storage.

DEFRs, proponents claim, will be powered by "green" hydrogen, produced via the electrolysis of water. No such generators exist today because the technology has yet to be invented (see the sidebar "DEFRs and Green Hydrogen"). No commercial facilities exist that produce hydrogen via electrolysis using electricity generated solely from wind and solar resources.[74] Nor do proponents consider the costs of developing the infrastructure (transmission pipes and storage facilities) for the hydrogen needed to power DEFRs.

DEFRs and Green Hydrogen

Dispatchable generators enable power to be ramped up and down in real time to ensure that electricity supply always equals electricity demand. The only DEFRs that exist today are large hydroelectric storage dams and pumped storage hydro facilities. Few, if any, new hydroelectric storage dams are likely to be constructed in the U.S., and there will be few opportunities to construct pumped storage hydro facilities, which are refilled when electricity demand is low and used to meet peak demand.

Proponents envision new DEFRs that will burn pure hydrogen made from surplus wind and solar power. These DEFRs would look like conventional natural gas-fired generators. But one cannot simply substitute hydrogen for natural gas, because hydrogen is far less dense and provides much less energy per unit of volume. As such, the combustion chamber and related equipment must be completely redesigned.

Then there is the problem that hydrogen embrittles steel, so a generator must be designed with other materials to prevent the metal from cracking under pressure. That also applies to the infrastructure (pipelines, storage tanks, etc.) that is used to deliver hydrogen from where it is manufactured to the generators that use it. As such, the U.S. system of natural gas pipelines could not be used to transport hydrogen. Instead, an entirely new pipeline infrastructure would need to be built.

Finally, there is the problem of manufacturing hydrogen. Currently, most hydrogen is produced by reforming natural gas.[a] Using natural gas to manufacture hydrogen to then burn in a turbine is far less efficient than just burning natural gas directly. Thus, hydrogen proponents envision manufacturing "green" hydrogen from surplus wind and solar power by electrolyzing (running a current through) water. However, producing hydrogen by using electrolysis is about three times more costly than by reforming natural gas. No commercial electrolysis plants yet exist.

[a] For a discussion of the manufacturing process, see U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, "Hydrogen Production: Natural Gas Reforming" (undated).

As for battery storage, the scale of storage capacity needed to provide reliable electricity even for short periods when there is neither wind nor solar generation available is staggering.[75] As an example, consider the New York Independent System Operator's (NYISO) most recent forecast of electricity consumption and peak demand for 2040.[76] NYISO forecasts total state electricity consumption in 2040 of about 184,000 gigawatt-hours (GWh), or 504 GWh per day. Hence, to provide enough electricity for just one cloudy, windless day, the total battery capacity would need to be 504 GWh of electricity.[77] By way of comparison, NYISO projects that, in 2040, the state will have 9.6 gigawatts (GW) of battery capacity—less than two hours of backup power on an average day.[78]

Today, utility-scale battery storage facilities typically provide four GWh hours of electricity for each GW of capacity. Hence, 504 GWh requires 126 GW of battery capacity.[79] The National Renewable Energy Laboratory projects that battery storage costs in 2040 will be between $125 and $250 per kilowatt-hour (kWh) in 2020 dollars.[80] Thus, 504 GWh of storage would require spending $63 billion in 2020 dollars under the most optimistic conditions.[81,82] In contrast, a 1,000 MW nuclear plant producing 8,000 GWh of electricity each year would cost around $5 billion to build.[83] Estimates of the cost of sufficient battery storage for the entire U.S. vary, depending on the amount of storage assumed. One detailed estimate is around $23 trillion.[84]

Renewable Fuel Standard

The RFS is another example of political largesse masquerading as environmental policy. Although the RFS was not enacted until 2005, the push for renewable fuels was originally justified on energy security grounds after the OPEC oil embargoes of the 1970s and subsequently justified on air-quality grounds.[85] These initial efforts focused on increased subsidies for the production of corn ethanol to be blended with gasoline. The RFS expanded the scope of renewable fuels to include so-called cellulosic ethanol, made from sources such as switchgrass, biomass-based diesel, and other so-called advanced fuels.

But the RFS has led to increased air and water pollution[86] and raised the cost of food by diverting 40% of the nation's corn production to ethanol.[87] The environmental benefits of biofuels generally are also questionable.[88]

The RFS mandate for biodiesel also has adverse economic impacts, as some oil refineries have closed to convert to biodiesel production. Biodiesel also is more costly to produce than traditional diesel fuel, which contributes to higher prices that have broad economic impacts by raising the costs to transport goods.[89] As with corn-based ethanol, biodiesel production diverts crops, such as soy, to fuel production, which increases food costs.

Although biodiesel CO_2 emissions are estimated to be as much as 69% lower than conventional diesel,[90] the overall reductions in CO_2 emissions arising from the EPA's biodiesel mandate, which will increase to about 3 billion gallons in 2025, is a negligible fraction of total U.S. emissions: about 21 million metric tons per year, or less than 0.5% of total energy-related CO_2 emissions.[91] Put another way, this reduction is equivalent to just over five hours of the 39.2 billion metric tons of world CO_2 emissions in 2021.[92]

CAFE Standards

To promote energy independence, the Energy Policy and Conservation Act of 1975 imposed CAFE standards that took effect for light-duty passenger cars in 1978 and for light trucks in 1979. In 2007, the U.S. Supreme Court determined that the EPA could regulate GHG emissions from new motor vehicles as "air pollutants."[93] Since then, CAFE standards have revolved around GHG emissions, not energy independence.[94]

In 2020, the EPA adopted fleet-wide CO_2 compliance targets, which translate into CAFE requirements: lower CO_2 emissions per mile require greater mpg. The CAFE standards announced in May 2022 will not only reduce allowable CO_2 emissions by almost 30% below those of the 2022 model year; they will also effectively require automobile manufacturers to sell increasing percentages of EVs to meet the new standards. NHTSA estimates that, over the period 2026–50, the new standards will reduce CO_2 emissions by 605 million metric tons,[95] an average of about 24 million metric tons per year. That is equivalent to just over six hours of world CO_2 emissions in 2021. Thus, although the NHTSA analysis of the new CAFE standards purports to demonstrate net monetary benefits to consumers,[96] the new standards clearly will have no measurable impact on world climate.

A Valid Framework for Evaluating Energy Policies

Government energy policies should be subject to rigorous cost-benefit analysis before they are implemented, but often they are not.[97] Unfortunately, even if subsequent analyses demonstrate that a program is not cost-effective, modifying it can be difficult because the costs are dispersed to the populace at large, while the benefits are concentrated among relatively few.[98] Regulatory capture also contributes to the difficulty of changing policies whose costs exceed their benefits.[99]

Although a few analyses of wind and solar energy have been conducted, they routinely find policies that favor these energy sources to be beneficial owing to the assumed environmental and health benefits of the SCC. However, SCC estimates suffer from both empirical and theoretical flaws and are subject to ongoing dispute.[100] Moreover, SCC estimates do not address the distribution of carbon reduction benefits, the vast majority of which accrue outside of individual states and the United States. Thus, while consumers fully bear the higher costs of green energy resources, they realize almost none of the benefits. Such distributional impacts can have adverse effects on consumer welfare, especially for lower-income consumers who spend a greater percentage of their income on energy than higher-income consumers.

The magnitude of the SCC effectively predetermines that almost any policy found to reduce fossil fuel consumption and carbon emissions will have positive net benefits. Yet even if one accepts the SCC estimates as valid, a showing of positive net benefits is insufficient. Instead, one should identify the policies providing the *largest* net benefits. Once again, that seems an obvious point, yet it is almost unheard of when determining state and federal energy policy choices.

Six Components of a Rational U.S. Energy Policy

The first component is to eliminate the RFS. As discussed previously, the earliest renewable fuel standard mandate was for corn-based ethanol, which consumes 40% of this country's total corn production and is broadly recognized to harm the environment because it increases fertilizer runoff that pollutes rivers and streams; it also harms low-income citizens by raising food prices. If politicians in corn-growing states insist on subsidizing farmers who grow corn, cash transfers are a simpler, lower-cost alternative. Similarly, cellulosic ethanol and biodiesel fuels are expensive to produce and provide virtually no environmental benefits.

Second, the U.S. should repeal the CAFE standards. The standards are inefficient because they distort vehicle markets and act as an indirect subsidy for EVs. If policymakers are truly concerned about the environmental costs of fossil fuel vehicles, the most efficient approach would be to increase taxes on gasoline and diesel fuel. Alternatively, although less economically efficient, the government could subsidize more efficient internal combustion vehicles (ICVs).[101] As for efforts to impose a broad-based carbon tax on fossil fuels, including taxing imported products based on their supposed carbon footprint (border tax adjustment), such a tax is fraught with pitfalls, not the least of which are the problematic estimates of the SCC (see the sidebar "Carbon Tax Pitfalls").

Carbon Tax Pitfalls

Although a detailed discussion of a carbon tax is beyond the scope of this report, the idea behind it is simple in principle: impose a tax on the carbon content of the energy used to produce goods and services, which will encourage reductions in carbon emissions and innovation toward lower-carbon technologies. In that sense, a carbon tax encourages lowest-cost approaches to reducing emissions versus higher-cost administrative mandates, such as for renewable generation, EVs, and so forth.

In theory, the tax would be set to a value equal to the calculated cost of future carbon emissions.[a] Hence, whatever the SCC value is determined to be, the market prices of fuels will reflect both the private cost and this "social" cost. As discussed in the body of this report, an SCC value of $185 per ton is equivalent to a tax of $1.79 per gallon of regular gasoline. Assuming the tax was placed on other GHGs, such as methane, based on their "carbon equivalency," prices for all goods and services would rise.

Determining border tax adjustments would be extremely complex and burdensome because many products contain inputs from multiple countries, all with different energy mixes. For example, determining how much energy was used to produce all of the parts sourced from multiple countries and to assemble a car in Mexico would be an administrative nightmare—as would sorting out disputes over border adjustments that arise between countries, as they almost surely would.

Whatever the level it was set to, a carbon tax would be regressive, affecting low- and middle-income citizens more than the wealthy because of its impact on basic necessities such as food, light, and heat. That is why some have proposed "recycling" carbon taxes collected, that is, providing rebates to everyone based on estimates of what they paid in carbon taxes. Again, the administrative complexity would be significant and the opportunities for meddling by politicians likely irresistible.

Finally, there is the issue of setting the value of the tax itself based on estimates of the SCC, which are inherently arbitrary. Restructuring an entire economy based on models that make arbitrary and untestable assumptions about the future impacts of carbon emissions would likely do far more economic harm than good.

[a] In economic parlance, this is called a Pigouvian tax, after the early-20th-century British economist Arthur Pigou. The tax is set to the marginal social cost of additional emissions.

Third, the Biden administration should end the economic disincentives it has created for the exploration and production of more oil and natural gas and should cease excoriating companies that fail to produce more gasoline. Companies, especially capital-intensive ones, will not invest in long-lived projects, such as new refinery capacity, if the government creates uncertainty about the returns on those investments. Demonizing fossil fuel companies, while simultaneously criticizing these companies for not increasing production to lower prices, is political demagoguery.

The U.S. fossil fuel industry is far more environmentally responsible than industries in foreign countries, such as Venezuela. Increased domestic production of oil and natural gas will increase energy security and reduce costs. Relying on foreign countries to produce these jeopardizes this country's energy security.

Fourth, federal and state governments should end all subsidies for EVs and related charging infrastructure, which overwhelmingly benefit high-income earners at the expense of everyone else. The adoption of EVs will have minimal impacts on carbon emissions when compared with new ICVs.[102] In any event, EV manufacturing is far more materials-intensive, hence carbon-intensive, than manufacturing ICVs.[103]

Fifth, subsidies for large-scale wind and solar generation should be ended, as should subsidies for battery storage facilities. Wind- and solar-generated electricity have low power density. They require huge amounts of land. The negative environmental impacts of wind, especially killing bats crucial for pollination[104] and large raptors, are substantial. Offshore wind development is likely to have significant adverse impacts on commercial and sport fisheries and endangered whales, including the North Atlantic right whale, which is on the verge of extinction. Eliminating subsidies for wind and solar energy will reduce distortions in wholesale electric markets. The subsidies allow these generators to bid negative prices while still remaining profitable and create more volatile market prices—low when wind and solar are generating power and high when they are not. Eliminating wind and solar energy subsidies will also reduce the need for further subsidies for nuclear power plants.[105]

The intermittency of wind and solar requires vast quantities of backup power if electric supplies are to remain reliable. Current battery storage technology is not viable, because the amount of battery storage required for a wind- and solar-based electric grid is enormous and the costs are prohibitive.

Sixth, the U.S. should increase R&D investment in advanced nuclear power technologies and reduce the regulatory and institutional barriers to building new nuclear plants. Those barriers include an inability to develop a permanent site for nuclear waste storage owing to environmental fears; inordinate fears that nuclear waste recycling, as has been practiced in France for decades, will create opportunities for terrorists; and changes in safety requirements midway through generator construction that delay plant completion and increase costs. Although nuclear power is emissions-free, many environmental groups continue to be opposed to the technology, viewing it as too dangerous. However, new small modular nuclear plants are well designed, safe, and reliable and can be developed as electricity demand increases, thus avoiding both "bet-the-company" investments and large, sudden increases in prices (rate shock). R&D funds should also be directed to fusion power, which relies on fuel made from seawater and produces no radiation. Barring technological breakthroughs, the prospects for commercialization of fusion plants remain decades away—but the technology holds long-term promise. Another potential area for R&D is space-based solar power, which would enable the round-the-clock provision of electricity and avoid issues associated with solar's large land requirements.

American policymakers should end their obsession with reduced carbon emissions because policies to bring this about will have minimal impacts, if any, on world climate. Instead, they are likely to cripple the U.S. economy by raising electricity prices, as has been experienced in Europe. An energy policy that allows consumers to make their own choices about end-use fuels, emphasizes natural gas production and nuclear power, and supports basic R&D efforts for new, cost-effective energy technologies will provide greater economic growth and well-being in the long run than the current mix of subsidies and unrealistic mandates. Successful R&D investments can be transferred to other countries, enabling them to improve environmental quality without sacrificing their economic growth goals.

Endnotes

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[16] U.S. Environmental Protection Agency (EPA), "Renewable Fuel Standard Program," September 2022. For a detailed history of ethanol mandates, see Caley Johnson et al., "History of Ethanol Fuel Adoption in the United States: Policy, Economics, and Logistics," National Renewable Energy Laboratory, November 2021.

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[19] U.S. Department of Energy, Alternative Fuels Data Center, "RFS2 Mandates and Net RINs Generated for Cellulosic Biofuels," December 2022.

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[21] Christopher Douglas, "The Costs and Benefits of CAFE Standards," Mackinac Center for Public Policy, Oct. 3, 2022.

[22] Garrett Golding and Lutz Killian, "Don't Look to Oil Companies to Lower High Retail Gasoline Prices," Federal Reserve Bank of Dallas, May 10, 2022.

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[33] For an introduction, see Frank Graves, "A Primer on Electric Power Flow for Economists and Utility Planners," Electric Power Research Institute, Report TR-104604, February 1995.

[34] "What's in the Inflation Reduction Act?" *National Law Review* 13, no. 2 (Jan. 27, 2023).

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[36] If U.S. emissions fell to zero, total world CO_2 emissions would decrease to just over 29 billion metric tons, about the same as emissions in 2006. Since 2010, the average annual increase in emissions from non-OECD countries has been 417 million tons. At that rate, those countries' emissions would replace the entirety of U.S. emissions in 12 years.

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[38] In the mid-1970s, global cooling, caused by burning fossil fuels, was the crisis of the day and eliminating fossil fuels was the solution. Thus, while the crises have changed, the solution has remained the same.

[39] For a detailed discussion, see Grossman, *U.S. Energy Policy and the Pursuit of Failure.* The appendix presents a model of the "do something" decision framework, based on a politician whose primary goals are to be elected and then reelected.

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[43] A discussion of the welfare losses associated with mandates and subsidies, versus the welfare losses of taxes, is beyond the scope of this report. In general, because mandates do not allow for consumer adjustments based on relative price changes, as taxes allow, the welfare losses will tend to be larger.

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[59] For an explanation, see Jonathan Lesser, "The Biden Administration's Offshore Wind Fantasy," Manhattan Institute (February 2022): 10–11.

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